Satellite Monitoring of Environmental Laws
Lessons to be learnt from Australia

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Contents

Executive Summary 1

Summary of Recommendations 5

Chapter One  Introduction to the project and report 9
Chapter Two  Satellite monitoring and its cost 19
Chapter Three  Vegetation clearance legislation in Australia 33
Chapter Four  Enforcement and the use of satellite monitoring 48
Chapter Five  The use of satellite imagery in courts 60
Chapter Six  The effectiveness of satellite monitoring for vegetation compliance 81
Chapter Seven  Attitudes towards vegetation clearance and the legislation 91
Chapter Eight  Awareness of satellite monitoring and impact on behaviour 101
Chapter Nine  Acceptance of satellite monitoring by regulated communities 119
Chapter Ten  Future monitoring and enforcement applications 139

Summary of Recommendations 154

Annex A  Project sponsor and members of the advisory board 158
Annex B  Interviewees 159
Annex C  Bibliography 160
Annex D  Key legislative provisions relevant to satellite monitoring 183
Annex E  Selected court decisions in Australia where satellite imagery was used 189
Annex F  Information about the survey 207
Annex G  Copy of the survey 213
Executive Summary

Current methods of monitoring and enforcement have made a substantial contribution to protecting the environment, but may not be so well suited to meeting future challenges. Those charged with environmental regulation are faced with an increase in the number of laws, which are applicable to a greater number of people. Given public sector finance constraints, we may have to devise new regulatory responses. There could be growing interest in whether satellite technologies could provide a cost effective legal tool in inspection and compliance regimes for next-generation environmental regulatory systems.

Satellite monitoring of environmental laws is still more theoretical than applied, its use having largely been limited to detecting fraud in the agricultural sector. Understanding amongst European Governments of the potential of using satellites in regulatory strategies is insufficient at the current time, because the development of satellites has been almost exclusively technology led to date. There has been little communication between the space sector and those in the legal field as to the immense improvements that have been made in what satellites can see, and consequently development of applications for use in an enforcement context has been stifled. The lack of empirical evidence on operational experiences and costs available to regulatory bodies has meant that there has been a poor level of the use of satellite technologies in regulatory strategies, relative to its full potential.

The use of satellite technologies by Australian regulators to combat illegal vegetation clearance is the first international example where satellites have been systematically used to monitor compliance with a specific environmental law. Australian regulators use satellite imagery to check legislative compliance, by analysing it to determine whether and when vegetation was cleared. They look for relative changes in vegetation response between two satellite images of the same location with different capture dates. Comparative images can show that the vegetation clearing took place between the first image date and the second. If the satellite image shows that an offence might have occurred, regulators can then take a decision as to whether to direct resources to further investigations.

Australia has been using satellite data in a regulatory context for about ten years and there have been a significant number of cases where imagery has been used in the courts. Many lessons can be learnt from Australia which could be useful to regulatory bodies in Europe. This is particularly so because Australia has a federal legal system, so each State has a different experience of designing and implementing satellite monitoring programmes for vegetation clearance. The experiences of each of three States examined in this report throws further light on the operational effectiveness and cost of using satellite technologies in a regulatory context.

State Governments in Australia acquire imagery from medium-resolution satellites, as it is relatively cheap and has good geographical coverage. Whilst this gives them a state-wide picture of land-use change, there can be difficulties in using such data in court. Experience has shown that medium and low-resolution satellite imagery of this type can be confusing to non-technical people, such as judges, as it can look blurry. In two States, if monitoring data from the medium-resolution satellite detects a potential offence, the Government might then purchase high-resolution imagery. It is particularly purchased if it is likely that a prosecution will proceed, as high-resolution imagery is more photograph-like in image quality, and can be more easily understood by laypeople in court. One Australian State has invested substantially more money in their monitoring programme and purchases state-wide high-resolution imagery on an annual basis.

Ad-hoc acquisition of high-resolution imagery can seem expensive, costing States approximately (AUS) $2000 for each image. However, as only in the region of five to ten cases might go to court each year, this could represent a net annual spend of approximately (AUS) $10,000 to 20,000. New South Wales, has a state-wide programme of monitoring using high-resolution SPOT imagery, costing in the region of (AUS) $2.5 million a year. Whilst numbers of court cases remain at current levels, buying high-resolution imagery as and when it is needed to corroborate evidence from medium-resolution satellites is therefore relatively cost-effective.

Buying the satellite data is not the only significant expense of a satellite monitoring programme. There are also costs associated with the recruitment and training of analysts, as well as purchasing computer hardware and data storage facilities. In New South Wales their vegetation monitoring programme costs approximately (AUS) $6,500,000 a year. However, the South Australian vegetation programme, which has less staff and fewer imagery costs, costs in the region of (AUS) $2,000,000 a year. This illustrates that satellite monitoring will in some ways be as expensive as a regulator wants it to be.
Purchasing satellite data will be more cost-effective if it can be used by others, or used for multiple purposes. Governments in Australia are always looking to find new ways in which the imagery might be used. Coordinating bodies have been established to champion and support activities in this field. Image purchasing is treated in a similar fashion, to obtain discounts for bulk buying and to make sure that the same or similar imagery is not purchased over and over again by different arms of Government.

A number of factors have influenced why Australia has used satellite technologies in environmental regulation before other countries, but the most significant is that they could not otherwise adequately monitor vegetation clearance. Satellite monitoring is the only feasible way to get land cover information over very large areas. Using traditional methods of detection, such as physical inspections, can be a major logistical exercise with a major cost in Australia. One Government estimated that in the time it would take inspectors to survey 20 hectares on the ground, a remote sensing team can potentially look at 2.5 million hectares using satellite imagery. Whilst satellite monitoring is well suited to regulating large tracts of land in Australia, it might not always be so cost-effective in smaller and more easily accessible areas.

There have been different approaches taken by States as to whether to include specific provisions relating to the use of satellite imagery in legislation. Two States decided at the outset that this was not necessary and that the general investigative powers of regulators under existing legislation should suffice. Queensland adopted a different approach, by providing in their legislation that any technological instrument used under the act, in the absence of evidence to the contrary, is deemed to be accurate and precise. It is also deemed to have been used by an appropriately qualified person and the report that this person has prepared, based on the ‘remotely sensed imagery’, is deemed to be correct in the absence of evidence to the contrary. These provisions were copied from breathalyser legislation and effectively reverse the burden of proof, making it harder for the defendant to cast doubt on the evidence by questioning the correct functioning of the satellite. This legislative support came about not because of losing any court cases, but because this State Government was trying to save time-consuming work in proving that the imagery was credible evidence in court. The other side must advise, within a notice period, which specific areas of the evidence they will challenge. This is intended to give the Government enough time to prepare and respond to any challenges before a court hearing.

Satellite monitoring can be a very pro-active method of enforcement. Before satellite monitoring, Governments mainly relied on detecting offences through tip-offs. Satellite monitoring made them aware of a lot more possible offences, meaning that they had to substantially increase numbers of staff if they wanted to conduct inspections and make compliance decisions. Satellite monitoring might not, therefore, always solve resource difficulties within Government, and in fact, in the short-term, it might increase financial pressure.

Governments wishing to introduce a satellite monitoring programme are required to have a far more strategic regulatory approach than those with conventional land-based approaches. Lawyers, scientific officers and investigators will all be required to work together as a team. Experience in Australia shows that there has not always been a good triangle of understanding and communication between these three groups. This has directly resulted in some prosecutions collapsing in court. It is, therefore, not just evidence that is an issue when satellite data is used in court, staffing and regulatory structures can sometimes be overlooked, even though these can be equally as important. Over time, States in Australia have been required to implement new strategies for encouraging liaison and interdisciplinary training between these three groups.

Australia has seen a significant number of cases where satellite imagery has been used as evidence in courts. There have been few challenges as to whether imagery should be excluded as unreliable evidence to date. However, the use of imagery in the Australian courts has been what can be best described as a ‘bumpy ride’ for Governments. After some early successful prosecutions, defence lawyers started to question the potential for date changing of the imagery, its quality and accuracy, the credentials of Government experts, and even whether the satellite was working correctly. Attacks such as these caught Governments by surprise. All three States have had phases where they have had problems with failed prosecutions, either for the above reasons or because of other procedural technicalities, causing them to pause enforcement programmes and reflect on their practices and procedures. A key cause of problems appears to be the initial lack of legal input in the development of monitoring programmes. Legal and technical disciplines need to work closely together, hand in hand, and not get out of sync with one another.

The judiciary in Australia appears to have a general openness towards new technologies and satellite images have been treated similarly to other forms of technological evidence. Judges appeared to be strongly persuaded by the facts and context of things visually. They were impressed that satellite imagery allowed...
them to view what the issue in dispute looked like at the time of the offence, allowing them to see for themselves what happened, rather than having to rely on recollections of witnesses as to what they saw, said, or heard. However, there was also recognition amongst the judiciary that as satellite imagery was digital data, there could be issues as to whether it could have been processed, or altered, in either a deliberately misleading or accidental manner, in a way that could affect its probity.

It is increasingly recognised by Governments in Australia that there are systems and protocols that can be put in place to enable satellite data to be a more effective form of legal evidence. For example, there is now greater emphasis on showing the chain of custody and events from the raw data, through processing, to the product that is used in court. Some States collect affidavits from external image suppliers to demonstrate authenticity. However, at the current time there are no national standards in Australia, which deal either directly or indirectly with using satellite imagery as evidence. Australia is not alone in not having developed standards in this area. There are no developed national or international rules or standards in place as to the specific use of satellite imagery as legal evidence. Such standards could give lawyers and judges greater confidence in the use of the technology and can also inform technical experts as to how to best manage digital data. The British Standards Institute and the American National Standards Institute have developed standards for the legal acceptance of records produced by information technology systems. Although these do not refer to satellite images per se, they advise on procedures and documentation required for submitting computer-generated digital documents as evidence. The International Organization for Standardization has also developed standards on information that is stored electronically, which apply to member countries across the world – including Australia. A cursory look at these standards suggests that they are complementary to the requirements of satellite imagery and might be followed by Governments.

Satellite technologies could have a higher deterrent effect than some other technology-based enforcement approaches, such as CCTV, because they are, by their nature, covert. Regulators could have an instrument by means of which the regulated can be made aware that they may be being watched at any time, but they cannot actually tell when, or whether, they are in fact being monitored. Regulatory bodies could create the impression of a substantial capability and threat of enforcement with only very limited regulatory resource commitment. A survey, undertaken during this research to examine the awareness and perceptions of Australian landholders of satellite monitoring programmes, found that there was a good awareness of satellite technologies in Australia, and the majority of farmers generally knew what level of detail a satellite image could show, as over two-thirds had actually seen a satellite image of their own farm. However, when they were asked to estimate the percentage of how many farms in their States were monitored by satellite and the frequency of this monitoring, many farmers massively underestimated the true extent of the satellite monitoring programmes. In practice every farm in each of the States examined was monitored annually. It was clear that a large number of Australian farmers surveyed did not know this. Less than half of all farmers surveyed thought that they were monitored at least once a year.

In an earlier UCL survey, conducted in the UK, farmers were asked comparable questions and their answers were similar to the findings in Australia. However, UK farmers massively overestimated the true extent of the satellite monitoring (which is used in the UK to check for agricultural subsidy fraud). Only 14% of the farmers thought that less than 10% of farms were monitored annually, with significant numbers believing that the answer was over 50%. 43% of UK farmers also thought that there was satellite monitoring at least once a year. The truth is that approximately 5% of farms each year are monitored, with each farm in the UK actually having been monitored on average once every 23 years. This perception of more substantial monitoring than was the case appeared to improve compliance levels with the legislation and reduced fraud in the UK.

It is understandable that the UK Government would not want to publicise their true satellite monitoring rates, because of the perception of farmers of more monitoring than was the case. Conversely, there is a strong argument that if very high numbers are monitored each year, as in Australia, then the true levels of monitoring should be communicated to those being regulated. There appears to be a problem of communication in Australia between regulators and those regulated, leading to the satellite monitoring being less effective than it might otherwise be. An important finding of the survey was that many Australian farmers did consider that the satellite monitoring was having an effective deterrent impact on illegal vegetation clearing. Nearly two-thirds agreed that the fact that they were being watched by satellite was acting as a deterrent. Satellite monitoring is clearly having an impact on behaviour in Australia, although compliance levels could be better still if there was higher awareness of true monitoring levels.

It is difficult to measure the precise impact that satellite monitoring might directly have had in terms of legislative compliance in Australia. Factors such as climatic and market conditions, changes in environmental
awareness, and the tightening of legislation can all influence levels of clearing. Furthermore, it is hard to pinpoint the timing of any effect because Government does not look at imagery in real-time during the monitoring process. Historical images from different time periods are used and prosecutions can take place four to five years after the clearing occurred. This can cause long time lags between the offence being committed and knowledge of the prosecution within the regulated community. It can similarly take a while for the impact of regulatory action to filter through to the statistics.

The clearest method of looking at impacts of satellite monitoring is to see if there have been any changes in levels of vegetation clearing over time in Australia. Queensland has the most established and longest running satellite monitoring programme, which is the most useful for change analysis. In 1999, vegetation clearing levels in Queensland were at 758,000 hectares a year (ha/yr). A decade later they are at 123,000 ha/yr (for 2007-2008). This represents a massive 83.8% decrease in clearing over ten years. In the latest statistics, only a small figure of 12,500 ha/yr was considered to be potentially illegal. This represents a decline in greenhouse gas emissions of an estimated 60 mega tonnes (Mt) of emissions in 2003-2004, to an estimated 24Mt in 2007-2008. However, declines in vegetation clearance have not been as dramatic in New South Wales, for example, and have stabilised over the same time period.

Before this report there had been no systematic effort to conceptualise how those being monitored this way felt about surveillance by satellite technologies. This research found that many of the farmers were either positive, or ambivalent, about satellite monitoring taking place in their State. Only about a quarter of them were, in some way, against being monitored this way. When asked how they would prefer to be monitored under the vegetation clearing legislation, a quarter of farmers wanted to be monitored by site visits only and a quarter by satellite monitoring only. By far the most supported monitoring method was for satellite monitoring to be used as the initial method of checking compliance (around a half), but if something was detected in this way, they wanted any subsequent investigation to be done on the ground by humans. Many farmers liked being regulated at a distance, but felt that if there were any problems, they could explain things to a human, which they could not with a satellite. There was also a perception that there could be anomalies or inaccuracies with the results from satellite technologies.

There were high levels of support for the use of satellite technologies in Australia, because they were seen by some to be a fairer, more equitable form of monitoring (49.4%). Some farmers considered them to be a more consistent and accurate method of monitoring vegetation clearing compliance than other means (54.2%), whilst others thought that they could stop dishonest people in the farming industry giving the law-abiding majority a bad name (73.4%). Governments wishing to adopt satellite programmes elsewhere might consider emphasising these ‘supports’.

Despite many Australian farmers supporting the use of satellite monitoring a number of concerns were also expressed. Privacy was an important issue for some of them (58.1%). For many, it was the covert ‘Big Brother’ nature of this form of monitoring that they did not like and they wanted to be informed when they were being monitored (68.3%). Concerns were also raised by farmers about the technology not being used properly and trusting regulatory bodies (36.1%). Communication and education is extremely important in this regard. Many in regulated communities are, in part, supportive of satellite monitoring, but massive numbers do not feel that they know enough on the subject: over two-thirds of the farmers surveyed did not think that they had received enough information from Government. The numbers that might support the technology could increase in the future if there are efforts made by Government to inform them of what they are doing and how and why they are doing it.

Australian farmers were generally supportive, or neutral, about the future use of satellite monitoring to check other environmental laws (except in relation to climate change). They appeared far more likely to accept, or welcome, satellite monitoring if they considered that there was something in it for them. This included making satellite data available for them to use (96.2%), or reductions in the numbers of ground-based inspections (45.3%). The farmers were also generally more supportive of satellite technologies being used if there were also benefits to society as a whole, including financial savings to the taxpayer (75.1%) and cutting Government bureaucracy (72.6%). Offering some form of ‘partnership’ approach in regulatory programmes where satellite technologies are used should, therefore, be encouraged wherever possible.
### Summary of Recommendations

**Recommendation 1**

Sourcing and getting access to satellite data is a major challenge without technical support. Satellite providers should look at providing better support and communication networks to Government. This could enable Government to see the possibilities that exist in a monitoring and evidential context and help them get the information that suits their needs. The introduction of a common database that could be used by non-technical laypeople, and which offered a simple search facility of databases where archived satellite imagery is held, is recommended.

**Recommendation 2**

Purchasing satellite data is more cost-effective if it can be used by others, or used for multiple purposes (subject to the relevant licensing authorisation). Governments should actively seek out these alternative uses. Government bodies considering purchasing data for monitoring programmes are recommended to establish a coordination body to champion and support activities where such images might be used elsewhere in their organisation.

**Recommendation 3**

There should be cataloguing of imagery holdings within Government to avoid purchasing the same, or similar, data repeatedly. It is recommended that if different Government departments purchase satellite imagery, then this should be coordinated through a single body. This would provide increased negotiation power and afford the opportunity for discounts when purchasing imagery in bulk.

**Recommendation 4**

Purchasing the satellite data is not the only significant expense in establishing a satellite monitoring programme. Work is required to design a programme methodology; source imagery and arrange contracts; buy computers and data storage facilities; and to employ analysts and train them. This can take a long time and cost significant sums of money. It is recommended that those considering using this technology in a regulatory context should endeavour to consider these costs in detail (with a view to avoiding under-budgeting) and do so in advance.

**Recommendation 5**

Governments should, as far as possible, consider keeping the vendor and satellite platform independent, in order to avoid dependence on a single satellite product. Although this might have cost implications, flexibility is needed to continue regulatory strategies. If only one satellite is used, there is always a danger that regulators could be left high and dry if something happens to that satellite. It is recommended that those wishing to use such technologies consider alternative strategies, such as using data from different satellites, in advance.
**Recommendation 6**

To assist in evidentiary support, a provision containing an evidential presumption could be introduced in legislation where satellite technologies are used in a monitoring programme. Placing the burden of proving incorrect functioning of equipment, and full disclosure of the grounds for any challenges to satellite evidence, on the other side would create fewer opportunities for spurious challenges by the defence. This could save the regulator and court time and resources.

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**Recommendation 7**

Those using imagery in a regulatory context should check to see if there are limitation periods in the law they plan to monitor. Monitoring some laws could require comparison of imagery over several years, and it can be a slow process before a case is investigated on the ground and then brought to court. These issues, coupled with unfavourable limitation periods, could pose barriers to successful prosecutions. In certain circumstances, Governments may wish to consider extending time periods to better support the use of satellite evidence.

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**Recommendation 8**

Use of satellite technologies could cause a substantial increase in the number of offences detected, requiring enhanced funding and resourcing in relevant departments. This could result in more money being required, as more staff would be needed to manage the increased caseload. The introduction of satellite monitoring into regulatory regimes does not solve all of a department’s resource difficulties, and in fact in the short-term it can impose increased financial and resource pressures. It is, therefore, recommended that such an outcome be considered in development of strategies.

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**Recommendation 9**

Satellite monitoring programmes require a far more strategic regulatory approach than conventional land-based approaches. Lawyers, scientists and investigators would be required to work together as a team. Regulatory agencies must, from the beginning of adopting a satellite monitoring programme, collectively understand their overall delivery aims, their individual roles within the programme, and how these varying Government functions will interact and work together. There should be dedicated personnel in each of the interdisciplinary groups appointed to work closely together and to provide communication and liaison between different arms of Government. Regular meetings, training events and published guidance should also be undertaken to foster interdisciplinary understanding and cooperation.

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**Recommendation 10**

Evidence from satellite technologies does not appear to have reached a stage yet where it should be used alone as evidence. It is recommended that, wherever possible, it should always be accompanied by other forms of corroborating evidence, such as witness statements from ground inspections, so as to give a young technology more credibility in the eyes of the judiciary and the public.
**Recommendation 11**

It would seem sensible for national bodies, such as Geoscience Australia and Standards Australia, to work together in order to develop national standards or codes of practice, dealing specifically with using satellite imagery in a legal context. It is further recommended that Governments should liaise with the International Organization for Standardization, in seeking to develop an international best practice scheme in this area.

**Recommendation 12**

The impact of satellite monitoring is extremely difficult to measure. The evidence available so far from Australia suggests that it has probably improved compliance. However, satellite monitoring does not produce instantly quantifiable results and it is a little early to reach a conclusion either way. Compliance research should, therefore, be revisited in five years time, to see if there are any clearer indicators that satellite monitoring has had a major compliance impact effect in Australia.

**Recommendation 13**

A further recommendation would be for international or regional initiatives like the Global Earth Observation System (GEOSS) and Global Monitoring for Environmental Security (GMES), or even the European Environment Agency, to begin to record instances of satellites being used in a compliance context. One of these bodies should take ownership of collecting data from other jurisdictions to share and educate. The data could be used and compared by regulatory bodies within the European Union or other jurisdictions that might wish to incorporate satellite monitoring into regulatory programmes.

**Recommendation 14**

If a satellite monitoring programme is undertaken, it is clearly in the interest of Government to let those who may be monitored know that this is happening. Knowledge of monitoring on the part of regulated communities is likely to alter their behaviour, potentially towards enhanced compliance. Any monitoring programme should be accompanied by a strong information dissemination strategy.

**Recommendation 15**

Regulated communities were in general more supportive of satellite technologies being used if they considered this offered a fairer, more equitable and more consistent form of monitoring than by other available methods. Governments wishing to use satellite technologies in a regulatory/legal process should emphasise these benefits when introducing such a monitoring programme.
**Recommendation 16**

For there to be confidence in this form of monitoring, the farmers have to trust that the satellite imagery is interpreted correctly. The satellite image will nearly always be accurate; it is the human element (i.e. how the image is processed, interpreted and secured) that can cause problems. Following best practice procedures on data handling and security could increase reliability and trustworthiness. In order to establish confidence in the technology it would be advisable for information management procedures to be introduced and followed by Government, and that these are made publicly available.

**Recommendation 17**

Governments wishing to use satellite monitoring in regulatory programmes should consider incorporating a provision expressly mentioning the use of these technologies in legislation. Although this might not be strictly necessary in a legal context, it could guard against challenges to admissibility, potentially under privacy legislation.

**Recommendation 18**

It would seem beneficial to ensure greater certainty as to what may constitute unacceptable or intrusive earth observation monitoring in advance, rather than after regulatory programmes are developed. Governments wishing to use satellite monitoring should be able to justify to their citizens why it is being used and put measures in place to limit intrusion. For example, there could be some form of government review on acceptable pixel size, or a regulatory impact statement might detail measures taken, to ensure that satellite monitoring is not overly intrusive.

**Recommendation 19**

Regulated communities are more likely to accept or welcome satellite monitoring if there is some corresponding benefit. It is recommended that Government consider ways of making satellite data available for regulated communities to use or offer reductions in ground-based inspections in return for being monitored this way. Offering a ‘partnership’ approach in regulatory programmes where satellite technologies are used should be encouraged wherever possible.

**Recommendation 20**

It is recommended that regulators wishing to undertake a satellite monitoring programme should aim to create good channels of information between themselves and regulated communities. Many farmers are, in part, supportive of satellite monitoring, but a significant number do not feel that they know enough on the subject, and would like further information. Support for the technology could increase if efforts are made to communicate to the regulated community what satellite monitoring entails, how it is done and, importantly, the reasons behind it.
Chapter One
Introduction to the project and report

Introduction

1.1 The study, ‘Smart Enforcement in Environmental Legal Systems: A Socio-Legal Analysis of Regulatory Satellite Monitoring in Australia,’ was funded by a United Kingdom (UK) funding body, the Economic and Social Research Council, during 2009 and 2010. This report is a direct output of this study and examines whether modern satellite technologies could provide a rigorous, legally reliable, and cost effective tool in inspection and compliance regimes in environmental regulatory systems.

1.2 The report considers these issues in the context of relevant experience and expertise in Australia, which is the only sustained comparative example where satellites have been used to monitor an environmental law. Satellite monitoring is used to monitor compliance with vegetation clearing legislation in Australia. This report seeks to demonstrate lessons learnt from this cutting-edge practice in Australia and to identify how best to build on this experience if satellite monitoring is to be used in new regulatory strategies.

Context of environmental regulatory systems

1.3 Current methods of environmental regulation and enforcement have made a substantial contribution to protecting the environment, but may not be so well suited to meeting contemporary and future challenges.

1.4 There has been an unprecedented increase in the number of environmental laws for which regulatory bodies are responsible. Many countries, including the UK, rely to a great extent on command and control style regulation, where the regulator issues permits, inspects activities, and where necessary takes enforcement action. Such environmental permitting systems require extensive regulatory resources and many activities need regular monitoring. For example, the Environment Agency in England and Wales can sometimes carry out up to 150,000 physical inspections a year. Command and control regulation has been a very powerful method of improving environmental performance on the part of regulated communities, but faced with modern resource pressures it may become less effective. Traditional methods of ensuring compliance based on licensing and bureaucratic physical inspection regimes are increasingly seen as blunt, deficient and resource intensive.

1.5 Conventional environmental inspection and enforcement approaches are progressively more unlikely to meet contemporary policy requirements, in particular when considering larger geographical areas, as is the case with habitat and forestry protection. The environmental problems being regulated are not only increasingly complicated, but are also applicable to a greater number of businesses. An example of this is that millions of farms across Europe now fall under the remit of European Union (EU) waste legislation. Regulators are having to adapt to monitoring a more diverse range of pollutants, over greater distances, using new and sometimes complex regulatory techniques. As we move from handling more familiar environmental pressures, to next-generation questions of resource and energy use, we will need to devise new regulatory responses. The monitoring and enforcement opportunities presented by satellite technologies appear to be becoming increasingly important and appropriate.

1.6 While the volume of environmental laws increases, the numbers of staff charged with monitoring or enforcing them in regulatory agencies often remain static or decrease. Public sector resource constraints mean that regular physical inspections, particularly in remote areas, are increasingly difficult to finance. Some regulators have already begun reducing the number of ground inspections they undertake. Regulatory bodies increasingly have to cope with austerity drives that require them to reconsider conventional ways of monitoring and enforcing environmental laws. The allocation of regulatory resources towards personnel and equipment

2 See, for example, N Gunningham and P Grabosky, Smart Regulation: Designing Environmental Policy (Clarendon Press, Oxford 1998).
already plays a critical role in environmental compliance and this could be impacted by further funding cuts during economic recession.

**The role of satellites in environmental monitoring**

1.7 Remarkable advances in the capabilities of satellite technologies suggest that their use as an information-reporting tool in environmental regulation could be increasingly relevant and appropriate. In the 1990s the spatial resolution of most commercial satellites was normally between 30-80 metres, but there have been dramatic technological changes since then and current resolution levels are now under 0.50 metres.\(^4\) In a little over ten years, high-resolution satellites have become able to produce pictures of near photographic quality with about seventy times more visibility than before. Table 1 below shows the step changes in resolution levels over the last forty years.

<table>
<thead>
<tr>
<th>Time Period</th>
<th>Resolution Level</th>
</tr>
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<tbody>
<tr>
<td>1970's</td>
<td>79 metres</td>
</tr>
<tr>
<td>1980's</td>
<td>30 metres</td>
</tr>
<tr>
<td>1990's</td>
<td>10 metres</td>
</tr>
<tr>
<td>2000</td>
<td>1 metre</td>
</tr>
<tr>
<td>2001</td>
<td>60 cm</td>
</tr>
<tr>
<td>2007</td>
<td>41 cm</td>
</tr>
</tbody>
</table>

1.8 Environmental regulators across the world face a number of common challenges which hamper their goal of effective and efficient enforcement. One of the most obvious challenges is implementing information reporting systems that can report on compliance. Satellite technologies by their nature are particularly useful at monitoring activities taking place outdoors, such as changes in environmental conditions and can potentially give unparalleled access to environmental information on the ground, water, or in the air. Environmental regulation already represents a potentially excellent application for satellites, but the unprecedented step changes in spatial resolution capabilities mean that it is now possible to simply see more from space. Resolution levels on current satellites can identify vehicles, ships, large pipelines, a single tree, a waste disposal site, or even the amount of water used for irrigation.

1.9 Key to Governments is whether satellite monitoring can offer opportunities over and above existing environmental enforcement methods. It would appear that weaknesses in conventional mechanisms of monitoring and enforcing environmental laws indicate increasing potential for the use of satellite technologies in this field.

1.10 Satellite monitoring can be seen to be a more pro-active form of environmental inspection, because continuous remote monitoring allows for the collection of larger quantities of information and with greater frequency. For example, it should be in theory easier to monitor damage in sizeable nature protected areas on a more regular basis by satellite than by ground inspection, as they can monitor large geographical areas more quickly. Satellite images may also be taken and archived, providing information to regulatory bodies on what has taken place in the past. No other historical information might otherwise be available, so having the ability to go back in time and having photograph-like evidence that can be used in a court of law is of obvious value to regulators.

1.11 Satellites are also going to be useful if they can present monitoring opportunities which are otherwise problematic or unavailable through conventional means. An example of this is satellites being used to prove responsibility for oil pollution in remote seas. Vegetation clearing in Australia also falls into this category.

\(^4\) Note, while the GeoEye-1 satellite is able to collect imagery at 0.41 meters, GeoEye's operating license from the US Government requires re-sampling the imagery to 0.5 meters for all customers not explicitly granted a waiver by the US Government.
1.12 Within the context of budgetary constraints, the use of satellite technologies could be increasingly relevant to current debates on risk-based regulation. Risk-based regulation enables Government to target regulatory activities and deploy resources, principally relating to inspection and enforcement, based on an assessment of the risks that a regulated group pose to a regulator’s objectives. It is a response to the challenges of often-limited resources and attempts to dictate strategies which are more efficient and designed with specific policy outcomes in mind.\(^5\) Austerity drives are going to be in place for the foreseeable future in many countries. Governments will become increasingly interested in new regulatory methods, especially if they can offer cost savings while protecting the quality of front line public services.\(^6\) If satellite monitoring can be shown to be affordable and fit well with risk-based strategies then in certain situations it will be increasingly attractive to Governments.

The link between scientific/policy development and environmental regulation

1.13 There has been growing interest amongst Governments across the world in whether satellite technologies could provide information for evidence-based policy decisions concerning environmental conditions. At a global level, the Intergovernmental Group on Earth Observation is leading a worldwide effort to build a Global Earth Observation System of Systems (GEOSS) over the next ten years, examining how satellites can contribute to developing a greater understanding of environmental factors and then improving the management and legal protection thereof.\(^7\)

1.14 Within the EU, the European Commission and European Space Agency have established the Global Monitoring for Environmental Security (GMES) programme, whereby EU Governments must develop satellite derived information to monitor environmental conditions and pressures.\(^8\) The GMES programme currently covers six thematic areas: marine, atmosphere, security, emergency, land and climate.

1.15 In the UK, a National Centre for Earth Observation was opened in 2008 to harness the full potential of space technology for environmental research. In July 2010, the UK Science Minister, David Willetts, announced the creation of a new UK centre for monitoring the earth from space, to be based at the International Space Innovation Centre in Oxfordshire.\(^9\) This earth observation hub will focus on acquiring environmental data, including information on marine pollution, deforestation and climate change.

1.16 The direction of most of these initiatives has been for scientists to develop a wide range of environmental monitoring applications for satellite technologies. This has had some success. However, there has been little interaction between, on the one side, regulators and lawyers, and on the other, scientists and the space industry. Environmental regulators and the legal community have yet to play a key role in any of the ongoing scientific or policy discussions on satellite monitoring taking place within Europe or the UK.

1.17 The use of satellite monitoring as part of a regulatory strategy is still very much in its infancy worldwide. To date, there have been very few instances of practical regulatory applications. Satellite technologies have, so far, primarily been useful in legal terms to regulatory bodies in the agricultural sector. This makes obvious sense, as large areas of agricultural land can be monitored, sometimes with significant cost savings.

1.18 Satellite monitoring has existed in the agricultural sector in the EU for over a decade. Legislation gives Member States, like the UK, the option of using satellites to monitor farm subsidy payments under agricultural cross compliance schemes.\(^10\) While the monitoring responsibility is with the individual Member States, the EU provides them with satellite imagery free of charge to assist them in fulfilling this requirement. The purchase of

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\(^{5}\) E.g. in the United Kingdom, see: P Hampton, ‘Reducing Administrative Burdens: Effective Inspections and Enforcement’ (HM Treasury, London 2005).

\(^{6}\) For example, the current Government in the United Kingdom are currently committed to finding ways of cutting spending whilst maintaining public services; The Conservative Party, ‘Invitation to join the Government of Britain. The Conservative Manifesto 2010’.

\(^{7}\) See the GEOSS website <http://www.earthobservations.org/index.html> accessed 21 July 2010.

\(^{8}\) See the GMES website <http://www.gmes.info> accessed 21 July 2010.


\(^{10}\) Commission Regulation 796/2004/EC laying down detailed rules for the implementation of cross-compliance, modulation and the integrated administration and control system provided for in Council Regulation 1782/2003/EC establishing common rules for direct support schemes under the common agricultural policy and establishing certain support schemes for farmers [2004] OJ L141.
satellite data from commercial providers costs the EU approximately €5 million each year, but this can result in significant financial savings at national level compared to the cost of ground-inspections. Almost all EU countries now use this satellite technology, which can identify crops, determine correct areas of agricultural parcels, and check if claimants are complying with certain environmental conditions attached to subsidies.11 The satellite images themselves have rarely been used as evidence in courts in EU countries and are most often used to provide advance notification to the authorities of potential fraud. The actual evidence of the illegal act is normally ascertained from subsequent ground inspections.

1.19 The Department of Agriculture in the United States also uses satellites to monitor field crop data through their Federal Crop Insurance Program. Satellite imagery is typically employed if a field investigator determines that claim-verification is warranted.12 There have been a small number of instances where it has been used as evidence in court to show false insurance claims.13

1.20 There is a low level of satellite technology usage in regulatory/legal strategies, at least relative to its full potential. Whilst there have been regulatory applications for satellites in the agricultural sector, there has been hardly any take-up, to date, in the environmental sector. Satellite monitoring appears to be a strategy with such potential, so why are Governments not making more use of it in an environmental context? The answer seems to be that the use and development of satellites has been almost exclusively technology-led from its inception. That is, technology is not developed with the regulatory or legal sectors in mind.

1.21 Many environmental regulators would currently have little or no knowledge of satellite monitoring or the potential value of it. An obvious consequence of this is that while some applications for environmental problems are being developed, this is not always compatible with the actual letter of the law, or with operational regulatory practice in mind. For example, in the context of air pollution, satellite monitoring is generally not capable of the temporal sampling and averaging necessary to determine exposure over short timescales. Much of the air pollution legislation in place in the EU, for example, also requires monitoring at ground level, meaning that the use of satellites would be incompatible with monitoring requirements under existing laws.14 This, of course, does not mean that current laws cannot be changed, or future laws developed, with EO technologies in mind.

1.22 Generally, regulatory bodies and lawyers are not yet seen by the space industry to be a key market for image products. It is unclear whether this is because they have not been involved with initiatives such as GEOSS or GMES, or because the technology was not until very recently considered to be of a quality useful for monitoring laws. In moving toward deployment in this area, there will be growing need for interdisciplinary cooperation and strong advocates of the new technology from both sides who can persuade others of its utility. In the future it is hoped that regulators and lawyers in the EU will play a greater role in programmes like GMES. There should be new strategies investigating how such future technologies might meet legal/regulatory user needs, or be bespoke commissioned for specific purposes and applications.

1.23 Whatever the potential for collaboration, it seems that research and development in this area will begin to catch the attention of those involved in developing regulatory strategies. It is clear that the significant scientific work and information being collected under initiatives like GMES could guide future policy-making. Experience from Australia tells us that policy-derived information can stimulate the downstream regulatory sector, as was the case with satellite monitoring of vegetation clearance.

Previous legal reviews

1.24 There have, in the last decade, been a number of publications and evaluations in the EU, which have looked at some of the fundamental legal issues raised by satellite monitoring. These include:

11 The image investigation itself can be performed either in-house, by the regulators, or contracted out to external expert companies.
12 The image investigation is also performed either internally by the USDA’s Risk Management Agency or contracted out to a private remote sensing expert.
• NPA Group, ‘Applications of Earth Observation to the Legal Sector’ (British National Space Centre Sector Studies Programme Report, 2001).
• ‘Satellite Monitoring as a Legal Compliance Tool in the Environmental Sector’ (AHRC Study, University College London, 2008).  

1.25 These earlier studies have mainly concentrated on issues of evidence in courts, as well as identifying potential future environmental applications for the use of satellite monitoring. Most recently, in the AHRC project, UCL used archived satellite imagery with the intention of looking at whether satellite monitoring could identify environmental offences which had taken place in the past, using historical prosecution data to locate site locations. 

1.26 In the AHRC study, UCL looked at a 2006 UK prosecution for an offence relating to an illegal landfill site. This was a major criminal operation and the rubbish burnt caused a mound of ash three metres high and 260 metres in circumference. At trial, the Environment Agency stated that this offence took place between May 2005 and January 2006. The two satellite images in the top of Figure 1, below, dated October 2005, appear to show, in the yellow circled area, the burning of waste on this land during the known time of the offence. The two satellite images in the bottom of Figure 1, dated June 2004, were taken nearly a year before the Environment Agency believed the offence was committed. In the red circled area there appears to be a large burned area on the land at this time. This might indicate that the illegal activity had been ongoing for a longer period of time than the investigators previously thought.

Figure 1. Imagery used in the AHRC Project demonstrating the value of historical evidence

1.27 Consideration of the issues raised in these earlier studies has been useful and the example above highlighted the practical function of imagery archives for prosecuting authorities. However, it was telling that UCL had to develop their own illustrative examples of environmental applications, as there had been so few instances where satellite monitoring had been used in practice. A conclusion of these earlier studies was that its actual application was more theoretical than applied, and understanding in the EU as to the wider regulatory implications of using satellites to monitor regulatory regimes was insufficient. The lack of any empirical evidence on experiences, operational effectiveness and cost has meant that there has been little

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15 All three of these reports can be accessed online via the UCL website at: <www.ucl.ac.uk/laws/environment/satellites/index.shtml?publications> accessed 21 July 2010.
17 Copyright: DigitalGlobe. Images kindly provided to me by DigitalGlobe on 5 June 2007. I am grateful to them for allowing me to use these satellite images in this report. Note the images to the right have been magnified to show the burnt area more clearly.
regulatory uptake and a low level of use of satellite technologies in regulatory strategies, relative to its full potential, in part because its effectiveness has not been adequately demonstrated to regulatory bodies. There will be reluctance by regulators to move from one form of obtaining evidence to a new form of technological evidence unless more substantiation is given as to its efficacy at an operational level. The primary purpose of this report was, therefore, to examine the lessons learnt from experiences in Australia and to provide examples to regulators of the extent to which this form of monitoring can work, together with a tentative indication of the costs involved.

Experiences in Australia

1.28 The country that is at the cutting edge in terms of experience with using satellite monitoring in a regulatory/legal context is Australia. For nearly a decade, State Governments in Australia have used satellites to detect and deter illegal vegetation clearing. The clearing of native vegetation from much of Australia’s prime agricultural land has emerged as a serious issue in land management, causing widespread fragmentation of natural ecosystems, reducing their viability and threatening maintenance of flora and fauna and the ecological processes upon which productive rural landscapes depend.18

1.29 The use of satellite monitoring in regulatory strategies to combat illegal vegetation clearance in Australia seems to be the first and only example internationally where satellites have been systematically used to monitor compliance with a specific environmental law. Australia has also seen numerous prosecutions and other forms of administrative sanctions where satellite data has been used as evidence to demonstrate vegetation clearance. Australia has tested satellite evidence in courts more than any other jurisdiction in the world (at least 50 times to date).

1.30 There is no clear reason why Australian Governments have used satellite technologies before other countries. However, environmental regulators in Australia, generally, appear to have a broader enforcement ‘toolkit’ than their counterparts in Europe, and also seem more inclined to experiment with new regulatory strategies and methods.20 The Australian population is also well educated and the country has a good technology infrastructure.20

1.31 A number of additional, quite unique experiences also appear to have influenced why Australia has been using satellite technologies in environmental regulation before European countries. The most obvious is that it difficult for regulators to get land-cover information over very large areas.21 Some Australian States are the size of small European countries. In the context of regulation, agriculture is also the most extensive form of land use in Australia. An estimated 417 million hectares, or 54% of Australia’s landmass, was used for agricultural activity in 2008.22 It would be extremely difficult, if not impossible, to police vegetation clearing legislation over such physically extensive areas through conventional monitoring techniques (i.e. on-site inspections). Aerial photography is considered too expensive to obtain land cover information over physically large areas, because of the large amount of fly-overs required. Regulators are similarly not able to adequately monitor vegetation changes in rural areas from the ground. Most of the terrain is too big, too rough and it is far too resource intensive to send inspectors in on the ground to investigate each rural landholding. It can sometimes take inspectors two days or more to drive to and investigate some rural properties. In one investigation used the evidence of a team of six forestry officials who took four months to map one property on the ground.23 Ground based monitoring in this context can, therefore, be a major logistical exercise with high

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20 In terms of using satellites, one Government official commented, “they were proud of their desire to be at the leading edge of the technology.” Personal Communication.
22 Australian Bureau of Statistics, Year Book Australia 2009–10 (ABS, Canberra, June 2010). Queensland had the largest estimated land area in agricultural use, in the country, with approximately 145 million hectares.
23 McKay v Doonan (2005) QDC 311 (District Court of Queensland, Australia). Note that the forestry officials were originally on the property many years before the court case to get a compensation figure for the State to convert the leasehold to freehold.
associated costs. An official with the Queensland Government worked out that in the time it would take inspectors to survey 20 hectares on the ground, the remote sensing team could look at 2.5 million hectares using satellite imagery in the same period.  

1.32 Australia also has an extensive landmass but a relatively small population, with most of its inhabitants living in cities by the coast. If an individual cuts down a tree in one of these cities, it would likely be highly scrutinised and reported to the authorities. However, in remote locations, away from the cities, 1000 hectares of trees could be removed and go unnoticed; and even if it was noticed, neighbours might not report it to regulatory agencies. A Government official in one State remarked that they ‘would have loved to have waited until the technology was better developed, but there was a need for it’.

1.33 Clearly, satellite monitoring has played an important role in monitoring vegetation clearance in Australia because it has been appropriate to the country’s circumstances. Monitoring by satellite might not, however, be so compatible with the circumstances of every country, or indeed so useful in the monitoring of every different type of law.

**Remit of this study**

1.34 There will be growing interest from European regulatory bodies, in the environmental field, as to whether satellite technologies can provide new methods of cost-effective monitoring and enforcement. As indicated earlier, assurances will be needed that using satellites in a regulatory context can be operationally effective, affordable, that they can achieve positive environmental outcomes, and that they can secure public acceptability and confidence.

1.35 A number of countries, many of which are developing countries such as Indonesia and Brazil, have introduced legislation to combat illegal deforestation/logging/vegetation clearing. It is likely that these countries may not have the regulatory resources to be able to monitor vegetation clearing to the same degree as States in Australia have done. Whilst some of these countries are now making use of satellite imagery, Australia has significant experience in this area. It is expected that monitoring forestry loss and carbon take-up from the forestry sector could be a major growth industry in the next decade. In this regard, countries will need reliable and cost-effective monitoring methods; new satellite technologies could become increasingly relevant.

1.36 The focus of this study has been to examine experiences and factors shaping Australian approaches to using satellite technologies in the context of vegetation clearance legislation. Australia was chosen as the focus for this study not only because it is a mature example of using satellites within an environmental monitoring programme, but also because it is the only such example. This study is more applied than previous research as it examines whether its use in a regulatory strategy has achieved desired outcomes and demonstrated the integrity of satellite monitoring. Such research has not been done before in Australia, or in a wider international context.

1.37 The remit of the study was:

- to consider lessons from Australian experiences as to whether new high-resolution satellite imagery could now be used as an environmental monitoring and compliance tool;
- to assess the operational effectiveness of existing Australian State satellite monitoring programmes and any constraints affecting its use as a compliance tool or lessons learnt in the Australian context;
- to investigate the awareness and attitudes of those regulated this way and evaluate how knowledge of being monitored by satellites is likely to influence their compliance behaviour;
- to analyse whether satellite monitoring is seen as more or less desirable than conventional forms of inspection, whether it is seen as more confrontational method of monitoring and enforcement, and the impact on relationships and confidence it might have between those subject to regulation, regulatory authorities, policy makers and the community;

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24 Personal Communication.
25 Personal Communication.
26 Personal Communication.
27 Personal Communication.
to derive recommendations that can inform and advance debate amongst a wide international audience as to the merits of using satellites primarily as a compliance tool in the area of environmental legal systems, but also as to implications for other legal monitoring.

1.38 This research seems to be the first substantive socio-legal research study, either in Australia or internationally, to address all of the research objectives above systematically. Considering the socio-legal, political and economic factors influencing satellite monitoring use in Australia will contribute to a more complete understanding of the implications for formulating policies and incorporating its use into regulatory regimes in the EU. It is unclear whether the experience in Australia, where there is a more obvious physical need for satellites, can be transplanted to other smaller countries, like the UK. However, it is hoped that by using Australia as a core example to analyse some of the general research questions above, key authorities from other countries that may have an interest in using such surveillance technologies will be in a stronger position to consider adopting them in their own regulatory strategies.

Overall Methodology

1.39 This project was funded by the Economic and Social Research Council (ESRC) between April 2009 and September 2010. At the outset an advisory board was established to guide the research. Further details about the ESRC and advisory board can be found in Annex A.

1.40 As regulatory satellite monitoring is performed at state level in Australia, this study examined practice in three separate States: South Australia, Queensland and New South Wales. These States were chosen as they are the only three jurisdictions in Australia which have enacted legislation dealing explicitly with native vegetation clearance, which works in concert with land management, development and planning and conservation statutes.28 All three States are examined as they have their own distinct compliance systems using satellite technologies at various stages of development. A further reason for their selection was that it was also anticipated that reactions of regulated communities might be different in States which had a history of heavy vegetation clearing activities from States which still had vast un-cleared rural tree populations.29 A final reason for choosing these three Australian States was because of existing working relationships within their respective Governments.

Interviews

1.41 A central aspect of the methodology of this study was to draw primarily on interview data in order to garner the key perspectives on satellite monitoring in Australia. A total of fifty eight semi-structured interviews were conducted between October 2009 and February 2010 in Australia. These took place in each of the three sample States and also at Federal Government level in Canberra. All of these were conducted in person, apart from three interviews which were conducted over the telephone. Interviewees included: Government officials, farming associations, practicing lawyers, scientific advisory bodies, environmental organisations, academics, journalists, judges, and farmers. A list of organisations and individuals that assisted in this interview process can be found in Annex B.

1.42 Personal communications from the interviews were given in a confidential manner, unless otherwise stated in this report. Sometimes if a State or organisation is not specified, this is also to protect the anonymity of personal contacts.

Collection of research materials

1.43 Key materials were collected and analysed through desk-based research in the UK, and also during the four month research visit to Australia. A large number of research materials, which were not available via the Internet, were supplied during meetings with organisations and individuals, as well as being sourced from Australian university libraries. A bibliography of research materials used is contained in Annex C. There are also lists of relevant legislation and court decisions in Australia contained in Annex D and Annex E.

28 S Bricknell, ‘Environmental crime in Australia’ (Research and public policy series no. 109, Australian Institute of Criminology, Canberra October 2010).
29 In terms of factors such as percentage of pre-European native vegetation cleared and volume of native vegetation cleared.
Surveys of regulated communities

1.44 There have been a number of surveys and evaluations of Australian landholders attitudes to the vegetation clearing legislation.30 Research to date has focussed on the attitudes of farmers to vegetation clearing itself, rather than the method of monitoring. None of these earlier studies have directly examined attitudes towards monitoring by satellite. There had been no systematic effort to conceptualise how those monitored feel about this type of surveillance. A further key component of the methodology was undertaking a UCL survey of regulated farming communities in the three Australian States. Key information about the ESRC survey including its structure, targets, procedures and response rates can be found in Annex F. This survey appears to be the first major attempt to examine the experiences of those monitored using satellites as part of a regulatory strategy. A copy of the survey that was used can be found in Annex G.

1.45 The surveys were not aimed at a particular group of farmers in Australia, but had general applicability to those in this regulated community who were monitored by satellite. Their purpose was to examine the general awareness and attitudes of those being monitored this way and to investigate both the benefits there might be to farmers, such as consistent enforcement, as well as any concerns that they might have; for example, did they consider it to be excessively restrictive or intrusive? The survey was also intended to investigate whether satellite monitoring was seen as more or less desirable than conventional forms of inspection, whether it was seen as a more confrontational method of regulation and the impact on trust-based relationships and confidence between regulators and those regulated it might have had. A further key component of this survey was to examine how the perception of being monitored by satellites influences the behaviour of landowners subject to regulation, in particular whether satellite monitoring could offer environmental agencies a new form of credible deterrence against non-compliance.31

1.46 A small pilot survey had already been undertaken by UCL in the UK during 2008, under a project funded by the Arts and Humanities Research Council (AHRC).32 This survey was carried out to assess attitudes of the UK farming community towards monitoring by satellite. At the time of the survey, satellite monitoring had been used in the UK for over a decade to check subsidy fraud under European agricultural support schemes. This survey was not identical to the one used in Australia, but contained a number of the same or similar questions. This survey is referred to a number of times in this report to highlight comparative differences between UK and Australian awareness and attitudes.

The following chapters

1.47 Chapter 2 provides details as to what satellite imagery actually is, how it is used in Australia for vegetation clearing compliance and what types of imagery are used. Australian States have adopted different styles of monitoring programmes, ranging from the ad-hoc acquisition of satellite data to state-wide programmes. A further key factor for the future use of satellites is whether they can be more cost effective than existing monitoring and enforcement approaches. This chapter also considers how much the imagery itself costs, as well as the other associated costs that potentially come with operating a satellite monitoring programme.

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31 E.g. as advocated by authors such as: J D Silberman, ‘Does Environmental Deterrence Work? Evidence and Experience Say Yes, but We Need to Understand How and Why’ (2000) ELR 10523.

1.48 Chapter 3 looks at the legislative controls in Australian States. States have come to different conclusions as to whether provision for satellite monitoring should be incorporated into legislation itself. It provides some context as to why there have been different responses in drafting and the impact of legislative controls. This chapter also considers whether legislative experiences in Australia can be transferred to other countries.

1.49 Chapter 4 considers the structures of regulatory bodies in each State and who has operational responsibility for different aspects of the satellite monitoring programme. Governments wishing to adopt such programmes are required to have a far more strategic regulatory approach than other conventional land-based approaches. This chapter considers the challenges of interdisciplinary working when using satellites in a regulatory setting.

1.50 There have been numerous court cases in Australia where satellite imagery has been used and as a country it has an unrivalled understanding of the benefits and limitations of its use as evidence. Chapter 5 examines the admissibility and use of satellite imagery in the Australian courts. It also considers how the judiciary in Australia have reacted to the use of satellite imagery as evidence, and considers national and international programmes on standardisation and best practice which could influence its probity.

1.51 There is little evidence as to impacts that satellite monitoring has had in practice. On a basic level, has it worked and improved things and to what extent? Evidence of effectiveness and any measurable differences will be extremely important to those regulatory bodies considering using such technologies. Chapter 6, therefore, examines whether there have been quantifiable effects and any other key impacts.

1.52 There are historical reasons why vegetation clearing legislation might be considered differently by Australian farmers, as compared, for example, to EU countries. Chapter 7 considers attitudes towards vegetation clearance and the legislation amongst the regulated community in Australia.

1.53 There has been little research, thus far, as to whether mere knowledge of being monitored by satellite has a deterrent effect. Chapter 8 examines whether this method of monitoring has influenced compliance behaviour of the regulated community. It uses the survey data to analyse how much regulated communities think they are being monitored and whether this method of monitoring might have altered their behaviour.

1.54 Chapter 9 looks at the attitudes of regulated communities in Australia to being monitored this way. The use of satellite technologies, in a legal context, has the potential to polarise opinions. It is expected that some of those regulated this way might dislike it; whilst others might consider that comparable data is publicly accessible on GoogleEarth, or embrace it. This chapter considers the opinions of the Australian farmers as to why they might like or dislike being monitored this way.

1.55 Chapter 10 considers the opinions of farmers, in particular their views as to increased or use of satellite monitoring, of its extension to other environmental laws affecting farming. It also considers ways forward that might lead to improved co-operation and make this form of monitoring more acceptable to those being regulated.

1.56 A summary of the key recommendations is provided at the beginning and the end of this report.
Chapter Two
Satellite monitoring and its cost

What is satellite imagery?

2.1 Satellite images are photos, or digital records, that reflect radiation of features on the ground. Satellites can orbit the earth, recording features on the ground in wavelengths not visible to the human eye, such as infrared. The use of satellite imagery is commonly referred to as earth observation or remote sensing.

2.2 Remote sensing is the process of extracting information from an object or analysis of data acquired by a sensor that is not in direct contact with that area. Although this definition is also applicable to aerial photography, or even other ground-based techniques, remote sensing is conventionally taken to refer to data acquired by satellite. 33

2.3 There are thousands of satellites in orbit, each with a cluster of sensors and specific data acquisition targets and scientific, technical, military, security commercial and political objectives. The satellites that are most useful for monitoring environmental legislation are earth observation satellites. These include the Landsat, SPOT, QuickBird, IKONOS, and WorldView satellites, to name a few. These are in a near polar, sun-synchronous orbit at altitudes of around 500-1000km. They revolve around the earth and on each orbit cross a particular line of latitude at the same local time. Their coverage depends on what satellite sensors are being used to record information at a range of spatial, spectral and temporal resolutions.

2.4 The latest commercially available high-resolution satellites can collect panchromatic (black and white) imagery at 0.40-0.80 metre resolution levels and multispectral (colour) imagery at 2-3 metre resolutions. 34 At this resolution, detail such as buildings and other infrastructure are easily visible. However, this resolution is insufficient for identifying smaller objects such as a licence plate on a car. In the context of environmental monitoring, both medium and high-resolution satellites can be useful for identifying land-use change, such as vegetation and tree loss. Generally, whether data from medium or high-resolution satellites is necessary depends upon the kind of environmental application that is required to be monitored.

2.5 There are numerous receiving stations across the world that receive raw data from satellites. This data, which can be purchased by anyone directly from commercial companies, allows a global view of countries, regions, areas, or a phenomenon of interest. Environmental surveillance can be targeted, as satellites can be programmed to record images of specific places, or supplied to meet the specific needs of data users. Otherwise, historical images can sometimes be purchased on an ad-hoc basis from commercial archives.

How is satellite imagery used?

2.6 Individual States in Australia use satellite monitoring to show unauthorised loss of native vegetation in their own regions. Government departments in each State analyse the satellite imagery against their own State legislative requirements to check compliance with the law. The imagery is used to determine whether and when native vegetation was cleared on properties within their State.

2.7 Infrared reflectance bands give a satellite analyst the most contrast between healthy, live vegetation and unhealthy or disturbed vegetation. Infrared bands primarily help analysts measure green leaf biomass: large numbers of healthy green leaves present in an image will result in a brighter and more intense infrared response. A dense coverage of trees with healthy leaves will provide greater contrast when the vegetation is destroyed or disturbed than would result from more scattered trees. For example, when a rainforest is felled and burnt, the contrast between the before and after satellite images is reportedly as clear cut to an analyst as black and white. 35

34 Governments in Australia generally classified NOAH AVHRR (1km) as a low-resolution satellite; Landsat (30m) as a medium-resolution satellite; and Spot 5 (2.5 m) as a high-resolution satellite.
2.8 When using satellite imagery to detect vegetation change, an analyst looks for relative changes in vegetation response between two images of the same location with different capture dates. If the first image is acquired prior to the commencement of the clearing of vegetation, it will provide evidence that the trees were intact at that time. If a second image is captured after the clearing has finished, this image can show any disturbance to the vegetation. If vegetation has been cleared, comparative images taken on different dates can provide irrefutable evidence of a clearing event (e.g. these can show that the clearing took place between the first image date and the second). What the image alone cannot always show is the type of vegetation removed, or how it was removed. Other forms of corroboration might be required where the law specifically distinguishes between whether it applies to native vegetation, as opposed to non-native vegetation.

2.9 This ability to identify the time period within which clearing occurred assists compliance officers in determining whether the clearing is an offence under legislation or permit conditions. The rates and extent of vegetation clearance can also be measured and compared over time. Satellite images cannot provide evidence of the illegality of the clearing alone, rather, that clearing has occurred within a certain timeframe, which in turn must be checked against permits and other exemptions under the legislation.

2.10 It is not possible to prove the exact start and finish dates of an historical clearing event from remotely sensed imagery. To do so would require an archive of imagery that was captured on a daily basis for the entire State. Satellite monitoring is, therefore, not a foolproof evidential tool. For example, if the land had different owners during the time between two images are taken, such images will not be able to show who cleared the vegetation.

2.11 Satellites can detect both broad scale clearing and under storey clearing. In some instances the images can show where single trees have been removed. Government departments in each State, depending on the detail required and the resources available, use a range of satellites. The difference between medium and high-resolution imagery is that you can see more detailed information on the latter.

2.12 Figure 2, below, contains two separate medium-resolution satellite images that were used by a State enforcement agency to show illegal vegetation clearance in Australia. There are clearly a large number of trees in the middle of the image on the left. The image on the right, which was taken at a later date, reveals that these trees were removed, without, as it turned out, legal permission.

Figure 2 (below). Medium-resolution imagery showing ‘before and after’ clearing.

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36 Ibid.
37 Broad-scale clearing is a long-used Australian term for a method of clearing land for agriculture. See S. Bricknell, Environmental crime in Australia (Canberra, Australian Institute of Criminology, October 2010).
38 Under storey is the term for the area of a forest which grows at the lowest height level below the forest canopy.
39 Source: Images were kindly provided to me by the New South Wales Government on 12 September 2007. Copyright: CNES: Distribution © Spot Image). I am grateful to Spot Image for allowing me to use these images in this report.
2.13 Figure 3, above, shows two more images that were used in a further vegetation clearance investigation in Australia. The image on the left, from an aerial photograph, shows in the marked circles five individual trees that were present on the land in 1999. The image on the right, taken from a high-resolution satellite image in 2001, shows that two of the original five trees (circled 4 and 5) are now clearly missing. These images were used to prove that the trees were removed illegally. Comparing the imagery in Figure 3 to that in Figure 2 demonstrates the resolution advances in the technology.

2.14 The images in Figure 4, above, also show before and after clearing using high-resolution imagery. The areas marked in red in the image on the right show that large areas of the trees shown in the image on the left are now missing.

What remotely sensed imagery is used?

Background

2.15 Environmental regulation in Australia is largely State controlled. States have different population levels and therefore widely variant tax bases. Generally, those States with larger populations, such as New South Wales, have more resources than States with smaller populations, like South Australia. Resources available and the affordability of imagery play a major role in decisions on which satellite data to use.

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40 Source: Images were kindly provided to me by the New South Wales Government on 12 September 2007. Copyright: CNES: Distribution © Spot Image). I am grateful to Spot Image for allowing me to use these images in this report.
41 From the IKONOS satellite, which has resolution capabilities of 1-4 metres.
42 Source: Images were reproduced from the report: Department of Environment, Climate Change and Water NSW, ‘NSW Annual Report on Native Vegetation 2008’, published by DECCW in July 2009. Copyright CNES 2007, Distribution Spot Image S.A., France, all rights reserved. I am grateful to Spot Image for allowing me to use these images in this report.
2.16 None of the State Governments in Australia own a satellite. Imagery is purchased from third party commercial providers (or obtained for free in some circumstances). Government departments, however, often carry out in-house remote sensing in the form of aerial photography.

**Medium-resolution satellite imagery**

2.17 All of the three States in this study use imagery data from the Landsat satellites. The Landsat program is the longest running enterprise for acquisition of Earth imagery from space. Landsat 5 operates at medium-resolution levels, with spatial resolution of 30 metres. This means that every 30 x 30 metre resolution section of each Australian State is covered.

2.18 The main reason for the use of Landsat is its unrivalled coverage, both in terms of geographical area and frequency. For most of Australia, from the launch of Landsat 5 (circa 1987), there is satellite data stored every 16 days over the same area on the ground. Landsat observes more in one pass than rival high-resolution satellites. One Government official estimated that the existing Landsat archive would have about 500 times more coverage than other platforms/supplier’s archives of high-resolution data: ‘this is why for conducting regular State-wide monitoring, Landsat has no peer’. This represents an amazing temporal depth of data to use for change detection that high-resolution imagery cannot hope to match at the present time. Using higher resolution satellites for the same purpose requires more passes and therefore takes longer. For example, it would take approximately 12 months to obtain SPOT imagery (2.5m resolution) for a whole state, and to capture state-wide imagery using Quickbird (1m resolution) would take approximately 2 to 3 years (at less than 10% cloud cover).

2.19 There are a number of additional advantages to using Landsat imagery for vegetation monitoring. Firstly, because of the age of the programme, there is an extensive imagery archive dating back to the 1970s. This enables good forward and backward (i.e. before and after) comparison of sites. Secondly, the Landsat satellite has a thematic mapper with excellent sensitivities towards identifying vegetation and woody matter. Thirdly, Landsat data is also more affordable than other high-resolution satellite imagery.

2.20 State Governments obtain Landsat data from the Commonwealth Government in Canberra, who in turn source this imagery for the whole of Australia as part of a greenhouse emissions carbon accounting system. The Landsat data is used to determine the area, extent and timing of native vegetation clearing. It is relatively good coverage and reliable for monitoring of this kind.

2.21 There can be difficulties in using Landsat data and other medium and low-resolution satellite imagery in court. Experience has shown that Landsat satellite imagery can be confusing to laypeople not familiar with satellite imagery. Despite looking like a photographic product of a large geographic area, Landsat satellite imagery becomes pixelated when zoomed in on, so that an image appears blurred. Whilst an expert analyst knows what these blurred colours on the image represent, they can sometimes confuse those with less scientific knowledge or experience. A number of Government officials commented that on its own, medium-resolution imagery was sometimes inadequate for use in courts to demonstrate the clearance in a visual before and after scenario.

2.22 However, when faced with evidence from both Landsat imagery and ground investigations, some landholders plead guilty to an offence. As such, sometimes there is no need to rely on any further evidence. If there is any dispute over whether an offence has been committed, further evidence will in most cases be required if the case goes to court. All three Australian States concluded that further evidence could be provided from higher resolution remote sensing data, which a layperson could more easily directly relate to and interpret.

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44 Landsat 5 imagery is currently used by most States. Landsat 7 imagery was used before a fault in the operations of the satellite.

45 Estimate provided in Personal Communication by the Queensland Government.

46 Most commercial high-resolution suppliers are more interested in getting complete coverage of their target market country before looking at archiving repeat acquisitions over the same spot on the earth. Personal Communication.

47 In some States there can be problems with cloud-cover, which can affect the quality of the imagery. For example, a small percentage of the total New South Wales area was not interpreted in the 2007-2008 period due to cloud cover in the 2008 imagery. In practice the Government in New South Wales will use Landsat images where there are gaps in coverage due to cloud cover.

48 Estimate provided in Personal Communication by the New South Wales Government for their own State.
2.23 Timing differences in capturing imagery over large areas illustrates that compromises between coverage and resolution are often necessary. Regulators wishing to use satellite imagery, therefore, need to consider which elements of satellite imagery products are more important than others. A key lesson learnt is that whilst regulators can use medium-resolution images for monitoring purposes, medium and high-resolution imagery is more useful as evidence in a courtroom setting.

Aerial photography

2.24 An obvious secondary source of information concerning land-use change is from aerial photography, and such imagery has historically supported monitoring programmes in Australian States. Aerial photography is taken at resolution levels of between 0.5 - 1.0 metres, and can assist understanding about what has taken place on the land in question. It is most often used by Government investigators to check land after an event is known to have occurred. Some Government departments have their own planes, otherwise, they can be privately chartered. Aerial photography can be used as ‘reasonable cause’ for ground-based investigations, or to investigate how the clearing might have taken place.

2.25 In the context of providing historical evidence, some States, such as New South Wales and Queensland, have had an dedicated aerial photography programmes for many years. This means that there are Government archives of aerial photographs. South Australia, however, used to have an aerial photography programme, but shut this down in 2005, primarily because satellite monitoring was considered cheaper.

2.26 Aerial photography can be an extremely powerful tool for proving historical evidence, but it does have its limitations. Firstly, it generates a lot of data, which is often too much for investigation teams to process. Secondly, when compared to satellite monitoring, it can be prohibitively expensive if required for large areas (for example, aeroplanes require refuelling, necessitating multiple trips). Because of financial constraints, Queensland, for example, only obtains aerial images of about 5% of the total area of the State. The New South Wales Government focusses their aerial monitoring on parts of the eastern and central divisions of the State.

2.27 The ground revisit frequency of existing aerial monitoring programmes in Australian States can be a number of years on average. If a revisit period coincides with when an offence occurred, then these would be used in investigations and court. However, their availability is obviously restricted by their temporal acquisition and coverage.

Ad-hoc acquisition of high-resolution imagery

2.28 Whether or not to use higher-resolution imagery is decided on a case-by-case basis, after consideration as to whether it is needed in prosecutions. Generally, if a case goes to court and no aerial photography exists, additional high-resolution satellite imagery would be purchased, if available. High-resolution satellites generally allow cleared areas of vegetation to be mapped accurately. The high spatial resolution of this digital satellite imagery in fact makes it appear as if it is a photographic product. As could be seen in Figure 3, above, individual trees can be seen in these images.

2.29 In South Australia and Queensland, the vegetation clearing programmes are based on Landsat data, supported by ad-hoc acquisition of high-resolution imagery. High-resolution imagery is specifically ordered as and when needed, because neither of these States have state-wide, high-resolution monitoring programmes. If high-resolution satellite imagery is required, Government departments have to source it. Despite extensive availability of commercial imagery, it is sometimes a challenge for Government departments to access. The marketing of satellite imagery is not currently developed with the regulatory or legal sectors in mind.49 The current status quo of shopping around through individual distributor’s websites is time-consuming and can be impenetrable to those without scientific training,50 and unfortunately there is not a searchable database compiling imagery from all distributors. Regulatory bodies in these States will, therefore, normally seek

50 e.g. geographic coordinates are required and the purchaser has to have some scientific understanding of complex technical information like image direction and cloud cover.
assistance in locating imagery from other arms of Government, including the Commonwealth Government, who will often have contacts and purchasing agreements with commercial companies selling satellite data. Imagery purchased in Queensland and South Australia on an ad-hoc basis has come from the Ikonos, QuickBird, and SPOT satellites, as well as a number of new satellites launched in China and Japan.

**Recommendation 1**

Sourcing and getting access to satellite data is a major challenge without technical support. Satellite providers should look at providing better support and communication networks to Government. This could enable Government to see the possibilities that exist in a monitoring and evidential context and help them get the information that suits their needs. The introduction of a common database that could be used by non-technical laypeople, and which offered a simple search facility of databases where archived satellite imagery is held, is recommended.

2.30 When States first began purchasing high-resolution imagery, they found that, generally, commercial archives did not include imagery of the areas they investigated. Whilst there was archived high-resolution imagery of cities aplenty, coverage of non-commercial and less populated rural areas was in short supply. This was because suppliers of imagery only considered there to be commercial demand for images of cities. One Government official commented that it seemed that imagery providers did not know there was a ‘needs market’ for this. However, the options in terms of image availability of rural areas in Australia are certainly better now than three years ago. The landscape is slowly changing, and some of the early problems with timing and coverage seem to be subsiding, particularly with increased competition between satellite providers.

2.31 Queensland and South Australia have not yet moved towards obtaining annual baseline imagery of the whole of their States using high-resolution satellites. This appears to be primarily because such programmes are expensive to run, although there are issues of coverage too. As mentioned above, high-resolution imagery can potentially take between one and three years (depending on which satellite is used) to give a full state-wide picture of land-use change. There can, therefore, be a timing issue with some types of high-resolution satellites.

**State-wide programme using high-resolution imagery**

2.32 In 2007, the New South Wales Government announced a four-year dedicated monitoring programme using high-resolution imagery. The Government purchased SPOT5 imagery with complete state-wide coverage. This has resolution levels of up to 2.5 metres and is seen by the Government as the best new high-resolution environmental monitoring system in Australia.

2.33 To purchase state-wide, high-resolution, satellite imagery requires forward planning. The Landsat satellite has a sensor covering a considerable area, which always records what it sees. All of this recorded data from the Landsat satellite is archived. With SPOT, the sensor can be tilted forty five degrees, to enable close up viewing of smaller areas, but this is only normally switched on when they have an order for the data. Generally, archives containing high-resolution imagery only contain purchased data (e.g. data which someone ordered and purchased in the past).

2.34 The New South Wales Government use SPOT satellite imagery because they found that SPOT’s competitors did not have the capacity to supply regular state-wide coverage that matched their requirements, when they were negotiating contracts. SPOT data was found to have the ‘veracity and image quality’ that they required. The Government also considered SPOT to be professional in supplying data that suited their

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51 Personal Communication.
52 The SPOT 5 data has resolution levels at 2.5m panchromatic (black and white) or 10 m (multispectral) – red/green infrared.
53 Personal Communication.
54 Personal Communication.
55 Personal Communication.
need for a ‘tighter’ standard of image than normally sold.\textsuperscript{56} Negotiations allowed for prices and specifications more suited to the Government’s requirements, for example data that was less than eighteen degrees, changing the field of view considerably (it is normally forty five degrees).\textsuperscript{57} The Government also only accepts imagery from SPOT with less than one per cent saturation in the area; if it is more than this, they will not accept it if it needs to be recalibrated.\textsuperscript{58}

**Use in combination with other data**

2.35 A large part of the decision whether to proceed with an enforcement action is based on the evidence from satellite imagery, as it can determine roughly when the vegetation clearing took place.\textsuperscript{59} However, this is not a foolproof method of providing evidence. For example, there may need to be identification of the type of tree species that has been removed. This cannot be reliably mapped from Landsat (medium-resolution) imagery alone. Therefore, a regulator can only get a full picture of what actually happened by ground-truthing (a term used to denote on-the-ground checks used as a way to verify the satellite data), and with other sources of evidence. However, experienced botanists can fairly reliably map vegetation species from high-resolution imagery.

2.36 Further spatial analysis might be required to determine if the clearing was in breach of legislation. Other departmental datasets and information sources are analysed in conjunction with the remotely sensed imagery to determine the exact sequence of events and administrative actions pertaining to the clearing event.

2.37 All changes to vegetation on the imagery are put into a Geographical Information System (GIS) that can be likened to an automated mapping system. Comparison of the clearing polygons against digital datasets in a GIS divides the clearing into potentially lawful and unlawful clearing polygons (spatial analysis of imagery allows a user to draw a polygon for feature-specific measurement and analysis). The GIS will contain geographical information such as roads, rivers, contours, cadastral boundaries (i.e. the precise boundaries of a given property) and survey control points. Each State has different datasets for analysing what has taken place on the land in question. Some States have software scripts, which are designed to highlight information such as whether the clearing was a result of bushfires or natural tree death. This will then be overlaid with other data including a database on ownership of the land and tree clearing permit data. If a permit exists, the analyst will check whether the clearing was outside the permitted areas and associated timing. Next, cadastral boundary information could be checked to determine if any clearing has occurred outside the subject property’s boundaries.

2.38 The GIS data is also integrated with information obtained from vegetation mapping. Some States have some form of spatially mapped information on digital databases. In Queensland, for example, the regional ecosystem mapping from the Herbarium is used to see whether the vegetation which had been removed was remnant or non-remnant. This has sometimes caused some confusion amongst farmers and in the courts. This is because the scale used is 1:100,000, which gives a general indication of what vegetation was there in large mapped areas, but not what was definitively there in each smaller section. It does, however, guide the analyst in assessing what was likely to be there, and this can inform ground-based investigations.

2.39 All of the States are building on their experience and actively seeking to improve automatic monitoring. New models are being built into automated systems for change analysis, so that less human analysis is required and information can be obtained through programmed digital signatures. It is hoped that these models will reduce the time taken after detecting clearing to notifying the investigator and ultimately presenting the satellite based evidence in court.\textsuperscript{60}

\textsuperscript{56} Personal Communication.
\textsuperscript{57} Personal Communication.
\textsuperscript{58} Personal Communication.
\textsuperscript{59} Some high-resolution imagery and aerial photographs can also show how the clearing occurred (e.g. mechanical clearing or fire).
\textsuperscript{60} Personal Communication.
Satellite Monitoring of Environmental Laws – Lessons to be Learnt from Australia

Time periods for the monitoring

South Australia

2.40 The South Australian Government first trialled the use of satellite data in a compliance context using Landsat imagery of Kangaroo Island (an Island in the south of the State). This trial was then extended to the south-eastern section of the State, as this was considered the most non-compliant region. The Landsat satellite monitoring was then extended to cover the whole State every two years, before finally being obtained state-wide on an annual basis. South Australia has been monitored using Landsat on a state-wide basis for approximately seven years, supported by the acquisition of ad-hoc high-resolution imagery when required. Part of the reason for the monitoring being expanded to the whole State, is that the Commonwealth Government now provides more regular and up-to-date satellite imagery than they did in the past. There was also a rationale that they might as well examine every farm in the whole of the State, as computer datasets are not labour intensive. However, in practice, the whole of the State is not ‘officially monitored’, because the Government does not look at imagery covering all outback desert areas (as they do not generally expect breaches of legislation to take place in these).

Queensland

2.41 In Queensland, Landsat satellite data is used state-wide in conjunction with ad-hoc acquisition of high-resolution imagery. As 100% of the State is monitored using the Landsat data, the Government monitors all of the farms and other properties in the State. This equates to approximately two and a half million properties. The Government began the satellite monitoring programme in 1995, by monitoring every property in the State from 1988 through to 1999, generally every two years, but sometimes up to four years. Since 1999 every property has been monitored on an annual basis.

New South Wales

2.42 Before, 2003 there was an ad-hoc aerial surveillance programme in New South Wales. 2004 saw the introduction of a hot-spot satellite monitoring programme in the State. The specific areas which satellites were targeting were kept secret so that a deterrent would be effective across the whole State, whereas only approximately 15% of the State was actually monitored each year. This hot-spot programme is similar to the agricultural monitoring programmes in the EU, where a minimum of 5% of farms receiving subsidies must be monitored each year. New South Wales was the last State to move towards the annual state-wide acquisition of satellite images. In 2006, monitoring of vegetation loss was examined in the whole State using Landsat data - with Spot 5 also continuing to be used in the hot-spot programme. There had been no systematic monitoring before this for political reasons: farming communities were extremely dissatisfied with vegetation clearing laws. The programme of annual state-wide monitoring is still partly based on Landsat data, although the New South Wales Government now, in addition, have state-wide comparison data from the high-resolution SPOT satellite for 2007-2010.

How much does the imagery cost?

Landsat satellite imagery

2.43 The Landsat data normally comes from the Australian Commonwealth (federal) Government and is usually provided either free, in raw data form, or at low cost. The Commonwealth Government is keen to support compliance projects, so are willing to provide copies of this data to States. Some States have to pay a small charge for processing costs associated with receiving this Landsat data. This processing costs in the region of (AUS) $50,000 annually. Some States also buy the data as ‘pre-released’ so they can process it

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61 Personal Communication.
62 Personal Communication.
63 Personal Communication.
64 Personal Communication.
65 Personal Communication.
66 Personal Communication.
67 Personal Communication.
68 Estimated cost given in Personal Communication by the New South Wales Government.
69 E.g. In a new, but raw format.
quickly and avoid delays in bringing a case to court within the limitation periods. Other States use data that has already been processed. For example, in Queensland the State’s SLATS vegetation mapping project purchase raw data to enable geometric and radiometric calibration of the data to a peer reviewed State standard. This calibration of satellite imagery ensures accurate change detection.

2.44 States are generally very happy to acquire Landsat data from the Commonwealth Government, because it is relatively cheap, well-documented, well-archived and secure. A Government official from one State said that obtaining Landsat data from the Commonwealth Government represented a ‘big saving for us’. The Queensland Government are also considering acquiring future comparative imagery from the United States Geological Survey, who now provide this data free of charge. However, the Government wanted first to examine whether there would be any potential problems with technical differences in the processes they use.

Ad-hoc high-resolution satellite imagery

2.45 There are cost implications for Governments wishing to use additional high-resolution imagery. As was mentioned above, this will probably be necessary if a case goes to court. Presently, ad-hoc acquisition of high-resolution images, such as from the IKONIS or Quickbird satellites, costs States about (AUS) $2000 each (per image). There are limited Government funds for buying additional imagery and spending (AUS) $2000 on a satellite image is generally considered expensive. However, as only approximately five to ten cases go to court each year per State, this could only represent an annual net spend of about (AUS) $10,000 to 20,000. If numbers of court cases remain at current levels, a program of buying ad-hoc high-resolution imagery to corroborate evidence from Landsat imagery could, therefore, operate at a relatively attractive price. In any case, some States also seek to recover costs in court if they use high-resolution imagery.

2.46 Imagery prices have come down a lot in recent years, making high-resolution data more affordable. One Government official commented that ten years ago, high-resolution imagery was impossible to afford. However, whilst the costs of satellite data have fallen over time, they have remained static for the last couple of years. State Governments expected the cost of purchasing high-resolution imagery to decrease in the next few years, and commercial providers were starting to offer new pricing models for bulk imagery purchases. One Government commented that any drop in price would mean that they would be able to purchase more imagery, whereas another considered that this would make little difference to them, as they would still be constrained by departmental budgets in expanding such a purchasing programme any further.

SPOT satellite imagery

2.47 As discussed above, there has been significant investment in high-resolution satellites in New South Wales, who now have a state-wide programme of monitoring using SPOT imagery. The first business case for using SPOT in New South Wales was made in 2004/5 and this was for approximately (AUS) $5 million per annum. SPOT was in part chosen, ahead of rival companies, because of cost. The Government in New South Wales estimated that if they purchased state-wide data using the Quickbird satellite, which has higher resolution capabilities than SPOT, then this could have cost them in the region of (AUS) $30 - 40 million per annum.

2.48 The New South Wales Government acquire SPOT imagery independently from the Commonwealth Government. The price of the imagery is constantly renegotiated, although presently costs in the region of (AUS) $2.5-3 million per year for raw imagery, and comes at a discounted price by sharing the data with GoogleEarth. There will be a renewal process in 2010, as the New South Wales State satellite programme

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70 However, the Government only receive data in a mosaic format (as opposed to the more useful digital change layer), or information showing unexplained clearing.
71 Personal Communication.
72 Estimated costs based on average amount paid in each State. Figure(s) given by Queensland, New South Wales and South Australian Governments.
73 Personal Communication.
74 Personal Communication.
75 Personal Communication.
76 Personal Communication.
77 Personal Communication.
78 So many of the images will be similar to those contained on GoogleEarth. However, the final product owned by Government will be different to that available on GoogleEarth. As one Government official put it, their imagery would be superior and contain the ‘fancy stuff behind the scenes.’ Personal Communication.
officially ends in the 2011/2012 financial year. If the State Government decides there is insufficient funding to continue purchasing the high-resolution imagery, then it is probable that they will go back to using medium-resolution imagery from Landsat alone, with ad-hoc acquisition of high-resolution imagery – like the other States. This would change their monitoring system considerably but would not end it.

2.49 The price of satellite data varies with where the data is sourced from and what kind of imagery it is. If medium-resolution data is being used, or high-resolution is bought on an ad-hoc basis, then this might not cost regulatory bodies significant sums of money. Buying high-resolution data covering large areas is not going to come cheaply, but it is not necessarily a fruitless cash investment. A key lesson learnt is that regulators wishing to buy in bulk should negotiate discounts and have the imagery specifically tailored to their needs.

Other uses for the imagery

2.50 In Australia, the data that used by State Governments is, normally, used not just for monitoring vegetation clearance, but can be available to all Government agencies for other purposes. Whether imagery can be used by anyone else in Government depends on the agreement that was reached with the commercial bodies supplying the satellite imagery. State Governments commented that the suppliers were often amenable to allowing this to be negotiated as part of the contract.  If this forms part of the contract, the imagery can be shared appropriately and utilised by a number of Government agencies.

<table>
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<th>Recommendation 2</th>
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<td>Purchasing satellite data is more cost-effective if it can be used by others, or used for multiple purposes (subject to the relevant licensing authorisation). Governments should actively seek out these alternative uses. Government bodies considering purchasing data for monitoring programmes are recommended to establish a coordination body to champion and support activities where such images might be used elsewhere in their organisation.</td>
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2.51 In Australia, there seemed to be growing interest amongst other Government agencies and departments in using the data that was purchased for vegetation monitoring, especially if it was free, but some of these would probably be reluctant to contribute financially towards a State purchasing programme. Those Government agencies that have shown interest in using satellite imagery tend to be those who use other forms of spatial data. Some environmental departments have started to use satellite imagery, or are considering its use, in species management and water monitoring. Other Government agencies interested in using the data have included the Department of Fire Services, Lands Department, Primary Industries Department, Planning Department and Energy Services Department. However, while satellite imagery does have a number of other potential uses and users, monitoring vegetation clearing remains the primary use of satellite data in Australian States.

2.52 In practice, heads of groups and departments in State Government meet and do seek to coordinate activities using remote sensing in the land management sphere. New South Wales is especially keen to champion activities within Government, particularly as they spend more money on such data than other States. The New South Wales Government has a sub-group on remote sensing to enable strong coordination in the State, and considers the expenditure on SPOT imagery to be ‘value for money, and even more so if its uses can cut across other areas of regulation and legal monitoring. Some States have looked into joining forces and pooling together when purchasing imagery. However, each State has different biophysical landscapes, so they have varying imagery needs. As the New South Wales monitoring programme was originally modelled on Queensland’s, these States have been working in a collaborative fashion with satellite imagery. There is a possibility that other States might collaborate more in the future, either in designing regulatory strategies which use satellites, or when purchasing data.

79 Personal Communication.
80 For example, in estuarine management, flood plain monitoring, irrigation rights and diversions of water-courses.
81 Personal Communication.
**Recommendation 3**

There should be cataloguing of imagery holdings within Government to avoid purchasing the same, or similar, data repeatedly. It is recommended that if different Government departments purchase satellite imagery, then this should be coordinated through a single body. This would provide increased negotiation power and afford the opportunity for discounts when purchasing imagery in bulk.

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**Comparative costs in the European Union**

2.54 There are very few examples of the costs of using satellite imagery in regulatory strategies outside Australia, but the experiences of Australia provide some first examples of costs. The only other comparative example comes from Europe, where every year approximately five million farming businesses declare more than fifty million agricultural parcels in order to claim up to €56 billion each year in EU subsidies.\(^\text{52}\) The initial responsibility for checking this expenditure for fraud and irregularities lies with the individual Member State, who must check a minimum of 5% of these claims in their own countries. While the monitoring responsibility is with the individual Member State, the EU provides satellite imagery free of charge to assist in fulfilling this requirement. The purchase of satellite data from commercial providers to check this minimum level of claims costs the EU approximately €5 million each year.\(^\text{55}\) The EU agricultural monitoring scheme appears to result in significant financial savings at national level compared to the cost of ground-inspection.\(^\text{84}\) Checking for fraud in 27 Member States, across a landmass of 4,324,782 km\(^2\) is a difficult task, but the satellite monitoring appears to be cost-effective.

2.55 It is arguable whether other major regulatory programmes in Europe would have such financial resources available to use satellite images as part of dedicated monitoring programmes. However, from the examples above in Australia, it is clear that EU Member States could chose to purchase high-resolution satellite imagery of their own country annually for a cost of approximately €1.5–2.5 million.\(^\text{85}\) If this data can be shared between departments, then the costs involved might not be considered too prohibitive by some Governments. However, it is more likely that individual departments and agencies in European countries could begin by buying high-resolution on an ad-hoc basis for use in major investigations. Satellite imagery will be particularly useful to such bodies where other historical evidence is no longer available. At a cost of approximately €700-1400 per image scene bought,\(^\text{56}\) this might be affordable to a number of regulatory bodies in EU Member States.

**What are the other associated costs with a satellite monitoring programme?**

**Different costs in each of the States**

2.56 In Australia, the overall costs of satellite programmes differ from State to State. More accurately, they exist at different ends of a spectrum. In New South Wales, the entire native vegetation monitoring programme costs the Government in the region of (AUS) $6 - 7 million a year.\(^\text{87}\) As the raw imagery purchased by New South Wales costs about (AUS) $2.5 - 3 million,\(^\text{88}\) it is clear that significant sums of money are also needed to employ staff and to purchase scientific equipment. Comparatively, in South Australia their native vegetation programme (including broader administration of the Act) costs in the region of (AUS) $2 million a year.\(^\text{89}\) The New South Wales monitoring programme costs approximately three times as much as the South Australian programme, illustrating that satellite monitoring will be, in some ways, as expensive as a Government wants it to be.

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\(^{82}\) Statement by Simon Kay, JRC European Commission (Personal Communication, 5 December 2007).

\(^{55}\) Statement by Chris Lee, UK Rural Payments Agency (Personal Communication, 4 December 2007).

\(^{85}\) This was estimated using my own calculations based on average purchasing costs (of SPOT satellite imagery) in New South Wales. Costs in practice will depend on the size of country and imagery required.

\(^{56}\) Ibid.

\(^{87}\) Personal Communication.

\(^{88}\) Personal Communication.

\(^{89}\) Personal Communication. The Native Vegetation Council in South Australia contributes about AUS $400K of these costs. This money goes towards purchasing imagery and employing two members of staff.
Staffing

2.57 What is normally a bigger expense than purchasing the satellite imagery itself is employing spatial experts to process and interpret the data. Some Government departments run their programmes using in-house analysts and others use a mixture of in-house and out-sourced processing/ortho-rectification experts. These have to be specialised, highly skilled professionals. There is only a relatively small pool of such graduates in Australia each year who are qualified to work on these monitoring programmes, and as such, demand is high and they will require reasonable remuneration. A number of State Government departments had suffered budget decreases, and while financial resources were reduced each year, salary costs had to go up over time. From a technical point of view, it was thought that some of the systems in place were increasingly moving towards being systematic, so the analysts would be needed less and less. However, there have been issues as to whether such datasets are ‘proven’ or work more effectively than human analysts. Staff will therefore always be required to at least review and check certain stages of the remote sensing data.

2.58 The South Australia monitoring programme, in terms of the number of remote sensing scientists employed, is run on a ‘shoe-string’ compared with other States, employing only one satellite data analyst. Queensland averaged six permanent remote sensing scientist positions, costing approximately (AUS) $500,000 a year. New South Wales had the largest scientific programme and employed up to twenty full time analysts. Both Queensland and New South Wales also had part-time employees working on the scientific side of the monitoring programme).

Recommendation 4

Purchasing the satellite data is not the only significant expense in establishing a satellite monitoring programme. Work is required to design a programme methodology; source imagery and arrange contracts; buy computers and data storage facilities; and to employ analysts and train them. This can take a long time and cost significant sums of money. It is recommended that those considering using this technology in a regulatory context should endeavour to consider these costs in detail (with a view to avoiding under-budgeting) and do so in advance.

Data storage

2.59 As well as increases in staffing costs in some States, software licensing costs and hardware costs have also gone up each year too. Government departments have had a desire to be at the leading edge of the technology, but some found that when they got to that level, computers and other hardware had then changed and needed updating.

2.60 The New South Wales Government had resource issues with purchasing high-resolution data from SPOT which were unexpected at the outset. They underestimated the sheer volume of data storage required and the data management needed. The Government also found that the SPOT data they were buying could not be stored on normal computers or servers, and so they had to purchase an expensive ‘super computer’ to handle the data storage. For example, they found that twenty years of Modis imagery required two terabytes of storage; twenty years of Landsat imagery required five terabytes storage; one year of Spot imagery required eight terabytes of storage; and one year of Quickbird imagery required about fifty terabytes of storage.

2.61 The Government in New South Wales also found that because the amount of information they were purchasing was enormous, they also had to be extra vigilant in their filing and processes of naming imagery, otherwise they would lose imagery in the sheer volume of data that they were processing. There have been frustrations in the business and IT side of managing the data. An unexpectedly slow part of the process has

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90 Personal Communication.
91 Personal Communication.
92 Personal Communication.
93 Personal Communication.
94 Personal Communication.
95 Personal Communication.
been loading data onto the ‘super computer’, which can sometimes take weeks. There was also an expectation in New South Wales that the technology and communication links would work better than they have done in managing the imagery. The Government found that their desires and expectations were ‘beyond the capability of national broadband capabilities’. The sheer volume of the data size meant that, sometimes, data could not be sent down an internet line. As they needed to send data quickly to different sites in investigations, they had to find different ways of moving data around.

2.62 Satellite imagery requires vast data storage capacity. A key lesson learnt is that there could be thousands of files covering different locations, so anyone archiving satellite data needs to adopt stringent procedures for the filing and naming process of imagery.

2.63 The Government in New South Wales were lucky not to be setting up their satellite programme from scratch, but rather had the assistance of the Queensland Government, who had experience at that stage. Governments ought to consult other bodies that have used satellite data in a regulatory/legal context before implementing their own data systems. This could enable them to ‘get a reality check on their own expectation management’, as well as to get advice on costs, so that there are no financial surprises once monitoring programmes are underway.

### Long-term future of satellite monitoring programmes

#### Political funding

2.64 Many Australian States are in a time of fiscal pressure, with budget cuts taking place across Government sectors. There appear to be no guarantees that satellite monitoring programmes will continue long-term, and their future appears to be dependent on Government priorities and politics. Vegetation clearing is no longer considered a top priority in some States and current political momentum in Australia is more focussed on water regulation. If the imagery that is used for monitoring vegetation clearing can also be used for other environmental monitoring (e.g. water law compliance), then it stands a better chance of having a secure future.

#### Relying on one satellite platform

2.65 Although there are many satellites in space, there are currently not a massive number of these with a focus on earth observation. Many of the key existing earth observation satellites have been mentioned in this report. Some of the others that have not been mentioned are either not commercial, are in some way unproven, or have been considered by Governments in Australia as not being of good enough quality.

2.66 One of the barriers to demand and the long-term use of regulatory satellite monitoring is over reliance on individual satellites. Satellites can stop working or fall out of the sky. For example, the Landsat 7 satellite, which many of the State monitoring programmes in Australia used, failed in 2003. Since then, approximately one quarter of the data in a Landsat 7 scene is missing and the visuals are stripy. Its predecessor, Landsat 5, which is used in all three of the Australian States examined in this study, has also faced difficulties. In 2005, there were problems with the primary solar array drive and in 2009, it tumbled out of control and its power failed for reasons unknown. It resumed normal operation after only a few days, but it is now on battery savings mode.

2.67 Landsat 8 is not due to be launched until 2012 with improvements in resolution and data management. However, there are obvious issues with what happens if Landsat 5 fails in the near future and there is no monitoring available for the time before the launch of Landsat 8. State Governments would not have access to the free or low-cost satellite data that is currently supplied by the Commonwealth Government.

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96 Personal Communication.
97 Personal Communication.
98 Personal Communication.
99 Personal Communication.
**Recommendation 5**

Governments should, as far as possible, consider keeping the vendor and satellite platform independent, in order to avoid dependence on a single satellite product. Although this might have cost implications, flexibility is needed to continue regulatory strategies. If only one satellite is used, there is always a danger that regulators could be left high and dry if something happens to that satellite. It is recommended that those wishing to use such technologies consider alternative strategies, such as using data from different satellites, in advance.
Chapter Three
Vegetation clearance legislation in Australia

Legislative background

3.1 Australia has a Federal legal system although environmental issues are regulated primarily at State or Territory level. Whilst there is environmental regulation at Commonwealth (Federal) level, this is generally confined to prescribed matters of national environmental significance. Each of the eight Australian State/Territory jurisdictions, therefore, has its own legislation regulating vegetation clearance and laws do vary from one State/Territory to another.

3.2 This report concentrates on legislation in three States: South Australia, Queensland and New South Wales. The reasons for the choice of these States were discussed in paragraph 1.40.

The impact of clearing

3.3 During the last 25 years, vegetation clearing has emerged as a very serious issue in land management in Australia. Almost two thirds of land in Australia has been modified for human uses. The widespread clearance and decline of native vegetation has been identified as one of the major environmental issues facing Australia.

3.4 Increased human occupation in Australia has resulted in a growing need for space for urban development and agricultural lands. Consequently, Australia has been one of the largest vegetation clearing nations in the world and has at various times been ranked in a number of studies between the fifth and tenth counties in the world with the highest rate of vegetation clearance. The scale of the vegetation clearance which has been undertaken so far has had detrimental consequences for the sustainability of the natural environment in Australia. Clearing native vegetation from much of Australia’s prime agricultural land has caused widespread fragmentation of natural ecosystems, reducing their viability and threatening maintenance of flora and fauna and the ecological processes upon which productive rural landscapes depend. Scientists consider that its impact has become a significant factor in land degradation (including dry-land salinity, weed invasion, soil erosion and soil structural decline), the loss of biodiversity and species and accelerated increases in greenhouse gas emissions.

Who is clearing vegetation and why?

3.5 There are three main groups which have historically undertaken vegetation clearing in Australia. The largest group to clear vegetation has been farmers. In spite of Australia’s harsh environment, agriculture is the most extensive form of land use. It has historically played an important role in the development of Australia’s economy and the gross national value of agricultural production has been estimated to be (AUS) $43.3 billion a year. Landholders have traditionally cleared vegetation as part of their farm management, or to intensify agricultural production on their landholdings. The second key group to clear vegetation in Australia has been property developers, who clear vegetation to make way for residential development. Growing populations have increased demand for housing in Australia and there are obvious financial incentives to build marketable property on prime untouched land near the sea. Some developers and homeowners also clear vegetation to sell or build on new residential sub-divisions (e.g. the land between houses). The third group that historically has undertaken significant vegetation clearance has been large commercial organisations, in particular mine operators. These have cleared vast tracts of land as part of their industrial operations to allow access for exploitation of natural resources.

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100 P Briggs and N Thomas, ‘Australia’, Chapter 6 in The International Comparative Legal Guide to: Environmental Law 2009 (Global Legal Group, 2009). There is, for example, Commonwealth legislation in Australia to protect vegetation clearing in Ramsar listed wetlands e.g. Environment Protection and Biodiversity Conservation Act 1999 (Commonwealth).
3.6. Environmental impacts increase as land-use intensifies, so intensive uses such as mining and urban development involve the greatest level of modification and thus generally have a more significant environmental impact than agricultural clearing of the same size. However, intensive uses account for less than one per cent of the total land use in Australia. This report, therefore, focuses on clearing which farmers have done, as they are the largest group in Australia to clear vegetation, and the most identifiable in terms of research analysis.

3.7 There are many reasons why landholders clear vegetation on their farms, the most important of which include:

- Fire Protection. Landholders clear vegetation close to properties to prevent the risk of property damage from bushfires.
- To increase the area of arable land available. This is to make available more land to plant crops, or to make the property more valuable if they are planning to sell.
- Management of regrowth and maintaining land.
- To install irrigation pivots. These sprinklers rotate around the centre of a pump irrigation line and irrigate in 360-degree circles (some of which are huge, covering areas of up to 267 hectares). Trees are removed if they block these sprinklers from being able to move round.
- To put stock on higher ground to enable them to feed or if there is a danger of flooding.
- Access. To allow farmers to get quad bikes on land to round up the cattle or because a tractors access is being blocked by large tree branches.
- Agricultural development. To put up sheds, structures, or factories for agricultural storage or processing.
- General farm management. For example, putting in fence lines.
- Crimping edges. Before advances in farming technologies, tough scrub on the margins was left and traditionally not cleared. Farmers now have access to bigger and tougher ploughs and tractors with GPS positional tracking that can clear the edges with more precision.

3.8 Not all of the above examples of vegetation clearing are illegal. When State Governments in Australia legislated, they had to balance which of these practices above to prohibit, and which to allow as exemptions, as many were deemed by farming communities as necessary for the essential running and maintenance of a farm. Whilst Government uses satellite monitoring to identify vegetation clearance, this still has to be cross-checked against exemptions under the Act, permits that might have been given and authorisations under other legislation.

3.9 Some of these examples are, however, prohibited by legislation. Some farms will have expensive compliance assurance schemes in place to make sure they are in full compliance with legislation, whereas other farmers will operate around the margins of the law and the exemptions, knowing that if there is a small chance that they would break the law then it is unlikely that they will be detected or prosecuted. At the other end of the spectrum, some will clear illegally, knowing there is no exemption or permit to rely upon, solely with the intent of financial gain. Others will clear because they are either ignorant of the law or the exemptions.

Policy influence and satellites

3.10 Satellites were originally used in some States to monitor changes in vegetation for the purposes of policy formulation. The use of satellites in a compliance context came about, in part, by accident, in both South Australia and Queensland. Governments in these two States were originally using Landsat satellite imagery for vegetation mapping, simply to see what trees were growing in their States.

3.11 In Queensland, satellite images of the Murray Darling area of the State, taken in 1992-1994, indicated that there was a lot of broad-scale vegetation clearing taking place. In 1995, there was much interest in the State as to whether satellites could monitor tree clearance. This was because at this time, different interests in the State were claiming that vastly different amounts of clearing were taking place. The farmers

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106 Personal Communication.
publicly argued that significantly less vegetation was being cleared than had been alleged by the Green Party. There were therefore political motivations to find out the correct figure of vegetation clearing. Money was put into a State-wide Landcover and Trees Study (SLATS) survey using satellites, to provide policymakers with accurate information on woody vegetation cover and information on changes to that cover. The first satellite monitoring done by SLATS reported that the actual clearing that had taken place was somewhere in the middle of the amounts claimed by the farming bodies and the Green Party.

3.12 Legislative controls came about in some Australian States in reaction to these early satellite studies which demonstrated the scale of the loss of native vegetation. When the level of the vegetation clearing became apparent from the satellite data, this assisted State Governments in making political commitments to reducing vegetation clearance rates. For example, the result of the second SLATS satellite study in Queensland showed that the levels of clearing had dramatically risen since the first study (in terms of hectares cleared), and this became the basis for the first Vegetation Management Act in Queensland.

**Panic clearing in anticipation of legislation**

3.13 There appear to have been increases in the amount of vegetation clearing when Governments were thought to be considering legislative controls on vegetation clearing. This was especially true in Queensland. In Queensland, for example, one Government official speculated there might not have even been any legislation at that time, if there had not been so much panic clearing in response to speculation that legislation was imminent. In the words of one State farming association in Queensland, ‘the farmers went berserk with clearing their land in anticipation of the legislation’.

3.14 The panic clearing that took place in some States would have undoubtedly had an impact on compliance figures. When the satellite monitoring programmes were first set-up, they were not as developed or intensive as they are now. In some States, the satellite monitoring was done every other year and in others resources were focused on ‘hot-spots’, meaning the monitoring was targeted at specific areas and was not state-wide. The results of some of this early satellite monitoring were, therefore, sometimes inconclusive as to whether the vegetation clearing took place before the legislation took effect, or afterwards. It would, therefore, not be unexpected to see a spike in vegetation clearing for some time after the legislation was introduced.

**State legislative controls**

3.15 When evidence of environmental damage as a direct result of land clearance became public knowledge, vegetation retention and management became an important issue within Australia. It was clear that fundamental changes to the way that vegetation was viewed and managed in Australia were necessary. There was a shift in attitudes at both Commonwealth and State level and it was decided that legislation was necessary to preserve the environmental benefits of vegetation for the public good.

3.16 Regulation of vegetation clearance was introduced in Australia during the last quarter of a century to reduce the impacts of vegetation clearance. Legislation has been implemented at State level, with different States responding at different times and in different ways. Laws have generally become more restrictive over time, with States introducing amendments to legislation aimed at prohibiting broad-scale vegetation clearing. It is hoped that through laws in Australia, the restoration of native vegetation, in combination with the protection and rehabilitation of remnant vegetation, can reverse some of the negative effects of clearing and fragmentation of natural ecosystems.

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107 Personal Communication.
108 Personal Communication.
110 Personal Communication.
112 Personal Communication.
113 Personal Communication.
114 Personal Communication.
3.17 Definitions of ‘clearing’ and ‘native vegetation’ differ between the sample States. ‘Native vegetation’ clearing, however, generally refers to any act that removes, disfigures or kills vegetation deemed indigenous to the region.115 ‘Illegal’ clearance, is any such vegetative removal or destruction, or clearance that takes place without due authorisation.116

Legislation in South Australia

3.18 The first legislative attempt to control native vegetation clearance in Australia took place in South Australia, originally one of the worst affected in Australia. Less than 25% of native vegetation remains in South Australia’s agricultural areas, with some regions lower than 10%.117 One quarter of all the plants and animals recorded in South Australia are considered to be threatened by vegetation clearing.118 Vegetation clearance legislation emerged in the State in the early 1980’s.

3.19 Permit based regulations, which treated the clearance of vegetation as ‘development’, were first introduced in South Australia under the Planning Act 1983 (South Australia). Vegetation clearance did not fit neatly into planning style controls, and the existing use provisions in this Act made clearance on land used, or expected to be used, for agriculture, exempt from permit requirements. The Native Vegetation Management Act 1985 (South Australia) was the first State law to specifically control vegetation clearance. The 1985 Act was itself replaced by the Native Vegetation Act 1991 (South Australia), as amended. The 1991 Act ensures that areas of high concentration value are protected. It also protects smaller areas of native vegetation including individual trees, making such clearance subject to a thorough assessment process. Under the 1991 Act, broad-scale vegetation clearance in South Australia was eventually prohibited in 2000.

3.20 ‘Native vegetation’, defined under the Native Vegetation Act 1991 (South Australia), includes any ‘naturally occurring’ local native plants, including trees.119 Associated with the Act are the Native Vegetation Regulations, which set out the circumstances and conditions for clearance of any native vegetation. Clearing is defined in the Act as the killing or destruction of native vegetation; the removal of native vegetation; the severing of branches, limbs, stems or trunks of native vegetation; the burning of native vegetation; and any other substantial damage to native vegetation.120 Clearing of native vegetation without complying with the Native Vegetation Act is an offence. Native vegetation can only be cleared with the consent of a statutory body, the Native Vegetation Council, with limited exceptions. This body must assess any application to clear native vegetation according to the ‘principles of clearance’ contained in the Act. The Council are permitted to consider applications by farmers to offset vegetation clearance.

Legislation in Queensland

3.21 In the 1980’s, Queensland had not seen the scale of vegetation clearing that had taken place in New South Wales or South Australia. The State was less developed than the others and over three quarters of it contained healthy vegetation.121

3.22 Codes controlling vegetation clearing were introduced in the early 1990s.122 These initially restricted vegetation clearance voluntarily. For leasehold land, legislative controls requiring a permit for vegetation clearance were first introduced in Queensland in 1995 under the Land Act 1994 (Queensland). This applied to approximately two thirds of land in the State. Legislation was introduced later to govern clearance on freehold

115 S Bricknell, ‘Environmental crime in Australia’ (Research and public policy series no. 109, Australian Institute of Criminology, Canberra October 2010).
116 Ibid.
119 s.3 Native Vegetation Act 1991 (South Australia). Native vegetation is any plant or plants of a species indigenous to South Australia including a plant or plants growing in or under waters of the sea.
120 s.3 Native Vegetation Act 1991 (South Australia).
121 Personal Communication.
122 Some controls have existed for a considerable time though. For example, s 231 of the Land Act 1897 (Qld), then s.198 of the Land Act 1910 (Qld), and then s.250 of the Land Act 1962 (Qld); all of which prohibited the ringbarking or destruction of timber on leasehold land without a permit.
land under the Vegetation Management Act 1999 (Queensland). These laws provided for the preparation of mapping and classification to identify areas of high conservation value, areas vulnerable to land degradation and remnant vegetation. The preservation and management of remnant vegetation was largely to be achieved through clearing controls under a further piece of legislation, the Integrated Planning Act 1997 (Queensland).

3.23 The Vegetation Management Act 1999 (Queensland) defines ‘clearing’ as, removing, cutting down, pushing over, poisoning, or destroying in any way including by burning, flooding or draining; but does not include destroying standing vegetation by stock, or lopping a tree.\(^{123}\) ‘Native vegetation’ is defined as a native tree or plant other than the following: grass or non-woody herbage; a plant within a grassland regional ecosystem prescribed under a regulation; or a mangrove.\(^{124}\)

3.24 Regional ecosystem mapping has also been undertaken by the Government at a State-wide level to enable identification of areas containing ‘remnant’ and ‘non-remnant’ vegetation. The Government produces A3 sized maps, each showing thousands of acres of mapped vegetation in the State. These do not map every single individual tree; instead they show the majority species in each area.\(^{125}\) These regional ecosystem maps are used in combination with the satellite data to identify illegally cleared areas of remnant vegetation.

3.25 An Amendment Act in 2004\(^ {126}\) removed the system of vegetation clearing laws for leasehold land under the Land Act 1994 (Queensland), and placed the control of vegetation management of most State lands under the Vegetation Management Act 1999 (Queensland) and the Integrated Planning Act 1997 (Queensland). These amendments meant that freeholders and leaseholders were regulated under the same legislation for the first time. Vegetation management on approximately 94% of land in Queensland is now regulated under this system.\(^ {127}\)

3.26 The Vegetation Management Act 1999 (Queensland) has been an extremely controversial legislative instrument. Many landholders reacted by panic clearing vast areas of land before restrictions could come into force.\(^ {128}\) It was then subject to a large number of amendments, the most significant and controversial being made in 2004, when a moratorium on tree clearing applications was imposed. These amendments phased out broad-scale land clearing in Queensland by December 2006.\(^ {129}\) There are a number of exceptions provided in the legislation which permit clearing under certain circumstances. The Vegetation Management (Regrowth Clearing Moratorium) Act 2009 (Queensland) sought to restrict landholders from relying on one of these, and introduced a moratorium on clearing regrowth under certain circumstances.

3.27 Further new arrangements protecting regrowth vegetation in Queensland took effect in 2009. The Integrated Planning Act 1997 (Queensland) was repealed by the Sustainable Planning Act 2009 (Queensland). Amendments to the Vegetation Management Act 1999 (Queensland) were introduced by the Vegetation Management and Other Legislation Amendment Act 2009 (Queensland). High-value regrowth vegetation and regrowth watercourses are now regulated under the vegetation management framework and are shown on the regrowth vegetation map. It is an offence to clear regulated regrowth vegetation otherwise than in accordance with the Regrowth Vegetation Code. The Regrowth Vegetation Code also imposes minimum requirements on clearing regulated regrowth vegetation. In certain circumstances an ‘exchange area’ is to be provided (i.e. as compensation) to replace the area to be cleared.

**Legislation in New South Wales**

3.28 The State of New South Wales also sought to regulate vegetation clearance in the first instance by adopting planning-style systems, with permits assessed against environmental and economic criteria. This was done first under State Environmental Planning Policy 46 (New South Wales) and then under the Native Vegetation Conservation Act 1997 (New South Wales). The wide range of definitions, exclusions and exemptions in this Act made it difficult to monitor and enforce in practice. For example, regulators had to show that there was vegetation cover originally there and that what was removed was an indigenous species.

\(^{123}\) s.5 and Schedule Vegetation Management Act 1999 (Queensland).

\(^{124}\) s.8 Vegetation Management Act 1999 (Queensland).

\(^{125}\) E.g. if the majority of vegetation is remnant in one area, the whole of this will probably be marked as remnant, even though there could be small pockets of regrowth areas.

\(^{126}\) The Vegetation Management and Other Legislation Amendment Act 2004 (Queensland).

\(^{127}\) The rest being regulated under the Land Act 1994 (Queensland) and other national parks and State forest legislation.


\(^{129}\) Vegetation (Application for Clearing) Act 2003 (Queensland).
3.29 The Native Vegetation Act 2003 (New South Wales) repealed the 1997 Act and was based on a model suggested by the Wentworth Group of Concerned Scientists, an independent body of Australian scientists. The key purpose of the Act was to end broad-scale clearing in New South Wales, with limited exemptions. The Act outlines what landowners can and cannot do in clearing native vegetation. ‘Native vegetation’ is defined as meaning any of the following types of indigenous vegetation: trees (including any sapling or shrub, or any scrub); understorey plants; groundcover (being any type of herbaceous vegetation); and plants occurring in a wetland. Under the Act, ‘clearing’ means cutting down, felling, thinning, logging, removing, killing, destroying, poisoning, ringbarking, uprooting or burning. For the purposes of the Act, ‘broadscale clearing’ of native vegetation means the clearing of any remnant native vegetation or protected regrowth. The clearing of native vegetation is subject to differing requirements depending on whether the vegetation is classified as ‘remnant vegetation’, ‘protected regrowth’ or ‘non-protected regrowth’. Remnant vegetation is any native vegetation that is not regrowth. All native vegetation that has regrown, since 1 January 1990, is regrowth (subject to statutory exceptions). Clearing remnant native vegetation or protected regrowth requires approval under the Native Vegetation Act 2003 (New South Wales) unless the clearing is a permitted activity.

3.30 Satellite data, alone, cannot always prove what type of vegetation was there before clearing, so the Government in some cases uses data from the New South Wales Botanic Gardens Trust to identify remnant vegetation, if this issue is in dispute. The baseline year of 1990 in the Act was arbitrary, rather than the result of the Government seeking to try and classify vegetation on a scientific basis. This date is the reason why historical satellite imagery and aerial photographs are relevant in terms of historical monitoring. This will possibly be amended in the future as 1990 is now twenty years ago and technology has moved on.

3.31 Under the Native Vegetation Act 2003 (New South Wales), the clearing of remnant vegetation or protected regrowth will only be approved when the clearing will improve or maintain environmental outcomes. Landholders who wish to clear native vegetation can apply for development consent or a Property Vegetation Plan (PVP), which outlines the planned clearing of native vegetation on a property for up to fifteen years. The Native Vegetation Regulations 2005 (New South Wales) set out an environmental outcomes assessment methodology which Catchment Management Authorities must use to assess clearing proposals for both PVPs and development consents. Clearing proposals that form part of a PVP can incorporate offsets to meet the ‘improve or maintain environmental outcomes’ test required under the Act.

Reference to satellite imagery in the legislation

In vegetation clearing legislation

3.32 Whilst systematic satellite surveillance of clearing was incorporated into the policing of laws in all three States (South Australia, Queensland and New South Wales), not all of these laws specifically provide for satellite-use in a monitoring context. Legislation concerning vegetation clearing in South Australia and New South Wales does not mention ‘satellite imagery’ or ‘remote sensing’ anywhere in their provisions. The view of these States is that they did not need to expressly mention satellite imagery, because it was considered another form of evidence subject to general laws of evidence.

3.33 Government in the States of South Australia and New South Wales have been using satellites to monitor vegetation clearance for some time now, with these images sometimes being used as evidence in court. It is clear that it is not necessary to expressly include provisions in the legislation stating that regulators as part of their investigations can use ‘satellites’ or ‘remote sensing’. General investigative powers of Government

130 s.6 The Native Vegetation Act 2003 (New South Wales).
131 s.7 The Native Vegetation Act 2003 (New South Wales).
132 s.8 The Native Vegetation Act 2003 (New South Wales).
regulators are usually provided in environmental enforcement legislation and these should suffice. The position in these two Australian States of not expressly mentioning any technological monitoring equipment because they have general investigatory powers under environmental legislation would most likely be common in many other countries around the world.

3.34 Specifically mentioning satellite monitoring within legislation could, however, have possible advantages. Firstly, it could let people know where they stand and allay any possible fears about covert technologies being used to monitor them. Chapter 9 considers this in greater detail, by looking at the acceptance of satellite monitoring by regulated communities. Secondly, the fact that a law states that it might be used as an investigative tool could actually inform regulated communities of its use, potentially having a greater deterrent impact than not mentioning it at all in the legislation.

3.35 Queensland adopted a different approach to the other two Australian States and included in its vegetation clearing legislation special provisions governing the use of data that is remotely sensed. Provisions under the Vegetation Management Act 1999 (Queensland) and the Land Act 1994 (Queensland) do not specifically mention 'satellites', but a 'remotely sensed image', which can include aerial photography and satellite images. Including these terms in the legislation was not originally done out of a perceived legal necessity. However, the later legislative approach, aimed at improving the admissibility and reliability of remote sensing data, meant that it became necessary to expressly mention these terms in their legislation. This is discussed further in paragraph 3.43.

3.36 The Vegetation Management Regulations 2000 (Queensland) also refer to 'image bases' in the context of property vegetation development plans. An 'image base' is defined as an image or mosaic of images, such as an aerial photograph or a satellite image. This is to allow the Government to see the location and extent of the area proposed to be cleared. Similar provisions concerning an 'image base' can also be found in the Land Act 1994 (Queensland), which concerns mapping boundaries of future conservation areas or a part of a leased land.

3.37 There are also analogous provisions concerning property development plans in legislation from New South Wales. Landholders who wish to clear native vegetation can apply for a Property Vegetation Plan (PVP), which outlines the planned clearing of native vegetation on a property for up to fifteen years. Under the Native Vegetation Regulations 2005 (New South Wales), if a PVP proposal is made, it must contain high-resolution satellite image or an aerial photograph of the property. This imagery aims to assist the decision-making body (the Catchment Management Authority) and the landholder when assessing whether the clearing proposal meets the requirements of legislation.

3.38 The legislative provisions discussed in paragraphs 3.35 – 3.37 are provided in Annex D.

In other legislation

3.39 The Survey and Mapping Infrastructure Act 2003 (Queensland) contains a provision that to develop, maintain and improve the State survey and mapping infrastructure, the State should have a ‘remotely sensed image library’. The Chief Executive of the State must maintain this, and it should contain any remotely sensed images of land and coastal waters of the State that they consider valuable for survey and mapping purposes and define administrative areas or boundaries. There are also further provisions covering evidence from a remote sensing image, which will be discussed later in this chapter.

3.40 The Water Management Act 2000 (New South Wales) contains a relatively new provision which concerned the use of a ‘remotely-sensed image’ as evidence in legal proceedings for water offences. It is curious that this State specifically has an Act containing a provision covering satellite imagery when it decided

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134 See s66B, s68, s68C Vegetation Management Act 1999 (Queensland); s431E, s431L of the Land Act 1994 (Queensland). Note that the Vegetation Management Act 1999 is the key piece of legislation in Queensland for vegetation clearance. The Land Act 1994 has limited applicability in connection with vegetation clearance, and is still in force to cover elements outside the Vegetation Management Act 1999, such as esplanades, stock routes and roads.
135 Section 1A and 3, Vegetation Management Regulation 2000 (Queensland).
137 Regulation 9(1)(d) of the Native Vegetation Regulations 2005 (New South Wales).
139 Section 50 Survey and Mapping Infrastructure Act 2003 (Queensland).
140 Section 131 Survey and Mapping Infrastructure Act 2003 (Queensland).
not to have something similar in relation to vegetation management. It could not be established why this was considered necessary or useful in relation to water legislation but not for vegetation management.

3.41 The legislative provisions discussed in paragraphs 3.39 – 3.40 are provided in Annex D.

3.42 There are also a number of other laws in Australia where satellite data is mentioned. The terms ‘image base’ and ‘satellite image’ are mentioned in a Queensland law, which permits satellite data to be used as part of a mapping process for the purposes of using chemical products from aircraft. The term ‘remote sensing’ is used in a mining law from Queensland, concerning information that can be included as part of an annual report required under a mining exploration permit. ‘Remote sensing’ is also mentioned in a law from New South Wales, which details approved measurement methods to be used in surveying.

**Legislative provision inserting an evidential presumption**

**Background to ‘evidential presumptions’**

3.43 Australia has more experience with using satellite data in courts than any other country in the world. This experience can be demonstrated, in part, in the way that the Queensland Government specifically amended the Vegetation Management Act 1999 (Queensland), inserting an ‘evidential presumption’ provision to make the use of satellite imagery as evidence more acceptable. This effectively makes satellite imagery prima facie evidence in vegetation clearing cases and appears to be the first provision of this type in the world in relation to satellite data.

3.44 An ‘evidential presumption’ denotes a conclusion that must be drawn by the factfinder on proof of the basic fact of the presumption in the absence of any evidence to the contrary. It is not uncommon for statutes in countries like Australia (and the UK) to provide that certain facts shall be deemed to exist until the contrary is proven. The precise words that are employed vary from statute to statute. Evidential presumption provisions are often used to cover the functioning of technological machines (e.g. computers, breathlysers, speed camera equipment). Where there is such a provision, the courts will apply the evidential presumption of correct functioning when a party adduces evidence from a machine, and the party may rely on a presumption that the computer was operating properly at the material time. An evidential burden is then on the party objecting to the admission of the document to produce some evidence to show that it was not working correctly. In the event of the issue of proper functioning being successfully raised, the burden will be on the party relying on the document to prove by evidence that the machine was operating properly. Despite its imposition on the accused, entailing that his failure to adduce evidence must not lead to what might be the only live issue in the case being determined against him. In accordance with the usual rules in criminal proceedings, if the prosecution have this burden they will have to prove the matter beyond reasonable doubt, whereas if the defence have the burden the standard of proof will be the balance of probabilities.

**Evidential presumption provisions in Australian State’s**

3.45 The State of Queensland inserted a new s66A into the Vegetation Management Act 1999 (Queensland) which states that any instrument, equipment or installation used under the Act, in the absence of evidence to

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141 Section 12V(4) Chemical Usage (Agricultural and Veterinary) Control Regulation 1999 (Queensland); as in force on 1 January 2010.
142 Ibid.
143 Section 13B(1)(ii) and 14B(1)(ii) Mineral Resources Regulation 2003 (Queensland); as in force on 1 July 2010.
144 Section 16 Surveying and Spatial Information Regulation 2006; as in force on 1 July 2010.
146 C Tapper, Cross & Tapper on Evidence (Eleventh edition, OUP, Oxford 2007) 148. E.g. For example, in the UK prior to the repeal of section 69 of the Police and Criminal Evidence Act 1984 by section 60 of the Youth Justice and Criminal evidence Act 1999, it was necessary to prove that a computer was operating properly and was not used improperly before any statement in a document produced by the computer could be admitted in evidence. A presumption now exists that the computer producing the evidential record was working properly at the material time and that the record is therefore admissible.
147 Ibid.
148 Ibid. 159.
149 I.e. it is necessary for there to be only such evidence as would, if believed and uncontradicted, induce a reasonable doubt in the mind of a reasonable jury as to whether his version might be true. Ibid.
the contrary, is deemed to be accurate and precise. It is also deemed to have been used by an appropriately qualified person. The assumption now is that the satellite technologies and the computers they are stored on have been working properly. This effectively reverses the burden of proof in relation to the evidence from the satellite, requiring the defendant to cast doubt on the evidence by questioning the correct functioning of the satellite or the computer that imagery was stored or worked on.

3.46 Pursuant to an amendment contained in s66B of the Vegetation Management Act 1999 (Queensland), the evidence from the ‘remotely sensed image’ must also be accompanied by a certificate or report from an appropriately responsible person. This report has to give details of the responsible person’s qualifications, details of the image, confirmation that it is an image of the stated area, the date the image was produced, their conclusions after examination of the image, the location of the stated area and the area within this which has been cleared, and whether the stated area is or is likely to be an area of ‘remnant vegetation’ or regulated ‘regrowth vegetation’.

3.47 The way the provisions in s66A and s66B are framed requires the defence to challenge any aspect of its use as evidence. If they do decide to challenge a matter relating to s66A or s66B, then they have to give notice to the other side of their intention to adduce relevant evidence. This must be at least twenty business days before the evidence is adduced. Amendments made in 2009 to both of these provisions require a party who wishes to challenge the correct functioning of the instruments, equipment and installations to formally give notice, stating the grounds on which they consider the evidence is not accurate. A formal notice is also required if the party considers a statement in the certificate or report about the remotely sensed image is incorrect. Again, this must be given to the other party at least twenty days before the evidence is adduced in court.

3.48 There are other provisions in legislation from Queensland which are intended to have the same effect. The Land Act 1994 (Queensland) also contains similar provisions in s431D (instruments, equipment, and installations) and s431E (certificate or report about a remotely sensed image). This Act now has limited applicability in relation to vegetation clearing. Similar provisions are also contained in s131 of the Survey and Mapping Infrastructure Act 2003 (Queensland).

3.49 Most recently in New South Wales, an evidential presumption provision was used for images, including ‘remotely-sensed’ data, in legislation covering water management. It appears that provisions under s367 of the Water Management Act (New South Wales) were intended primarily to cover readings from river gauges, but they are also applicable to evidence from satellites. Under this Act, a remotely sensed image is deemed to portray specified land at a specified date. A certificate issued by the relevant Minister is admissible in any legal proceedings and is evidence of the facts, or facts so stated. Evidence from a certificate of an authorised analyst is also considered to be evidence of the facts contained in the certificate and the correctness of the result of the analysis or examination. It could not be ascertained why the New South Wales Government have an evidential presumption provision, which includes ‘remote sensing’ in their water management legislation, but not in relation to laws covering vegetation clearing.

3.50 Queensland appears to be the first Government to introduce a law enabling satellite-derived evidence to be treated this way (closely followed by New South Wales – in relation to water management). The validity of evidential presumption provisions, in connection with satellite imagery, have not yet been considered in any court outside Australia. This is because there does not appear to be any examples of legislation in any other country outside Australia which specifically relate to evidential presumption provisions and evidence from satellites.

3.51 The legislative provisions discussed in paragraphs 3.45 – 3.49 can all be seen in full in Annex D.

The reasons behind having an evidential presumption

3.52 The legislative support for using imagery as evidence by having an evidential presumption provision, came about because the Queensland Government was trying to avoid complexity in proving that the remote sensing was credible evidence in court. After the first few years of court cases in the State in which satellite imagery in vegetation clearing prosecutions had been used, the Government realised that they could potentially be questioned in court on every aspect of the use of the technology. In early cases, defence

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150 E.g. it now appears only to cover vegetation clearing in relation to elements such as esplanades, stock routes and roads.

151 Personal Communication.
arguments in court questioned whether the satellite and computers were functioning correctly, whether the land in the imagery was the defendant’s land, and whether it could be shown that the satellite image was taken on the day in question.152

3.53 The Queensland Government considered such challenges to be ‘futile’ and ‘unnecessary’.153 There was a perception that the defence realised that they could not win on the facts, so resorted to relying on attacking technicalities connected with the history of the image.154 Government considered that having to show such a high level of proof in each case was found to put enormous pressure on the prosecution and witnesses.155 Satellite experts within Government could spend days or weeks at court hearings waiting to be called to give evidence, and in some cases cross-examination was lengthy.156

3.54 To assist in evidentiary support, and reduce opportunities for challenges by the defence, the Government developed internal procedures so that the evidence could be fit for court. This was relatively successful, but it meant that the experts spent a great deal more time on administrative procedure. A Government official in the remote sensing team in the Queensland Government told the legal group that this was putting pressure on the satellite specialists, as each expert needed about ‘four weeks to prepare a report and presentation covering every aspect of their work’.157

3.55 Government lawyers also recognised that with computer packages, it was relatively easy to doctor an image, although this would be a serious allegation for the defence to make about a Government body. They considered that in every case there was a risk that defence teams would try and establish reasonable doubt by questioning the authenticity and accuracy of every satellite image.158 There was also a different view from other States as to the evidential basis of digital imagery. A Government lawyer described the rules on evidence submission as ‘still somewhat draconian [which] had not responded to developments in technologies’ and commented that he thought it was very difficult to meet the standard of proof required in criminal matters without a statutory mechanism like the one they introduced through the amendments in the Vegetation Management Act 1999 (Queensland).159

3.56 The ideas for the original amendments in ss 66A and B of the Act came from comparative breathalyser legislation, which also says that the equipment is presumed to be working correctly unless there is evidence to the contrary.160 This was similarly introduced to stop drunk drivers questioning whether the technical instrument (the breathalyser) was working correctly.

3.57 The evidential presumption provision in the native vegetation legislation was not introduced because of losing any specific cases in court, or just because of questions concerning the veracity or otherwise of the satellite imagery, although there were some concerns within Government.161 The Government’s primary motive was to reduce time-burdens placed on staff.162

3.58 Remote sensing scientists in the Queensland Government considered that the original legislative amendments under ss 66A and B, introducing an evidential presumption, had in many ways not made life any easier for them.163 They were still spending vast amounts of time ensuring that the evidence was fit for court, because the defence was only required to say they were disagreeing with the evidence, without having to spell out what it was precisely that they were challenging.164 They were also in some ways under a little more time pressure, because under the evidential presumption provisions they were now additionally required to prepare a certificate and a statement as well.165 Amendments were made to ss 66A and B in November 2009 to relieve the time pressure on the remote sensing scientists. These amendments require the other side to advise on

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which areas of the evidence they are going to challenge and to spell out the basis for this challenge. The notice period of twenty days if there is going to be an identified challenge to the evidence is intended to give the Government enough time to prepare and respond.

3.59 A Government employee in South Australia commented that, in the future, his department would also like to have an evidential presumption provision as Queensland had done.\textsuperscript{166} The Government of New South Wales did not appear to have any plans to introduce similar legislative changes.\textsuperscript{167}

**Judicial interpretations of ss 66A and B**

3.60 The Queensland Government appealed a case in 2009 on the basis that the magistrate had not correctly applied ss 66A and B of the Vegetation Management Act 1999 (Queensland). The Magistrate in the earlier case had concluded that the image certificate could not be acted upon safely and rejected the statement in the certificate that remnant vegetation had been cleared on the defendants land.\textsuperscript{168} The Magistrate also thought that the prosecution should have relied upon an expert who had gone to the land and based their opinions on personal observations, rather than using the satellite imagery alone. The Government argued on appeal that the Magistrate’s approach to the certificate was incorrect; that s66B permitted the certificate to state, as it did, that an area of remnant vegetation had been cleared, and that as this was uncontradicted evidence, it should have been accepted. The appeal court found that the Magistrate erred in thinking that the techniques utilised by the expert witness in proving vegetation type were incapable without supplementation by visual observations.\textsuperscript{169} The judges found that ss 66A and B was relevant, but also considered that the section was silent as to the weight to be given to statements made in the certificate.\textsuperscript{170} What weight should be given by a court to the contents of such a certificate depended therefore on matters such as: the relevant expertise of the certifier; the personal knowledge of the certifier as to the matters certified; the credibility of the certifier; and the reliability of the sources of information relied on to establish the certified areas. Whether what was done was sufficient to satisfy these depended on the individual facts of each case.

**Impact of introducing an evidential presumption**

3.61 It is anticipated that the vegetation clearing legislation in Queensland, by introducing an evidential presumption provision requiring notice if evidence is to be challenged, will save the Government time and resources. As the latest amendments to the legislation were made in November 2009, it is too early to see the full impact of these amendments.

3.62 The Government considers that the notice requirement will give them a clearer idea what is going to be disputed in court (removing the element of surprise); in turn enabling them to collect the necessary proof in good time.\textsuperscript{171} Since its introduction, the Government has not been asked for any further proof, such as whether the satellite was going over the right property and had taken the image at the relevant time.\textsuperscript{172} A lawyer with the Queensland Government commented that because of the evidential presumption changes in the legislation, he considered the use of satellite imagery as evidence to now be ‘pretty much watertight’.\textsuperscript{173} In the future, it seems likely that there will be fewer cases where it is argued that the data is inaccurate or unproven. Future cases are more likely to turn to the interpretation of the data. While the evidence from the satellite is clearly admissible, and with the evidential presumption it is now up to the other side to challenge it, the Government still has to demonstrate the connection between what the image shows and its relevance to what has taken place on the ground. Corroborative evidence from other sources, such as ground inspections, or local knowledge, will still be necessary.

3.63 In Queensland, a number of farmers have been upset by what one lawyer representing them described as the ‘arrogance of the legislation’.\textsuperscript{174} There is a perception that the evidential presumption means that Government is saying ‘we are always right unless you can prove otherwise’.\textsuperscript{175} However, the reality is that the

\textsuperscript{166} Personal Communication.

\textsuperscript{167} Personal Communication.


\textsuperscript{169} Ibid.

\textsuperscript{170} Ibid.

\textsuperscript{171} Or in the words of one Government official ‘not be ambushed in the courts.’ Personal Communication.

\textsuperscript{172} Personal Communication.

\textsuperscript{173} Personal Communication.

\textsuperscript{174} Personal Communication.

\textsuperscript{175} Personal Communication.
other side can still find their own expert in the field to interpret the evidence and challenge the human interpretation of the other side, although hiring their own specialist could be expensive, and, for some farmers, financially impossible.

**Impact if the legislation does not have an evidentiary presumption provision**

3.64 Experience from the States of South Australia and New South Wales suggests that not having any legislative support for satellite evidence does not mean that proving a case is impossible. It just potentially means that more work and preparation will have to be undertaken by the prosecution and expert witnesses before a case reaches court.

3.65 All courts like technical evidence to be agreed before a trial. They do not have the time, capacity, or resources to consider large numbers of technical challenges or new attacks on evidence once a trial has begun. A number of judges that were interviewed in Australia commented that the culture has changed within courts and that they considered that it was frowned upon to keep putting the onus on the prosecution to prove key facts in relation to the correct functioning of technical/scientific evidence. The judges felt that the court would consider many such challenges to the evidence as unreasonable.  

3.66 As the court supports issues being agreed before court, ‘agreed evidence lists’ are drawn up in cooperation with the prosecution and defence before trial. This can enable prosecutors to see what is likely to be challenged, enabling resources to be allocated towards showing the right things and preparing legal argument and expert witnesses. This potentially saves both sides time and money and allows the court to consider only those points which are contentious. Lawyers in the South Australian Government have found that dedicating more time than usual to agreed evidence lists can greatly assist the use of satellite imagery in the courtroom.

**Recommendation 6**

To assist in evidentiary support, a provision containing an evidential presumption could be introduced in legislation where satellite technologies are used in a monitoring programme. Placing the burden of proving incorrect functioning of equipment, and full disclosure of the grounds for any challenges to satellite evidence, on the other side would create fewer opportunities for spurious challenges by the defence. This could save the regulator and court time and resources.

**Limitation periods in legislation**

3.67 In Australia, a number of statutes have limitation periods, so that enforcement action must be undertaken in accordance with set time periods. These limitation periods apply to some environmental offences in all three Australian States, including those relating to vegetation clearing. Experience in Australia demonstrates that these statutory limitation periods can restrict ‘comparison monitoring’ (e.g. before and after) using satellite imagery, and there may also be difficulties in the enforcement process showing cumulative clearing over time.

3.68 ‘Comparison monitoring’ requires looking at whether something has changed, or taken place, over discrete time periods. This means that imagery might not be sourced until months, or years, after it was taken. Monitoring vegetation clearance requires comparison of imagery over different years, because States cannot generally afford to buy imagery more regularly than annually, or it may be technically impossible in some circumstances. Satellite monitoring of vegetation clearing is, therefore, often a year old. So, for example, if an investigator is comparing land from imagery taken in 2007 to that taken in 2008, they will probably not receive data allowing this comparison until 2008/2009. If satellite monitoring is carried out every two years then this process will take even longer. Even after the imagery is acquired, time is needed for regulators to analyse large amounts of data, to investigate suspected offences on the ground, and possibly prepare a case and put it before the courts. This can be a time-consuming process. As the satellite imagery is not analysed at the

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176 Personal Communication.
177 Personal Communication.
178 Personal Communication.
same time as the offence (i.e. in real time), it is, therefore, quite common in vegetation clearing cases for prosecutions to take place a number of years after the offence has occurred.

3.69 Most environmental statutes in Australian States have short limitation periods. With such a huge number of suspected vegetation cases to investigate, under the conditions described above, timelines under these limitation periods became difficult to meet where satellite imagery was used. There have been lapses in limitation times in some Government investigations in Australia.

3.70 To allow for the use of evidence from satellites, limitation periods under vegetation clearing legislation have been extended in some Australian States. In South Australia, the Government extended the limitation period under the vegetation clearing legislation from three to four years.\(^{179}\) They also put in a provision that allowed them to extend the limitation period to six years with the authorisation of the Minister.\(^{180}\) In Queensland, the limitation period for vegetation clearing was extended from three to five years.\(^{181}\) The Government can also apply to a Magistrates’ Court to extend this time further still in individual cases.\(^{182}\)

3.71 There are also limitation periods on prosecutions in some States framed in terms of when the Government found out about the offence. Although Queensland has a five year limitation period running from when the offence is committed, this is restricted because a prosecution for vegetation clearing offences must also take place within one year of the offence becoming known to the Government department.\(^{183}\) Similarly, in New South Wales, proceedings for an offence must also be commenced within two years of the date on which evidence of the alleged offence first came to the attention of an authorised officer.\(^{184}\) A major difficulty with limitation periods which are linked to the ‘knowledge’ of Government is, when do these start? Do they start when the investigator examines a remote sensing image and realises that there has been clearing, or when all the investigations (including interviews with the defendant and ground checks) have been completed and a decision has been made to prosecute? A case in Queensland raised this issue.\(^{185}\) The applicant received a letter from the Government saying that, after an examination of a satellite image, the department believed that an offence had been committed, and they requested cooperation in their further investigations. It seems from the judge’s conclusions in an earlier hearing that mere analysis of an image itself does not show knowledge of an offence.\(^{186}\) The court found that a complainant possessed the requisite ‘knowledge’ when they had such information as to give reasonable grounds for a belief that an offence had been committed.

3.72 In New South Wales, it has not yet been examined in court when the clock for the limitation period starts in relation to the vegetation clearing legislation. To protect themselves from a defence based on this limitation period, those that work in the remote sensing department are not officially classed as ‘investigators’. The remote sensing information is also placed on different Government servers, which cannot be seen by any of the Government investigators or lawyers.

\begin{center}
\textbf{Recommendation 7}
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Those using imagery in a regulatory context should check to see if there are limitation periods in the law they plan to monitor. Monitoring some laws could require comparison of imagery over several years, and it can be a slow process before a case is investigated on the ground and then brought to court. These issues, coupled with unfavourable limitation periods, could pose barriers to successful prosecutions. In certain circumstances, Governments may wish to consider extending time periods to better support the use of satellite evidence.

\(^{179}\) s33(1) Native Vegetation Act 1991 (South Australia).
\(^{180}\) Ibid.
\(^{181}\) s.68(2) Vegetation Management Act 1999 (Queensland).
\(^{182}\) s.68(4) Vegetation Management Act 1999 (Queensland).
\(^{183}\) s.68(3) Vegetation Management Act 1999 (Queensland).
\(^{184}\) s.42 Native Vegetation Act 2003 (New South Wales).
\(^{185}\) Witherman v Van Riet & Ors [2008] QCA 168 (Queensland Court of Appeal).
\(^{186}\) Witherman v Van Riet & Ors [2007] QDC 342 (Queensland District Court).
Drafting and the intention of the legislation

3.73 There have sometimes been underlying problems in the link between the legislative definitions connected with the vegetation clearance legislation in Australia and what can actually be seen on the satellite image. The vegetation clearing legislation in each State contains statutory exemptions, and it is common for farmers when presented with evidence from the satellite to argue that they were relying or one or more of these exemptions. Some States found that the satellite imagery could show that there had been clearing, but they could not always accurately prove whether a certain exemption could be relied upon. In the words of one Government enforcement officer: 'you are always going to be stuffed if the interpretation of the law or the drafting is not clear. It is not the evidence from the satellite that is normally the problem, but the legislation itself'.

3.74 A lesson learnt from experience in Australia is that there should be checks at the planning stage that the satellite monitoring programmes can manage and pick up any exemptions contained in the legislation, otherwise enforcement can get complicated. If a satellite monitoring system cannot identify an exemption under the law, a defendant could seek to rely on this.

Penalties under the legislation

3.75 The satellite monitoring will have a reduced regulatory impact if the fines themselves are insufficient to act as a deterrent. The level of fines available under State vegetation clearing legislation has historically been low. Sentences have also been considered to be low because cases are heard in Magistrates’ Courts. Magistrates often deal with a list of approximately seventy different criminal matters and they do not always appreciate the significance of environmental crime in relation to other offences. Low fines in environmental cases are also common in many other countries across the world.

3.76 Many farmers in Australia comply with the vegetation clearing laws. However, it is clear that there is a small minority who do not. A problem in Australia, particularly in the first few years of using satellite monitoring, was that some farmers made an economic decision to clear, knowing that if they were caught the fine would be less than the profit from clearing. A small minority would even budget each year with a fine in mind. A lesson learnt from Australia is that satellites have to be accompanied by dissuasive sentences to act as an adequate deterrent. Fine levels have been raised over the years, and these are now an additional deterrent to more landholders. What has probably been a bigger deterrent has been Governments asking courts to impose sanctions such as restoration and remediation orders. These penalties are considered by farmers to be a bigger burden than a fine, as they deprive them of any financial benefit from an illegal act (particularly if the potential profit of any illegal clearing was greater than the minimum financial penalty in the legislation).

Recovery of Costs

3.77 Environmental regulators sometimes look to recover their investigative costs from the defending party. There is normally a provision that allows the recovery of ‘reasonable costs’ for preparing the prosecution of an offence. In Queensland, the legislation specifically states that an example of a reasonable cost are those involved in ‘obtaining and analysing remotely sensed images’. It appears that Government can recover cost

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187 e.g. in New South Wales landholders can clear regrowth that is not protected regrowth, without approval; clearing native groundcover is also permitted without approval where: less than 50% of the groundcover comprises live indigenous species and 10% or more of the area has some form of vegetative cover whether dead or alive.
188 Personal Communication.
190 Personal Communication.
191 Personal Communication.
192 Personal Communication.
193 Personal Communication.
194 Personal Communication.
195 Personal Communication.
196 Personal Communication.
197 Personal Communication.
198 s68C Vegetation Management Act 1999 (Queensland).
of purchasing images themselves, although it is unclear whether this applies to satellite data purchased in bulk, or just ad-hoc acquisitions of data which are used in the specific case.

3.78 If Government was relying on a satellite image from one provider in a case, and the other party challenged this, it seems that the Government could purchase further imagery, taken of the same time period, from another provider. This could be used to corroborate the earlier evidence and, if the Government wins the case, they could recover the costs of buying this additional imagery. It might just be a sufficient deterrent to a frivolous challenge from the other party for Government to tell them that if they did intend to contest the imagery, they would buy additional, better quality, high-resolution imagery to prove their case. There is a question of fairness in such methods, but interviews in Australia have suggested that parties relying on weak arguments do sometimes back down if faced with the prospects of further costs. Governments wishing to use satellite imagery might, therefore, wish to introduce a legislative provision that allowed for the recovery of reasonable costs involved in obtaining data, additional or otherwise.

199 Personal Communication.
Chapter Four
Enforcement and the use of satellite monitoring

Background to regulatory structures

4.1 Environmental regulation in Australia is largely State controlled, so regulatory structures for monitoring vegetation clearing differ from State to State. Population levels in each State, which can result in variant tax bases, heavily influence the enforcement and monitoring that can be undertaken. Consequently, States with higher populations tend to have more money available to spend on this. South Australia had some of the earliest regulatory controls for vegetation clearance and led the way for quite some time in Australia. However, because it has a smaller population base, it currently has fewer resources available for monitoring than larger States, such as Queensland and New South Wales.

4.2 Australian State Governments have constantly re-organised regulatory structures in environmental departments in the last decade. In each State there have been periods of change and organisational rebuilding, where departments have been merged or re-branded. This has meant that resources have been shifted, people have been moved and regulatory systems have had to adapt or change. This has undoubtedly had an impact on regulatory memory.

4.3 One of the key regulatory changes in each State has also been to move the regulatory responsibility for agriculture to those bodies customarily charged with environmental compliance. In Australia, enforcement had been traditionally weak in agriculture. Some of the departments originally charged with compliance in respect of vegetation clearing laws often thought of themselves as the ‘farmer’s friend’, and had cultural difficulties adapting to a new regulatory and enforcement role. Until relatively recently, some of these departments had no cohesive compliance plan. These earlier departments have been replaced in recent years by new bigger departments, which have a more focussed compliance role and more experienced environmental lawyers and investigators.

Basic regulatory enforcement structures

4.4 The native vegetation regulatory programmes in each of the three Australian States require cross-disciplinary cooperation within Government, including scientific support, investigative services and a legal division. A Government official in one State remarked that what is needed to be successful in a satellite monitoring programme is a ’good blend of science with investigative and legal practice’.

South Australia

4.5 In South Australia, the native vegetation programme has scientific support, investigative services and lawyers, and cuts across two departments within Government. Coordination amongst these Government groups is organised by a dedicated manager in the Native Vegetation and Biodiversity Management Unit of the Department of Environment and Natural Resources (DENR).

4.6 South Australia has a much smaller scientific support base in the satellite monitoring programme than the other States. There is no separate unit within the DENR to work on satellite data, primarily because there is only one member of staff in the department with responsibility for this. This technical expert is based in the Native Vegetation and Biodiversity Management Unit.

4.7 The Native Vegetation and Biodiversity Management Unit of the DENR handles all the reports on possible vegetation clearance, including those from the satellite assessment. The scientific officer in this Unit informs the other members of the group, including a prosecution liaison officer, of the findings of satellite monitoring. This Unit can then look to see if a permit has been issued and can collect other data, such as mapping, land-ownership information, vegetation assessment information and photographs. The Native Vegetation and

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200 Personal Communication.
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202 During the research visit to Australia this Department was called the Department of Water, Land and Biodiversity Conservation changes. Recent changes in 2010 created the new Government Department, the Department of Environment and Natural Resources (DENR), with water being separated into a new Department for Water.
Biodiversity Management Unit then report to a Steering Committee on Native Vegetation Compliance, which is made up of the various Government groups. The Steering Committee normally meets once a month to decide the level of resource for dealing with each incident. This can include making a decision as to whether further satellite imagery or other remote sensing is required to prove a case.

4.8 The cases that are considered to be the most serious are normally given to an Investigations Unit to consider further. The Investigations Unit contains about eleven investigators. Most of the investigators in this Unit are generic, providing support to all the different units in the department. The Native Vegetation and Biodiversity Management Unit will have already done many of the checks, so the investigators gather new information about why the clearing was done. This can include site visits to the land in question, where they might formally interview both the owner of land and neighbours. This Investigations Unit acts as a ‘buffer’ between the Native Vegetation and Biodiversity Management Unit and the lawyers.203

4.9 The Investigations Unit report back their findings to the Steering Committee on Native Vegetation Compliance. This Committee then makes the decision as to what compliance option is used. The compliance actions available include an education notice and a formal caution. Administrative penalties are also available, but this form of sanction normally has a 12-month statutory limitation period and satellite images showing land-use change often go beyond that. Civil or criminal enforcement can also be undertaken.

4.10 The lawyers responsible for advising on vegetation clearing cases and handling the cases through to court are from the Crown Solicitor’s Office, which is part of Attorney-General’s Department. The lawyers are based in the Administrative and Environment Section of the Crown Solicitors Office and have experience in working in environmental litigation and prosecutions. They also have generic caseloads and will work on many different cases, not just ones concerning the clearing of vegetation.

4.11 Overseeing this process is a legislative statutory body, the Native Vegetation Council (NVC). The NVC has broad representation and Government makes appointments to it. It is an independent council with independent decision-making capabilities on applications to clear. This high-level policy and supervisory body also supports the various Government entities involved with vegetation clearing and decides on resource allocations to native vegetation funds.

Queensland

4.12 The Queensland Government’s State-wide Land and Tree Survey (SLATS) project provides annual vegetation clearing data from satellites for the whole of Queensland. This body is only concerned with state mapping and maintains a distance from enforcement functions, as there is recognition that it will be hard to gain entry on to land if they are seen to have a role in vegetation compliance.

4.13 There is a Remote Sensing Centre in the division of Environment and Resource Sciences, which is part of the Government’s Department of Environment and Resource Management (DERM). There are approximately six remote sensing experts working in this Remote Sensing Centre. The remote sensing specialists analyse the SLATS data against legislative compliance requirements and other spatial data to determine cases of potentially illegal clearing.

4.14 The results of the remote sensing work are sent to a compliance and investigatory division of DERM. This division contains an investigations team and a compliance strategy and planning team. This compliance strategy and planning team has a principal policy and planning officer, who coordinates the regulatory response. The investigations team is responsible for gathering more evidence as to whether the clearing was unauthorised. As in South Australia, the Department originally had a small number of vegetation investigations staff, before deciding to make environmental investigations staff duties more generic. Staff are responsible for investigations under five different environmental acts. There are now approximately nine investigators and seven operational staff, who are part of the compliance and investigatory branch of DERM. They gather evidence on the ground and undertake targeted visits, interview suspects and make recommendations to prosecute.

4.15 The Litigation Unit of DERM has an Environment and Natural Resource Regulation Group, which works on the legal side of native vegetation cases. The decision whether to go to court is made by this Group, in

203 Personal Communication.
conjunction with the Compliance Strategy and Planning Unit and the Investigations Unit. The lawyers will not advise on a particular matter until the complete investigation is done, unless there is an overriding reason that they should be asked. As well as undertaking prosecutions, lawyers can initiate other lesser compliance sanctions, such as warning notices and penalty infringement notices provided under the legislation.

**New South Wales**

4.16 In New South Wales, the native vegetation programme similarly cuts across a number of divisions within the State’s Department of Environment, Climate Change and Water (DECCW); including the Environment Protection and Regulation Group, Scientific Services Division and Legal Services Branch. A manager in the Native Vegetation Operational Support Section of the Environment Protection and Regulation Group oversees coordination amongst these groups.

4.17 The Scientific Services Division (SSD) manages the remote sensing program, including the acquisition, processing and interpretation of spatial data. This includes using medium and high-resolution satellite imagery, aerial digital photography and newer technologies (e.g. LIDAR).204 Technical members of staff involved in the analysis and review stages of the satellite data normally number between six and twelve people (as some are employed on temporary contracts for seasonal variations). Within the SSD is the Information Sciences Division there is a dedicated manager responsible for Remote Sensing and Land Assessment. The SSD conduct visual inspections, by looking at satellite imagery comparisons and undertaking validations of the imagery taken (e.g. to check whether clearing was caused by fire).

4.18 The input of the SSD has progressed significantly over the past two years, particularly in providing support to their native vegetation compliance and enforcement activities. The SSD also maintains strong links with their Queensland counterparts and continue to work with the University of Queensland and Queensland Government to develop automated methods to process the enormous amount of information being acquired. The technical review in SSD happens at both state-wide and regional levels and, when complete, is given to those in Government responsible for compliance.

4.19 The Environment Protection and Regulation Group (EPRG) in DECCW has a broad range of environmental management responsibilities, including compliance and enforcement under the Native Vegetation Act 2003. The remote sensing products support EPRG’s work; in particular, they are being used to identify unexplained vegetation change and to assist with managing the risks of the large areas of vegetation change that may be associated with illegal clearing. The imagery only alerts them that there might be a problem, and they still have to do a desk and field examination to see whether the vegetation changes were through other means, or, alternatively, whether they were the result of an approved clearing. The Compliance team in EPRG manages communications between Government and landholders. There are a number of models for the use of investigatory staff. In some parts of the State, there are specialist enforcement officers with a focus on native vegetation alone, whereas in other areas their remit is mixed. There can be up to nine specialist investigators working with the legal branch on complex matters involving clearing. The investigators are not ecologists, but highly trained and qualified officers possessing investigation skills and/or evidence skills. A number of guidance documents support their role. There are compliance staff across New South Wales, so analysis and decision-making is made on a State-wide basis in different areas. The operational staff in EPRG consider all the evidence that has been collected and decide what the regulatory response should be. There can be sanctions including: penalty notices, on the spot fines, remedial directions, warning/advisory letters or court action.

4.20 The Legal Services Branch (LSB) have a number of roles in relation to compliance and enforcement, in particular, providing legal advice on the legislation administered by DECCW and preparing and conducting litigation. There are no designated lawyers working solely on native vegetation legislation. However, there is a strong group of internal lawyers in DECCW who are experts in environmental prosecutions. They carry out work in the areas of civil litigation, enforcement and criminal prosecution. They may also provide specialist input into the investigation of serious conservation and environmental incidents and suspected breaches of legislation administered by the DECCW.

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204 LIDAR (Light Detection And Ranging) is an optical remote sensing technology that measures properties of scattered light to find range and/or other information of a distant target. The prevalent method to determine distance to an object or surface is to use laser pulses. Like the similar radar technology, which uses radio waves, the range to an object is determined by measuring the time delay between transmission of a pulse and detection of the reflected signal.
Identification of vegetation clearance and the impact of satellite monitoring

4.21 Satellite monitoring can be a very pro-active method of monitoring and enforcement in the change detection programmes of each State. As can be seen from the descriptions of regulatory structures in each of the States, satellite data is used as a key trigger for the investigatory processes. However, States do not rely on this satellite data alone in identifying vegetation clearance, and there are a number of other important sources of information.

4.22 States will become aware of some vegetation clearance through applications for permits to clear. In some States, the sanctions available to Government can be a financial incentive for landholders to go through the correct channels, and many do comply with the legislation and seek authorisation before clearing vegetation. As the laws have toughened over time in allowing permitted clearing, the numbers of applications has decreased.205

4.23 A further method of detecting vegetation clearance is through other Government operations and investigations. Government is charged with many functions, and field staff with responsibilities as diverse as forestry management or road maintenance can sometimes spot vegetation clearance and report this to the department responsible for compliance. Local councils and catchment bodies also play an active role in noticing changes in their area.

4.24 There is also a human element to managing compliance. Government departments handle a large number of complaints from members of the public or neighbouring farmers. Some farmers will report their neighbours because of connected disputes about boundaries, fencing or water use. The levels of tip-offs are quite high. In South Australia, an average of 250 fifty reports a year are made in this manner, and in New South Wales, approximately 500 reports a year are made to a dedicated telephone number.

4.25 Before satellite monitoring, Government departments relied on detecting vegetation clearing through the methods described above. When satellite monitoring was introduced into monitoring and enforcement strategies, they were suddenly aware of significantly more possible offences.

| Recommendation 8 |
| Use of satellite technologies could cause a substantial increase in the number of offences detected, requiring enhanced funding and resourcing in relevant departments. This could result in more money being required, as more staff would be needed to manage the increased caseload. The introduction of satellite monitoring into regulatory regimes does not solve all of a department’s resource difficulties, and in fact in the short-term it can impose increased financial and resource pressures. It is, therefore, recommended that such an outcome be considered in development of strategies. |

Targeting resources

4.26 An outcome of using satellite monitoring in a monitoring and enforcement strategy is that it will potentially reveal far more breaches of the law than the regulator has resources to investigate. There could, therefore, be a need for Governments to target the resources at their disposal.

Number of reports of illegal clearing

4.27 During 2008/2009, the satellite monitoring programme of the Department of Water, Land and Biodiversity Conservation in the South Australian Government received 223 reports of suspected illegal clearance of native vegetation contrary to the Native Vegetation Act 1991.206 It is not known what proportion of this figure was from satellite change detection alone.

205 Personal Communication.
206 Personal Communication.
4.28 Since the coming into force of the Queensland Vegetation Management Act 1999 in 2000, satellite change detection initially revealed an average of 3,000 notifications of suspected illegal clearance per year (2000-2004).\textsuperscript{207} This number has dropped substantially in recent years, in part because the Government is now using a new methodology for presenting the figures and numbers of cases. In 2008/2009, the Department of Environment and Resource Management received approximately 700 unexplained cases of clearing.\textsuperscript{208} Approximately 30\% of these notifications were the result of public complaints and the rest from the satellite data.\textsuperscript{209}

4.29 In 2007/2008, the Department of Environment Climate Change and Water, New South Wales Government, detected in excess of 1,000 properties where suspected vegetation clearing had occurred from the analysis of satellite data.\textsuperscript{210} There was also an additional 500 clearing reports from public tip-offs to a telephone hotline.\textsuperscript{211}

4.30 The regulators in the three Australian States above are unable to investigate all of the cases of potential non-compliance. This would require a phenomenal workload and they simply do not have the capacity or resources for this. Therefore, Governments in each of these three States strategically prioritise investigations.

**Assessment of which reports to investigate**

4.31 Within the context of budgetary constraints, an increasingly common regulatory response to dealing with environmental non-compliance has been to implement so-called flexible risk-based enforcement strategies. In line with the Hampton Review of inspection and enforcement in the United Kingdom,\textsuperscript{212} risk-based regulation implies using what are often limited resources in the most effective manner possible to achieve specific policy outcomes. Presently in Australia, experience with satellite monitoring has shown that regulatory bodies are given more compliance work than they can cope with. However, rather than carrying out inspections to the same level of intensity on all of the activities falling within the scope of control, risk assessments are made in order to target enforcement attention where the risks associated with non-compliance are most severe; generally speaking, operators whose activities are likely to cause greater environmental damage and/or those most likely to non-comply. The United States Environmental Protection Agency has similarly adopted a targeting approach to reduce the cost of ensuring compliance.\textsuperscript{213}

4.32 In Australia, each State has a different model of risk assessment in deciding where to target regulatory resources and effort. In many of the States, the tip-offs that Departments receive are given priority for further investigations, as Government believes they have to be sensitive to public perceptions.\textsuperscript{214} Governments want the public to be ‘good sheriff’s deputies’,\textsuperscript{215} so try to ensure that all allegations are responded to. They also strive to let people who have complained know what is going on and, when the investigation is complete, whether further action will be taken. Complaints from members of the public therefore, often receive investigative priority over the results from the satellite monitoring. This is sometimes described internally within Government, as ‘the satellite does not write to the minister’.\textsuperscript{216} What is done with the data collected by the satellite depends on the result of a risk assessment carried out by Governments in each State.

4.33 In South Australia, the Department of Water, Land and Biodiversity Conservation undertakes a risk assessment which looks at how significant the clearance is, its size, its biodiversity impact and resource impact.\textsuperscript{217} The result of this process is that the Department arrives at a preliminary list of about 30-50 incidents that they intend to look at in greater detail each year.\textsuperscript{218} An official from the South Australian Government estimated that change detection information from the satellites only accounted for about a dozen of these

\textsuperscript{207} Personal Communication.
\textsuperscript{208} Personal Communication.
\textsuperscript{209} Personal Communication.
\textsuperscript{210} Personal communication.
\textsuperscript{211} Personal Communication.
\textsuperscript{212} P Hampton, Reducing Administrative Burdens: Effective Inspection and Enforcement (HM Treasury, London 2005).
\textsuperscript{214} Personal Communication.
\textsuperscript{215} Personal Communication.
\textsuperscript{216} Personal Communication.
\textsuperscript{217} Personal Communication.
\textsuperscript{218} Personal Communication.
cases, the rest coming from tip-offs. The fact that less than one third of cases short listed for further investigations come from the satellite monitoring does raise the question of whether the Government is saving money by using satellites, or even whether it is discovering sufficient potential cases to justify the expense of such a monitoring programme.

4.34 The Department of Environment and Resource Management in Queensland have also developed a prioritisation system/formula for checking sites. Factors considered include the number of hectares removed and whether further investigations are in the public interest. The number of cases shortlisted for investigation by the Department is usually 30-60 a year. Unlike the position in South Australia, checks revealed by satellite alerts make up the largest proportion of this figure.

4.35 In New South Wales, the Department of Environment, Climate Change and Water also has a filtering system to decide which cases to pursue further. For those detected by satellite monitoring, they look at those which pose the highest risk, assessed by reference to size (e.g. biggest areas cleared), environmental significance (e.g. highly cleared landscapes / land with a high conservation value) and whether those investigated are repeat offenders. To do the latter, they have built in an additional filter to look at historical trends and changes. After this risk assessment, approximately 150 detected cases are looked at each year, and many of these are revealed by the satellite monitoring process.

4.36 Of the cases that Governments decide to investigate following the risk assessment process, many will turn out to be a breach. Government departments will normally be reasonably sure from all of the evidence that there has been illegal clearing before deciding to investigate further. That is not to say that the system is foolproof - it is not - and investigators can still find that there were legitimate reasons for the clearing when they carry out site visits of the properties. However, they would have the evidence from the satellite imagery, combined with the desktop analysis, where they would have already looked at permits, data from fire authorities and considered many of the exemptions under the legislation.

4.37 The risk-based method of targeting investigations has recently, in most States, resulted in an increase in prosecutions. This is probably because Governments are diverting their resources to those cases most likely to succeed in court. In South Australia, approximately 10 cases go to court each year. In the last financial year in Queensland, the litigation team received approximately 20 briefs, with about 5 to 10 of these reaching court each year. New South Wales had 10 prosecutions in 2008 and 11 prosecutions in 2009. More landholders are also issued with other sanctions, such as infringement notices. Prosecutions in court are discussed in greater detail in Chapter five.

What happens to those cases that are not investigated?

4.38 The use of satellites in Australia fits well with risk-based enforcement approaches, allowing regulators to focus their investigatory efforts on high-risk properties. As ground-based monitoring is less available and accessible in Australia, the targeting of resources to the more critical cases is a sensible approach. However, there are also limitations to such risk-based approaches. Allocating the hardcore cases for investigation removes the heavier load of small and medium cases, but this means that many people who have been identified as potentially illegally clearing will not be investigated. If they are not investigated, they will not be aware that their offence has been detected. In some Australian States, it seems that only about 10% of cases where vegetation change has been detected are investigated. This sharpens the focus on what happens to potential offenders in the other 90% of cases of unexplained clearances.

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219 Personal Communication.
220 Personal Communication.
221 Personal Communication.
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223 Personal Communication.
224 Personal Communication.
225 Personal Communication.
226 In 2008/2009, there were three successful criminal prosecutions in the Magistrates Court and four civil actions in the Environmental Resources and Development Court. There are currently eight ongoing prosecution matters before the courts and a further four incidents have been referred to the Crown Solicitors Office for advice as to sufficiency of evidence to proceed to prosecution. Personal communication.
227 Personal Communication.
228 Personal Communication.
4.39 It is likely that there will be many landholders in Australia who are deterred from clearing land illegally because of the satellite programmes. However, a small number of other landholders could potentially perceive the limits of the risk-based monitoring and enforcement. Some could flout the law if they think that they can clear small amounts of land without being noticed, or at least without being selected for further investigation. There are examples from the satellite monitoring in each State of small cases of repeat offenders ‘chipping vegetation away’ each year. In the absence of any further checks, those farmers who clear small amounts could stay beneath the regulators’ radar and get away with repeatedly breaking the law. Even if some are eventually prosecuted, because of statutory time limits for bringing prosecutions, it is difficult to prosecute for cumulative clearing over a long period of time.

4.40 States in Australia have, therefore, developed, or are in the process of developing, a number of schemes to complement risk-based enforcement approaches.

Compliance lottery and random inspections

4.41 The DECCW in New South Wales also undertakes random inspections, so farmers and farming associations cannot second-guess what the thresholds in the investigatory risk assessment are. The Department of Environment and Resource Management (DERM) in Queensland have also considered a similar idea. They have considered a ‘compliance lottery’, where random names of properties identified as unexplained clearing could be drawn from lists over certain time periods and be investigated. Whilst they were unsure whether the randomness of this would act as an increased deterrent, they considered that it could influence any second-guessing of the risk assessment process.

Fixed penalty ticket

4.42 The DERM in Queensland have also considered adopting fixed penalty notices, to be imposed on those farms identified as having unexplained clearing. This is modelled on the ‘speeding ticket’ system, whereby a copy of the proposed fine with a satellite image showing the clearing is sent to suspected offenders. This could mean that the onus would then be on the person accused to argue why they should not pay this. Adopting such a system has been put on hold, as there is uncertainty as to whether there are sufficient grounds for relying on the satellite imagery as evidence alone. The Government presently considers it preferable to have supporting evidence from an investigation, particularly as the accused might have a legitimate reason for the clearing (the statutory permit system is not always up-to-date, for example).

Departmental letter

4.43 Another method to improve compliance has been to conduct a targeted letter campaign. In South Australia, the DENR has for many years contacted farmers suspected of breaches of the legislation by letter, informing them that the monitoring programme has detected unexplained clearing on their land. The wording of the letter is careful not to be accusatory in tone, because there is a recognition that the satellite image itself cannot identify it as illegal clearing or not. Farmers are, therefore, simply requested to help the Government with their enquiries. There have been occasions when some farmers have written back admitting guilt. This has led in some situations to warning letters or prosecutions. If farmers reply to the Government that they had cleared, but were relying on exemptions, they might be sent a further letter asking if they minded a Government inspector visiting them when they were next in the area. This method of letter writing in essence informs farmers they are being closely monitoring, seeking to deter them from future clearing.

4.44 In New South Wales, the DECCW is also considering implementing a similar state-wide letter campaign. These letters will also be carefully worded to inform and deter, rather than accuse. The main difference between the DECCW’s planned campaign and the one operating in South Australia is that DECCW plan to include with their letter before-and-after satellite pictures of the land in question. DECCW have trialled issuing warning letters in the past, but not to such a large number of recipients (only approximately 600 people), so there is great interest as to the impact of this.

229 Personal Communication.
230 Personal Communication.
231 They tested the letters campaign idea in 2007 from the regional office in Newcastle, contacting those landholders where the clearing was not serious enough to go to court at that time.
negative response from the earlier trial, they do consider that a state-wide campaign is more likely to cause a backlash in regulated communities.\textsuperscript{232}

4.45 Fear of a bad reaction from those regulated is one of the reasons why the Queensland Government have not adopted a letter campaign. One Government official commented that there was a fear that they were already considered to be too hard on farmers (particularly by the farmers), and in the extreme case they were worried that ‘if it caused one person to commit suicide then this could have significant implications’ for the whole of the vegetation monitoring programme.\textsuperscript{233}

4.46 Most of the investigators interviewed during the course of this project were supportive of letter campaigns using satellite imagery and wished this to be developed further.\textsuperscript{234} Some were frustrated that large numbers of landholders were not investigated, and wanted to incorporate such a letter campaign into risk-based enforcement strategies.\textsuperscript{235} This was both to raise the profile of the native vegetation clearing laws, as well as to inform landholders that satellites were monitoring them and there was an increased chance of illegal clearing being detected. Having such a letter campaign is particularly suited to the methods of monitoring and regulation in Australia, where all landholdings in each of the sample States are monitored annually. A letter campaign would not work as effectively in the EU, for example, where under the agricultural subsidy monitoring programmes, only a minimum of 5\% of farms are monitored each year.

4.47 It is unknown what the impact of a letter campaign including satellite images will be. This question should be revisited in five years time, when more developed research conclusions should be identifiable. There is a potential method for testing whether satellite monitoring is effective. The regulator could send to a third of those identified as possibly breaking the law a letter only. A further third considered to be potentially in breach of legislation could receive a letter accompanied with before-and-after satellite images. The remaining third would not be contacted at all in the first instance. By examining changes in compliance over the next few years, based on the responses of regulated communities to the methods of communication outlined above, Government could potentially measure the impact that such a compliance campaign has had.

**The challenges of interdisciplinary-working when using satellites in monitoring**

**Why teamwork is required**

4.48 One of the key challenges in using satellite data in a regulatory environment is building good working relationships within Government. In order understand the challenges of each other’s needs, there has to be an evolving process of collaboration between different disciplines.

4.49 At the outset of a monitoring and enforcement programme where satellites are used, most Government lawyers will have little knowledge or experience with digital evidence. They will in most instances not completely understand the science of satellite imagery, or its limitations and strengths as evidence. The lawyers need to ask the Government scientists these questions before prosecutions commence in order to understand the vulnerabilities of the technology. Government scientists also need to assist investigators, because this group may also have had little or no prior training with satellite imagery. Without communication, some will not be clear about what the satellite image has actually shown. Similarly, Government scientists responsible for remote sensing will, in the early stages, have little knowledge of legal procedure and the time frames necessary to conduct a case, in accordance with statutory limitation periods. They will also be unlikely to have experience of preparing reports, affidavits and other documentation to a standard that is required for court. Many will also have not appeared in court before, and could have limited experience of aggressive cross-examination by defence lawyers. They will require briefings from lawyers as to how to prepare the evidence and what to expect in court.

**What can happen if relationships are not built**

4.50 Experience in Australia shows that there has not always been a good triangle of understanding between lawyers, scientific officers and investigators. When satellite programmes were first adopted, in some instances

\textsuperscript{232} Personal Communication.

\textsuperscript{233} Personal Communication.

\textsuperscript{234} Personal Communication.

\textsuperscript{235} Personal Communication.
there was little communication between disciplines. This meant that not all prosecutions went smoothly, with a small number of cases even collapsing in court.

4.51 Government scientists in two States commented that there had been cases where they (or their team) had received no briefing from a lawyer/prosecutor at all before court, or if this had taken place, it had been less than ten minutes long and on the courtroom steps. This had sometimes resulted in the lawyers showing an ignorance or lack of understanding about the evidence and the issues in court. Sometimes, their questions had even been counter-productive and made the evidence more vulnerable. One Government scientist remarked that a lack of communication increased the prospect of a lawyer making the satellite data seem more complicated in front of the magistrate.

4.52 In one court case, Landsat satellite images containing writing underneath, which provided key information such as dates, location, direction taken, were prepared by a Government Scientist for use in a court prosecution. The lawyer handling the case removed the writing underneath the satellite image, as they did not want the image to be thought of as a ‘copy’ in the court (so that it was considered to be an ‘original’ document in law). These changes were done without consulting the Government Scientist who had prepared the imagery. When it was shown in court, the Government Scientist, who was appearing as an expert witness for the prosecution, could not provide any details about the case as the information he needed had been removed from the bottom of the image. The lawyer had just assumed that the Government Scientist would know all the information, and was unaware that this expert had worked on hundreds of images over a few years and needed the information on the image to recall the case. The defence seized on this opportunity.

4.53 If there had been better liaison and communication between these different groups from the start, then better outcomes might have been achieved. Building relationships is, therefore, of great importance, and Government should be ‘all learning’, and focus on communication strategies from an early stage.

Appointing key liaison officers

4.54 The lack of communication between departmental groups is not surprising; Government staff are often under-resourced and extremely busy. However, the use of satellite imagery requires all sides of the regulatory triangle (satellite scientists, compliance investigators and lawyers) to devote more time to teamwork. It takes a lot of energy to bring these groups together, but this is necessary, to enable them to understand each other’s needs. Otherwise, there is the danger that satellite monitoring and enforcement programmes become disjointed or scientifically/technically-led.

Regular meetings

4.55 A solution from Australia to try and improve education and liaison has been to hold regular meetings with staff from all of the key groups attending. The DECCW in New South Wales, coordinated by the Environment Protection and Regulation Group, has held such meetings regularly. General discussion at these meetings includes the status of the technology, issues arising from its use, operational issues and the use of the imagery in the courtroom.

Training events

4.56 The size of the Government workforce in environmental departments in Australia, is in some States reducing, due to austerity drives. Training grounds for civil servants are no longer in existence or have been considerably reduced. Any training for staff working with satellite imagery in a monitoring and enforcement context, must, therefore, now be organised on top of a person’s normal staff role. It has to be recognised as being beneficial, but at the same time, be carefully balanced in terms of timing, so that it does not impact on their day-to-day role.

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243 Personal Communication.
4.57 The New South Wales Government appears to be leading the way in training staff across DECCW who are involved in the use of satellite imagery. The Government has run an expert witness course for their science and remote sensing staff which was very well received. They have also, with the aid of Government lawyers and external barristers, held moots (mock trials), so that remote sensing staff can participate in the court process and understand what questions they may be asked. The Science group in DECCW has also provided sessions for the lawyers, so they can understand the limitations and strengths of the imagery in constructing a case. The Government is also trying to train the investigatory staff in DECCW, as it is only with experience of satellite imagery and a long connection to recognising and working with the landscape that they will perform better.

4.58 Geoscience Australia, a Commonwealth Government agency which carries out geo-scientific research, has also recognised the need for training roles in the context of the satellite monitoring and enforcement framework. It is also considering training programmes focussing on the data-use of satellite imagery in court.

4.59 A further lesson learnt from Australia is that it is preferable to have published operational guidance for regulatory staff. In some States, there is also operational guidance on handling technical information from satellites, including its use as evidence, traceability and the handling of satellite data.

4.60 Whilst Governments have been recruiting staff with remote sensing experience, some States are finding it hard to get people who also have photo interpretation skills. This is also required in remote sensing programmes, especially where aerial photography is used in combination with the satellite imagery. Government is dependent on existing staff for this skill, and many of these people will have been with departments for many years. This photo interpretation skill set is not being taught, or taught well enough, and consequently is being lost over time. Therefore, some form of training within Government might also be required to pass on this skill to early-career staff.

**Recommendation 9**

Satellite monitoring programmes require a far more strategic regulatory approach than conventional land-based approaches. Lawyers, scientists and investigators would be required to work together as a team. Regulatory agencies must, from the beginning of adopting a satellite monitoring programme, collectively understand their overall delivery aims, their individual roles within the programme, and how these varying Government functions will interact and work together. There should be dedicated personnel in each of the interdisciplinary groups appointed to work closely together and to provide communication and liaison between different arms of Government. Regular meetings, training events and published guidance should also be undertaken to foster interdisciplinary understanding and cooperation.

**Building better relationships with others**

4.61 The remote sensing staff in the Queensland Government have been frustrated that there is not more inter-State cooperation in Australia, and have been trying to improve networking between Australian States to facilitate knowledge transfer. They have suggested setting up a remote sensing experts group, possibly facilitated by a networking group focusing on environmental regulatory bodies, named AELERT. This would help establish a network of standardisation, problem solving and lesson-learning.
4.62 The Queensland Government have also provided expert witnesses to other Australian States and would like to see a scheme of this type expanded, so that States could provide expert witnesses for court cases in other States. However, there are administrative and resource issues, including whether each State has enough staff to cover absences of this kind.

4.63 The New South Wales Government were lucky not to be setting up their satellite monitoring programme without the benefit of learning from experience elsewhere, and its start-up was achieved with the assistance of the Queensland Government, who had an extremely well developed programme. All States agreed that establishing monitoring programmes of this kind was an ‘all-learning experience.’ One Government official in Australia commented if they ‘knew then what they knew now, we would have been able to get there far quicker.’ It would seem advisable for other regulatory bodies in Europe and elsewhere wishing to start a satellite monitoring programme to consult others with experience first. Additionally, having expert groups on satellite monitoring would seem a favourable idea, and this could be implemented in Europe through environmental networking bodies like the IMPEL network, or through the GMES programme.

Satellite expertise in monitoring programmes

Imagery analysis: in-house v out-sourcing

4.64 A satellite monitoring programme needs skilled people to carry out imagery interpretation. These can be in relatively short supply or expensive to employ. Most Australian States have in-house experts carrying out imagery analysis, with the exception of New South Wales, which has a combination of internal and external analysts. Comparatively, in the UK, all of the agricultural monitoring using satellites is out-sourced to commercial companies. There is no right or wrong answer in deciding whether to carry out analysis in-house or to out-source. However, a lesson from Australia is that if it is out-sourced, one will still have to explain the regulatory processes to the commercial company, which can be challenging. If analysis is done in-house, relationships can be built and analysts can support the Government with their skill sets. In satellite monitoring and enforcement programmes, what is needed is an evolving process of different disciplines collaborating; one Government official commented that this was not an easy thing to outsource.

Staff numbers and programme vulnerabilities

4.65 New South Wales and Queensland have a significant number of experts managing the scientific side of the satellite monitoring programme, but South Australia only has one analyst. This appears to make the whole of the change detection programme vulnerable, because if that expert left, or was taken ill, the Government would have no-one else working in-house to take over this role. This could result in the satellite programme stalling, or even being dropped.

4.66 A connected issue concerning a shortage of technical staff is that of having a review process. Many of the States have a process of internal review, so that colleagues check each other’s work. Human error can occur, and it is important that this is detected so that the evidence in a court case or even the whole monitoring programme is not tainted. Some States have introduced extensive checking procedures through a clear management chain (both internal and external) to make sure that problems are discovered and the imagery is ready for court. For example, in one State, ‘scientist A’ might have responsibility for the image,
but their work will be passed to a more senior checker in the remote sensing group. If there is some disagreement about interpretation, then it will then go to three or four senior managers to look at as a group. If there is no system of support, or confirmation that the work has been correctly processed and interpreted, this suggests that the evidence might be more vulnerable in court. Whilst it will not be excluded as evidence, this might affect the weight that a court might attach to the image as evidence if this argument is raised by the defence. Some sort of validation process in a satellite monitoring programme involving separate analysts, therefore, seems like a good idea.

4.67 A final issue with having a shortage of technical staff is that departments could find it onerous to require scientific staff to appear as expert witnesses in court. Experience in Australia shows that if scientists have to go to court, they may be away from their desks for a day or even a week (whilst waiting to appear as witnesses, or being cross-examined). This can mean that the monitoring programme is constantly halted, with staff spending less time detecting criminal activity and more time proving a case in court.

258 Personal Communication.
Chapter Five
The use of satellite imagery in courts

Introduction

5.1 Whatever its potential for enforcement agencies, it is clear that a potential barrier to using satellite imagery has been a lack of examples where it has been successfully used as evidence in courts. To date, imagery has been admitted as evidence in court in relatively few cases around the world. Australia has internationally been unique, in that there have been a significant number of cases where satellite imagery has been used as evidence in its courts. Annex E to this report contains details of 53 cases in which satellite imagery was specifically mentioned in court decisions from Australia. There have also been a number of unreported cases where this form of evidence has been used. This is because most prosecutions under vegetation clearing legislation are heard in local Magistrates’ Courts in Australian States, where cases are not reported.

5.2 The fact that Australian enforcement agencies were the first group to really test satellite imagery in an evidential context meant that they were entering unchartered waters. State environmental regulators in Australia would admit that at the outset of using satellite technologies in the courtroom, they did not have a clear picture of what to expect in terms of legal challenges. One Government official I spoke to in Australia described the early use of satellite imagery in Australia as not being ‘game-fit’ for court.259 The experiences of Australia are therefore extremely important, as no other country has built up such a wealth of understanding in addressing the challenges of using satellite imagery as evidence.

Differences of satellite imagery to other forms of evidence

5.3 Evidence from digital satellite imagery differs from traditional analogue photography because there is no ‘original’ on which to rely, and first-stage copies are just visual representations of binary data. Several processing stages undertaken by a technical expert are normally required before the evidence could be considered useful. Certain assumptions may be questioned, such as whether the satellite and computer were working properly, so further proof of correct functioning from expert witnesses may be required. It is also this human processing element that could diminish the weight attached to evidence and even render it being treated as hearsay.

5.4 The use of hearsay evidence is subject to constraint rules in many common law countries, including Australia. Hearsay evidence is often thought of as ‘second-hand’ evidence where, for example, the witness has not directly seen the matter in question, but is recounting what others have told him. Satellite imagery differs from other comparable forms of evidence, such as aerial photography, in that a court can obtain conformation from a person in the aeroplane that the camera was working properly and that they witnessed first-hand what was on the photograph. In contrast the satellite has no astronaut to confirm an image was taken of a particular location and on a given date. Hearsay rules were largely developed when evidence was mostly reliant upon human witnesses, but the courts have increasingly had to handle evidence obtained by technological means. Evidence in the form of digital imagery from security cameras and automatic cameras, for example, has been considered to be real evidence and it is likely that satellite imagery would be treated similarly.260 Nevertheless, a degree of human intervention such as image manipulation or enhancement may render such imagery hearsay. The party adducing the evidence would probably have to convince the court that it was not hearsay because the deductive processes that had taken place in constructing the image could be examined against the raw data in each case.

Admission of evidence

5.5 Although there are some common principles, the rules of evidence differ from country to country and according to the type of legal proceedings in which they are used. In relation to environmental law, four main categories are common: (i) administrative proceedings, concerning areas such as appeals over licences; (ii) judicial review actions, where legal action is taken against public authorities for failing to comply with legal duties; (iii) criminal

259 Personal Communication.
proceedings, where prosecution for environmental offences is undertaken; (iv) civil proceedings, where enforcement authorities are, for example, seeking recovery of costs for environmental remediation.

5.6 In many legal systems, the primary test for admissibility is that the evidence is ‘relevant’ to the case, and does not fall within any rules of exclusion. Satellite imagery used as evidence in court will, more often than not, be relevant to the fact in issue, so an informed lawyer is more likely to seek to have it excluded on the basis that the techniques which are employed are unreliable. A lawyer faced with satellite imagery could seek to challenge its admissibility as evidence. A theoretical position might be that satellite imagery is excluded, as a matter of discretion, because of the significant risk that in the circumstances of the particular case the evidence is unreliable. Its weight is thought to be so uncertain that it is not safe to allow the fact finder to evaluate the evidence, in view of the significant risk of error. Obviously, different countries impose varying evidential rules, but generally it seems quite unlikely that a court would find that satellites are an unreliable technology and that the rules of admissibility would prohibit the use of satellite imagery as evidence per se.

Use of satellite imagery in the Australian courts

5.7 The use of satellite imagery in the Australian courts has been a bumpy ride. All of the States examined in this report have experience a phase of problematic prosecutions. This has caused them to pause and reflect on their practices and procedures for using satellite data as evidence in court.

Vegetation clearing cases in South Australia

5.8 The South Australian Government has nearly ten years experience using satellite imagery in court. Satellites images were used in court in a vegetation clearing prosecution in 2001. The Government secured a conviction and the evidence from comparing satellite imagery played a significant role in securing this. This case received significant publicity because, although the clearance was not that large, the defendant kept appealing, unsuccessfully, so the fine was substantial in the end.

5.9 At the outset of using satellite data in the courtroom, the South Australia Government were “feeling their way, as far as getting runs on the board in the court.” At the time of taking the decision to use satellite imagery in a monitoring context, a Government official commented that they never gave much thought to its admissibility and evidential challenges. It appears that the satellite monitoring programme was initially scientifically led, with very little control or input from lawyers.

5.10 For about five years after satellite imagery was first used as evidence, there were a number of successful prosecutions brought by the Government. Much of the court work was considered to have been of a high calibre and as such the defendants in many of these cases either pleaded guilty or a civil settlement was negotiated. Most reported legal challenges were not related to whether an offence occurred, but rather appeals to the sentences imposed. In 2006/2007, there was an appeal heard in a case concerning whether a charge could be brought as one act of clearance, rather than for 27 separate groups of cleared areas. The satellite images themselves were generally not challenged in court and most defendants were convicted. From 2007 onwards, the South Australian Government ‘started facing a higher degree of procedural scrutiny

262 Ibid
264 Dridan v Brinkworth (2003) SADC 179 (District Court of South Australia, Australia).
265 Personal Communication.
266 Personal Communication.
267 Personal Communication.
268 Personal Communication.
269 In most instances the appeals were made by the Crown, who considered the sentences imposed to be manifestly inadequate.
270 (i) Dendy v Brinkworth & Brinkworth (2006) SASC 179 (Supreme Court of South Australia, Australia); (ii) Brinkworth & Anor v Dendy (2007) SASC 120 (Supreme Court of South Australia, Australia).
271 Personal Communication. Although in one case the defendants were acquitted after successfully relying on the defence that the clearing was an ‘honest and reasonable mistake’. See further, Paul Leslie Gould v Austral Tree and Stump Services Pty Ltd & Craig Hosking (2007) MCPAR-05-9553 (Magistrates Court of South Australia, Australia).
than previously experienced, as the substantive proof became compelling, particularly, in regard to satellite monitoring.\textsuperscript{272}

5.11 There were a number of cases where the Government found it difficult to obtain a conviction, mainly because informed defence lawyers started to question the soundness of the satellite imagery. The defence found what a Government official described as ‘the Achilles heel of the evidence’\textsuperscript{273} and started to question the potential for date-changing of the imagery and whether the satellite was functioning correctly. In one case, a defence lawyer also claimed that the use of the imagery was hearsay, as it was not backed up by any supporting materials.\textsuperscript{274} When the imagery was attacked for the first time, the Government was genuinely taken by surprise and only realised then that the evidence was vulnerable. The native vegetation programme was in the words of one Government official, ‘hit for six’.\textsuperscript{275} In one case where the satellite imagery itself was subject to greater scrutiny from defence lawyers, the Government decided that the area that had been cleared was such a small area of land that it was better to abandon the prosecution.\textsuperscript{276} The Government did not want to risk losing the case and potentially creating a precedent that the technology could not be relied upon.\textsuperscript{277}

5.12 In 2007/2008, four prosecutions were withdrawn on the advice of the Government’s Crown Solicitors Office and in 2008/2009, two prosecutions were withdrawn.\textsuperscript{278} Some prosecutions were, however, also successful in this period.\textsuperscript{279} One Government official commented that ‘for all intent and purposes we had been ambushed by defence lawyers’ and ‘that the defence are playing the man, not the ball’.\textsuperscript{280} One conclusion to be drawn from these comments (given by a non-lawyer) is that the South Australian native vegetation programme was probably not legally driven, or even enabled with any significant input from Government lawyers. A clear lesson from this is that strong interdisciplinary input, including ensuring lawyers are involved from the start, is advisable in the development of any programme where satellite monitoring is to be used.

5.13 After the above setbacks, the Government’s Crown Solicitors Office started making serious strides towards making the evidence more fit for court. They considered making evidentiary changes to the legislation by introducing an evidentiary presumption provision, as the Queensland Government had done.\textsuperscript{281} Before these legislative changes can be considered, in the short-term the Government have declared a satellite image a ‘public record,’ strengthening its reliability. Any imagery, which is now sourced from a Government programme is now, a ‘public record’, but ad-hoc acquisitions of high-resolution imagery are not. The Crown Solicitors Office have also been paying closer attention to agreeing facts before a case (with the other side), so they can get a clearer idea of what might be challenged in court and preparing a way around any challenges to the evidence from the satellite.

5.14 In a case in 2009, the defence sought not to challenge the reliability of the satellite imagery but the Government scientific officer’s credentials to be working on the imagery and interpreting it.\textsuperscript{282} However, the judge accepted the Government officer’s evidence concerning the approximate areas cleared and ruled this was reasonably accurate and reliable. This case was appealed to the Supreme Court in South Australia in March 2010.\textsuperscript{283} This higher court concluded that it could identify the period in which the clearance occurred by comparing the two satellite images taken on two different dates, and it was held that the Magistrate did not err and the appeal against the conviction was dismissed.\textsuperscript{284}

5.15 Enforcement action under the State’s native vegetation programme now seems to be back on track, even though the Government would still like to make changes to the legislation’s evidence provisions in the long-term. Most recently, in May 2010, the South Australian Government had another successful case in the matter

\textsuperscript{272} Personal Communication.
\textsuperscript{273} Personal Communication.
\textsuperscript{274} Personal Communication.
\textsuperscript{275} Personal Communication.
\textsuperscript{276} Personal Communication.
\textsuperscript{277} Personal Communication.
\textsuperscript{278} Personal Communication.
\textsuperscript{279} Personal Communication.
\textsuperscript{280} For example - Gould v Austral Tree and Stump Services Pty Ltd & Another (2008) SASC 149 (Supreme Court of South Australia, Australia).
\textsuperscript{281} Personal Communication.
\textsuperscript{282} Gould v Overland Corner Station Pty Ltd and Mitolo (2009) AMC-08-11847 (Magistrates Court of South Australia, Australia).
\textsuperscript{283} Overland Corner Station Pty Ltd & Another v Gould (2010) SASC 61 (Supreme Court of South Australia, Australia).
\textsuperscript{284} Ibid.
of Ariver Run Pty Ltd, where fines totalling $244,000 were imposed on a company and its director. Satellite imagery was used to help determine the scale and timing of a clearance.

Vegetation clearing cases in Queensland

5.16 None of the other States in Australia have had the volume of success in prosecutorial terms than Queensland have enjoyed since the introduction of their native vegetation legislation. There has, however, been four distinct phases in Queensland's of using satellite imagery as evidence in court.

5.17 When satellite imagery was first used in the native vegetation programme, the prosecutions and monitoring programme was new to everyone. In this first phase, the scientific staff in Government did not have a sound grasp of the legal and evidential issues, and just assumed that the lawyers would know about this form of evidence. In court, the first few cases were successful where the imagery was used as evidence. One Government official commented that this was 'even though they were naive and unsophisticated'.

5.18 In the second phase of using the imagery, there were changes within the Government's Crown Solicitors Department and they became more organised and aware of the evidential implications of using satellite imagery. They were also fortunate to be able to find an informed barrister who had a good understanding of spatial information to represent them in court. Questions concerning satellite imagery then started to be raised by defence lawyers. This included questions of proof concerning whether the satellite was going over at the time in question and if the image was on taken on that date, the issue being whether the clearing was done before or after the Act came into force. These types of questions have not been raised since. This could be in part because of the evidential support amendments to the legislation.

5.19 The Government lost only two court cases during these first and second periods. The imagery itself in one forestry prosecution was not under scrutiny and the judge had no doubt the defendant cleared the areas claimed in the remote sensing assessment. However, some, but not all, of the charges on appeal were overturned because of ambiguity in the permits the defendant had applied for. During the period before 2006, there had not been any successful challenges to the satellite imagery itself. The remote sensing team had been directly involved in 29 prosecutions. In all cases, except the forestry prosecution above involving the Remote Sensing Team, the Queensland courts fully accepted the satellite evidence adduced. Defendants in most vegetation cases pleaded guilty in court.

5.20 In the third stage of using satellite imagery in the State, there were changes to the legal unit responsible for the vegetation programme. In-house lawyers were recruited to save money. This was the start of what was described by one Government employee as their 'black period'. The Government lost a few high profile cases in quick succession during 2006 and 2007. In one case, the prosecution failed because of a timing issue, as the case went over the limitation period prescribed under the legislation. Another case, which was won by a defendant, has since been successfully overturned on appeal. In the third case, where the defendant was

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286 Personal Communication.
287 Personal Communication.
288 Personal Communication.
289 Personal Communication.
290 Personal Communication.
291 Personal Communication.
292 Personal Communication.
293 Personal Communication.
294 McKay v. Doonan (2005) QDC 311 (District Court of Queensland, Australia).
295 Personal Communication.
296 Personal Communication.
297 Approximately 96% of defendants would plead guilty and only 4% would go to trial. Personal Communication.
298 Personal Communication.
299 (i) Witheyman v Van Riet & Ors (2008) QCA 168 (Queensland Court of Appeal, Australia); (ii) Witheyman v Van Riet & Ors (2007) QDC 342 (District Court of Queensland, Australia).
300 Witheyman v Simpson (2009) QCA 388 (Queensland Court of Appeal, Australia). The Magistrate in the first instance found that the applicant had not proved beyond reasonable doubt that "the clearing had taken place in areas where it was unlawful to clear at a time when it was unlawful to do so". In this case, the Magistrate found that in order for the clearing to be unlawful, the area cleared was required to have been within an area of land properly mapped as remnant endangered regional ecosystem in a regional ecosystem map of the VMA. Additionally, the Magistrate failed to accept that a certificate
cleared, the Department decided not to appeal as a ‘business decision’, as there could potentially have been evidential arguments raised about the imagery itself.301

5.21 The cases that were lost failed on what the Government described as ‘technicalities’,302 but there were also deeper underlying problems within the structures of Government concerning using satellite imagery as evidence. It was claimed that the new departmental lawyers representing the Government began prosecutions without ever seeing a satellite image, or even consulting with the Remote Sensing Group. One official commented that during this time there was not even a run-through with a Government remote sensing expert before some court hearings.303 A further key reason for the failure of some prosecutions at this time was because a lawyer acting for the defence was a barrister with spatial expertise, and he knew where the weaknesses lay in the evidence and legislation. The Government were, on reflection, unprepared for this.304 These failed cases generated negative publicity in the farming press.305 It was decided by Government to put prosecutions which might be contested on hold.306 Because the defence lawyer with spatial expertise was testing the evidence, there was reluctance in the Department to be seen as losing.307 The Government put enforcement actions on hold for approximately eighteen months.308 This created a backlog of cases when the programme was eventually resumed again.309

5.22 In late 2008, the Queensland Government entered its fourth phase of using satellite imagery. There was another structural change in Government in this period and a new legal group was formed within a new merged Department. This new legal group had more enforcement experience and were keen to pursue more prosecutions and larger fines.310 It is still a little early to determine the effect of these changes, but the Government now appears to be winning cases again.311

5.23 The defence would seem to have difficulties challenging the accuracy of the satellite imagery itself after amendments were made to legislation. These legislative amendments, wherein the other side have to advise on what areas of evidence they will challenge and the reasons for this challenge, were, in the words of a Government official, to make the Act itself more ‘bullet-proof’ and to ‘save getting ambushed on the day in court’.312 A Government official, when questioned about the fairness of the evidential presumption provisions, commented that whilst he could see there was now an argument that they have gone too far in the legislation, the reality was that the defence could still employ their own expert in the field.313 The Remote Sensing Team did not think that it would be easy to manipulate an imagery undetected if a defence expert were given access to all of the data.314 In a court decision in December 2009, the Queensland Court of Appeal commented that s66B in the legislation was silent ‘as to the weight to be given to statements made in the certificate. What weight should be given by a tribunal to the contents of such a certificate will depend therefore on matters such as: the relevant expertise of the certifier; the personal knowledge of the certifier as to the matters certified; the credibility of the certifier; and the reliability of the sources of information relied on to establish the certified

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under s 66B (Evidentiary Aids) of the VMA demonstrated that any of the vegetation cleared by the respondent was remnant. On this basis, it was found that the applicant had failed to discharge the burden of proof, and the respondent was found not guilty.

301 Personal Communication.
302 Personal Communication.
303 Personal Communication.
304 Personal Communication.
306 Personal Communication.
307 Personal Communication.
308 Personal Communication.
309 Personal Communication.
310 Personal Communication.
311 E.g. (i) Witheyman v Simpson (2009) QCA 388 (Queensland Court of Appeal, Australia); (ii) Department of Environment and Resource Management v Russell Winks (2009) 3009209 D.1 T01-02/KMP (IPS) M/T BEAU01, Transcript of Proceedings (Magistrates Court of Beaudesert, Queensland, Australia); (iii) Department of Environment and Resource Management v Bruce Henderson (2009) 10112009 T(0)3/JK & T(0)1/ELS/SJB (ROK) MT ROC1/2009 (Magistrates Court of Rockhampton, Queensland, Australia).
312 Personal Communication.
313 Personal Communication.
314 Personal Communication.
matters. This illustrates that those adducing satellite imagery evidence cannot simply rely on the evidential presumption alone, and will be expected to address the above points.

5.24 In 45 out of 109 prosecutions brought under the Integrated Planning Act 1997 and Vegetation Management Act 1999 in Queensland the Remote Sensing Team has given expert evidence. A significant number of cases are negotiated settlements, where a guilty plea has already been agreed. The Department has only lost three cases where a remote sensing expert has given evidence in court. There does not appear to have been any case in Queensland brought under the native vegetation laws where the evidence from the satellite has proved to be unreliable or misleading. In the cases the Government has lost in the Magistrates’ Court, the judges have never found that there was no clearing and most challenges thus far have been points of law or challenges to permits.

**Vegetation clearing cases in New South Wales**

5.25 Out of the three sample States, New South Wales has historically had the most sustained problems in courts when enforcing unlawful vegetation clearing. The regulatory bodies that had responsibility for the regulation of native vegetation clearing before the current department, DECCW, all experienced these problems. During 1998 to 2005, Government undertook 29 prosecutions for illegal vegetation clearing. The majority of these prosecutions were actually successful (eighteen), but none were successful when contested in court (six). A further five prosecution cases were withdrawn; some of these after the defence notified the Government of their intention to contest the cases.

5.26 This lack of success in contested proceedings in court was, according to an Auditor-General’s report in 2006, due to problems with meeting the evidence requirements in the Native Vegetation Act 1997. There had been problems, in particular, with the exemptions under this Act, and also being able to accurately detect and measure illegal clearing. The report noted that there were difficulties meeting the need to identify the individual clearing the land, problems with inadequate information on areas cleared and with deficiencies in preparation and presentation of evidence to a level fit for presentation to courts.

5.27 In New South Wales, the early stages of using imagery in court involved challenges by the defence as to whether the satellite had been working correctly, as well as whether it had even been ‘switched-on’ at the relevant time. Defence lawyers also sought to challenge the chronology of the imagery and some even argued that it was too ‘grainy’ to be able to prove an offence. Some judges also expected original photographic prints and had difficulties with the concept that there was no original with digital data. Whilst the satellite imagery itself was not the primary reason why all of these contested prosecutions failed, a Government official commented that their ‘inexperience with using it as evidence did cast doubt in the eyes of some judges’ and they ‘did get rocked and rolled a bit’. There was recognition within Government that if there were any doubts in a prosecution ‘the whole case could fall over.’ The Department was by their own admission ‘not geared up at the beginning’ to deal with using satellite imagery as evidence.

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317 Personal Communication.
318 Personal Communication.
319 Personal Communication.
320 Including the Department of Land and Water Conservation, the Department of Infrastructure, Planning and Natural Resources and the Department of Natural Resources.
322 Ibid.
323 Ibid.
324 Ibid.
325 Ibid.
326 Ibid.
327 Personal Communication.
328 Personal Communication.
329 Personal Communication.
330 Personal Communication.
331 Personal Communication.
332 Personal Communication.
5.28 In one high profile case against a landholder named Greentree, the case ran for three weeks before the prosecution case failed. The Government had also served notices to desist activities in other areas of the defendants land and these were dealt with in settlement, with no admission of any liability by the defence. This case was considered a disaster for the Department; it had spent considerable time and money on the prosecution and yet was unsuccessful. The failed prosecutions received wide publicity in the rural communities. There were concerns that some farmers in the State might perceive they were unlikely to be penalised for illegal clearing if caught. Applications for approvals for clearing in the western areas of the State fell to very low levels even though satellite images between 2003 and 2006 indicated that illegal clearing continued.

5.29 For fear of further bad publicity, from mid 2004, there was an internal moratorium within Government on initiating any prosecutions for clearing, although the Department continued to issue remediation notices and negotiated remediation agreements when landowners were willing. These negotiated agreements, however, did not always comply with the intent of the legislation that original native vegetation be retained or restored. This self-imposed break in bringing prosecutions lasted for approximately two years.

5.30 The Auditor-General’s report in mid 2006 recognised that there were problems in the regulatory structures and compliance approaches in New South Wales, particularly compared to those in Queensland. This report concluded that Queensland had moved quickly to establish comprehensive vegetation mapping in its State by satellite surveillance and ground control, and therefore had a better basis for evidence acceptable to courts: it had a centralised administration of compliance; and although it had fewer vegetation compliance staff than New South Wales, they had appointed compliance officers with a background of providing evidence for courts. Following the failed prosecutions and the Auditor-General’s report, there was some ‘soul-searching’, within Government. New procedures and policies were gradually introduced which sought to rectify some of the problems that had been identified and more money was invested in vegetation clearing enforcement.

5.31 It can be the legislation itself which can define a dispute and a major contributing factor to the earlier enforcement failures, was poor drafting of the 1997 Native Vegetation Act. The Environmental Defender’s Office (New South Wales) described this legislation as ‘having a lot of evidentiary problems’. The Native Vegetation Act 2003, which came into effect in December 2005, was intended to address many of the enforcement problems under the previous Act. The 2003 Act changed some of the exemptions. For example, the occupier of the land became responsible for clearing in the absence of evidence to the contrary.

5.32 What was far more positive in an enforcement context was a policy decision that the State should have a good monitoring database and spend a significant amount of money obtaining satellite imagery to achieve this. In 2007, the New South Wales Government announced a four-year dedicated monitoring programme using high-resolution imagery. The Government purchased SPOT5 imagery with complete State-wide coverage. This gave them what they considered to be the best high-resolution environmental monitoring system in Australia. The Government would not thereafter have so many of the earlier problems it encountered with having to use different types of ad-hoc remote sensing images, which were spread over longer date revisits.

333 Personal Communication.
334 Personal Communication.
335 Personal Communication.
337 Personal Communication.
338 Personal Communication.
339 Personal Communication.
340 Personal Communication.
341 Personal Communication.
343 Ibid.
344 Personal Communication.
345 Personal Communication.
346 Personal communication.
347 Personal Communication.
348 Personal Communication.
5.33 In the last few years there was also recognition within Government that there were some legal arguments that they had to tackle before evidence from satellites could work in a legal context. The Government has increasingly looked at rectifying problems connected with the use of satellite imagery as evidence. The ‘defence trick’ of questioning whether the satellite was working is now in the Government’s opinion a non-issue, having been rectified by the introduction of detailed affidavits from image suppliers and image process managers.\textsuperscript{349} Further, there are now processes within Government showing the chain of custody from the raw data, through processing, to the product that is used in court.\textsuperscript{350} Whilst it has always been acknowledged that satellite imagery is digital and therefore can be altered, the Government recognised that there should be internal guidance and manuals about how to handle this data.\textsuperscript{351} They also put into place checks, both internally and externally, for additional quality assurance of the data.\textsuperscript{352} A Government official commented that they believe they can now show the credibility and quality of the information because of the rigour that accompanies the preparation of the evidence.\textsuperscript{353} The Government consider that there is now less scope to pick holes in the satellite imagery and its interpretation.\textsuperscript{354}

5.34 There was also recognition that the key regulatory agency was not operating as effectively as it could. Prosecutions were originally often done in-house, instead of through the Office of the Director of Public Prosecutions, and there were some criticisms of Departmental handling of cases.\textsuperscript{355} The key regulatory agency responsible for vegetation clearing, the Department of Natural Resources, was abolished in 2007 and replaced by Department of Environment, Climate Change and Water (DECCW). DECCW had a rethink of their ‘business processes’ and their compliance role. The new Department began putting their resources and skills to those cases that were most likely to go to court.\textsuperscript{356} Communication was also traditionally done on a more regional basis and this new Department concentrated on becoming geared up state-wide.\textsuperscript{357} There has been additional training for staff and development of an enforcement strategy\textsuperscript{358}

5.35 In the early stages of these changes, there were still problems proving cases in court. During 2008, DECCW commenced ten prosecutions under native vegetation legislation but secured only four convictions.\textsuperscript{359} The reasons behind unsuccessful prosecutions are unknown. However, prosecutions completed in 2008 would have almost certainly have been prepared years before, under the previous regulatory regime. In the last two to three years, the Department has been ‘ramping up’ its response to illegal clearing.\textsuperscript{360} There has been an increased number of prosecutions in New South Wales, and a handful of recent cases where the Government has brought successful prosecutions.\textsuperscript{361} Many of the prosecutions were based on guilty pleas. In the cases that have gone to court, none of the satellite images used as evidence appears to have been challenged on the basis of lack of provenance.\textsuperscript{362} In a 2010 case, the defence argued that the interpretation of a SPOT5 satellite image involved a flawed methodology, suggesting that the prosecution expert witness could not assess the age of vegetation because he was not able to identify particular vegetation, or the heights of the vegetation, from these images. The Judge, however, found that the evidence was soundly based.\textsuperscript{363}

\textsuperscript{349} Personal Communication.
\textsuperscript{350} Personal Communication.
\textsuperscript{351} Personal Communication.
\textsuperscript{352} Personal Communication.
\textsuperscript{353} Personal Communication.
\textsuperscript{354} Personal Communication.
\textsuperscript{355} Personal Communication.
\textsuperscript{356} Personal Communication.
\textsuperscript{357} Personal Communication.
\textsuperscript{358} E.g. see Department of Environment, Climate Change and Water NSW, ‘Native Vegetation: Compliance and Enforcement Strategy’ (State of New South Wales and Department of Environment, Climate Change and Water, August 2009).
\textsuperscript{359} Department of Environment, Climate Change and Water NSW, ‘NSW Annual Report on Native Vegetation 2008’ (State of New South Wales and Department of Environment, Climate Change and Water, July 2009).
\textsuperscript{360} Personal Communication.
\textsuperscript{361} (i) Department of Environment and Climate Change v Olmwood Pty Limited (2010) NSWLEC 15 (Land and Environment Court of New South Wales, Australia); (ii) Director-General, Department of Environment and Climate Change v Mario Mura [2009] NSWLEC 233 (Land and Environment Court of New South Wales, Australia); (iii) Director-General, Department of Environment and Climate Change v Jack & Bill Issa Pty Ltd (No 5) (2009) NSWLEC 232 (Land and Environment Court of New South Wales, Australia); (iv) Director-General, Dept of Environment and Climate Change v Calman Australia Pty Ltd; Iroch Pty Ltd; GD & JA Williams Pty Ltd t/as Jerilderie Earthmoving (2009) NSWLEC 182 (Land and Environment Court of New South Wales, Australia); (v) Walker Corporation Pty Ltd v Director-General of the Department of Environment and Climate Change (No. 2) (2009) NSWLEC 177 (Land and Environment Court of New South Wales, Australia).
\textsuperscript{362} Personal Communication.
\textsuperscript{363} Department of Environment and Climate Change v Olmwood Pty Limited (2010) NSWLEC 15 (Land and Environment Court of New South Wales, Australia).
5.36 A Government official from New South Wales commented that their recent successes in court had been due to the systems and protocols that were now in place to respond to clearing events. They ‘can see [these] changes starting to happen in the outputs’. A judge from New South Wales also confirmed an improvement in prosecution successes and thought that this was because of both the professionalism of enforcement by regulators and improvements in the quality of satellite data. Whilst there have been enormous improvements in New South Wales to Government monitoring capabilities and enforcement strategies, there are still potentially drafting issues with the native vegetation legislation itself that might affect its overall success. It is also feasible that certain aspects of satellite imagery and its use as evidence might still be tested in the New South Wales courts.

5.37 In comparison with 1998-2006, if farmers break the law, and are caught doing so, a prosecution is more likely to be successful. However, having a strong deterrent effect in the State will take time, as the Government is still waiting on some outstanding prosecution matters. As it can take several years before cases in which satellite data has been used in investigations to come to court, it will take some time for the impact of the changes in Government practices to be fully felt.

Expert witnesses in court

Adversarial system

5.38 Like the UK, rules of evidence in Australia have developed against the tradition in criminal and civil litigation of testing evidence by adversarial means. Both the prosecution and the defendant have the right to test the authenticity and accuracy of the evidence by means of cross-examination, with the judge playing a largely passive role in factual investigation. In criminal cases, there is a strong lay element present; with juries in serious criminal trials deciding on the facts, and in lower courts lay (non-professional) magistrates’ deciding both legal and factual issues. In a jury trial, the role of the judge is to determine questions of law which may relate to the admissibility of evidence and sentences. Even in civil litigation, where juries have largely been removed and the judge determines both questions of fact and law, the judicial tradition is still to leave it to the parties involved to test each other's evidence.

5.39 Hearing expert evidence on technological matters is in some ways a relatively simple process for a judge. The hard part of their role is where two experts reach different conclusions. A judge will have to consider the statements of each witness and how they reached their opinion, and then make a decision whether they prefer one process of reasoning to another.

Court appointed experts

5.40 Some courts in Australian States have the concept of a ‘court appointed expert’ or ‘single expert’. In such cases, both sides agree to appoint a single expert to avoid the problems and costs involved in defence and prosecution experts disagreeing on fundamental points. Whilst it appears that some courts have the power to appoint their own experts, there does not appear to be any example of this in relation to cases where satellite imagery has been used as evidence.

Experience with expert witnesses in Australia

5.41 In the majority of vegetation clearing prosecutions, the defence team have not used their own expert witness. This does not, however, mean that the defence before a trial did not consult an expert. If they had consulted their own expert and he/she endorsed what the prosecution expert has said, then the prosecution will not get to find about this. This is because they do not have to disclose that their expert did not find anything wrong with the satellite imagery or methods used. A defence expert witness will only usually appear in court if they do find some form of fault which could show reasonable doubt with the prosecution’s case.
5.42 In Queensland, which has had the highest number of prosecutions, there do not appear to be any cases where an expert witness has appeared for the defence.\textsuperscript{369} The Government has, however, been up against a barrister with spatial (remote sensing) experience.\textsuperscript{370} Whilst experts from the Remote Sensing Team have never been asked anything too difficult that they could not answer, they have been asked questions by this barrister which have fallen outside their ‘comfort zone’.\textsuperscript{371} This questioning by someone with knowledge of satellite technologies has in some cases made the technical evidence seem overly complex and made it harder for the judge to understand.\textsuperscript{372}

5.43 There have been some examples when defence expert witnesses have been used in court elsewhere in Australia. For example, an expert witness was used in a Federal court case to argue that the imagery was of the wrong location and that the prosecution could not prove with a sufficient degree of accuracy where the latitude and longitude location of a protected wetlands site was on the owner’s property.\textsuperscript{373} Whilst the judge had reservations about the evidence from the satellite, following the evidence given by the defence expert witness the prosecution in this case eventually succeeded.\textsuperscript{374}

5.44 There could be some cases where the court finds that there is little difference between expert opinions.\textsuperscript{375} In one case concerning an appeal against a remediation direction pursuant to the native vegetation legislation, the court was persuaded to accept the evidence of one expert witness mainly because his approach was more site-specific, based on a field inspection of the site and correlation with actual vegetation and soil conditions.\textsuperscript{376}

5.45 Some prosecution expert witnesses have little experience of cross-examination or presenting in a courtroom. For example, one Government official commented that he thought it ‘unfair’ that he found himself in court against an expert witness that was a university professor.\textsuperscript{377} A judge interviewed in this study commented that he would never decide a case based on the fact that one person is a professor and the other a government employee; he would only look at the rigour in how they developed their findings and if the conclusion was supportable itself.\textsuperscript{378} The comment from the Government expert witness above arguably highlights the value of training for witnesses before they enter a courtroom.

Independence of expert

5.46 Some States have strict internal guidelines on expert witnesses. For example, in Queensland, they will use a different expert witness in court to the one who prepared the evidence.\textsuperscript{379} They do not let someone who has a past connection to the imagery go to court, because they want to show that expert’s ‘independence from everything,’ rather than giving the defence the opportunity to throw into doubt ‘its believability’ in the witness box.\textsuperscript{380}

Mix of skill sets

5.47 The general legal approach adopted in most Australian States is that satellite imagery is a useful tool for demonstrating in court the extent of the clearing, although showing whether or not it is native vegetation also needs to be confirmed through a different mechanism. Depending on facts in each case, this could require evidence from other experts.

5.48 In vegetation clearing cases a mix of different skill sets would normally be required when the Government goes to court. These skills are not usually found in one person alone and the Government will require a number of different experts, depending on regulatory structures, both external and in-house. Typically, States will have a remote sensing expert to show that there has been a change in the vegetation cover and to lead the

\textsuperscript{369} Personal Communication.
\textsuperscript{370} Personal Communication.
\textsuperscript{371} Personal Communication.
\textsuperscript{372} Personal Communication.
\textsuperscript{373} Minister for the Environment and Heritage v Greentree (No2) (2004) FCA 741 (Federal Court of Australia).
\textsuperscript{374} Personal Communication.
\textsuperscript{375} ANZ Banking Group Ltd v P A Wright & Sons Pty Ltd (1999) NSWSC 628 (New South Wales Supreme Court, Australia).
\textsuperscript{376} Dalmien P/L v Director General Department of Infrastructure Planning and Natural Resources (2005) NSWLEC 204 (Land and Environment Court of New South Wales, Australia).
\textsuperscript{377} Personal Communication.
\textsuperscript{378} Personal Communication.
\textsuperscript{379} Personal Communication.
\textsuperscript{380} Personal Communication.
court on the imagery; an aerial photography expert if this form of evidence is used; a surveyor or global positioning system (GPS) expert to give the court details about the site location; then they will also have a qualified botanist or expert from a herbarium to look at the imagery and other evidence to tell the court what vegetation was actually there, or how many trees of a certain species might have been removed. Governments have found that they could potentially need a number of professionals to be expert witnesses in vegetation clearing cases. A recent Court of Appeal case in Queensland required four witnesses to give expert evidence.

5.49 If satellite monitoring is extended to other areas of legal enforcement beyond vegetation clearing cases, then it is likely that there will be a similar requirement for expert witnesses from varying backgrounds to present satellite imagery as evidence in court.

Lessons learnt from court

Bigger cases – better lawyers

5.50 In some States, only about five to ten cases concerning vegetation clearing will make it to court each year. These cases will normally be those identified through the Departmental risk-based procedures as being the largest, or having the highest environmental impact. A lesson learnt was that these bigger cases were more likely to attract bigger fines in the event of a conviction, so were more likely to be defended and by better lawyers. This was an ‘additional incentive’ for always making sure that the evidence was ‘fit for court’.

Presentation in court

5.51 The view of many Government staff in Australia was that the satellite imagery always provided good evidence, but a potential weakness in using it in prosecutions was its presentation to a legal or lay audience (that is, those of little experience in satellite imagery) in court.

5.52 Any evidential report should be written with the court in mind. In one case, concerning a negligence action, a court in Western Australia found that the satellite evidence report contained too much technical discussion which, without elaboration, made it difficult to follow. The court thought this report made it difficult to ‘properly assess the cogency of his [the experts] conclusions’.

5.53 Like any other technical evidence, its relevance also needs to be communicated well in court. In court there is a need for a human face to the scientific information. A case could also fail if the expert cannot explain the imagery properly, or adequately convince the court of their interpretation of it. In one tribunal case concerning a planning dispute, an expert witness was asked to present evidence showing that a proposal to build an indoor recreation centre might cause overshadowing. The expert gave computer generated shadow analysis carried out using satellite imagery. The tribunal found that this evidence was not easy to decipher, even after expert explanations in the principal evidence and cross-examination.

5.54 In another case in Australia, an expert witness claimed in an affidavit that they had personally written the expert witness report, whereas it came out in court that they had not. This was revealed after questioning had shown that a number of reports had been prepared with contradictory statements. As well as causing

381 Personal Communication.
382 Witheyman v Simpson (2009) QCA 388 (Queensland Court of Appeal, Australia). Expert witnesses included: (i) a botanist with the vegetation management section of the Queensland Herbarium at the Botanical Services Unit; (ii) a remote sensing specialist (iii) two government inspectors who went to the land and took photographs etc.
383 Personal Communication.
384 Personal Communication.
385 Personal Communication.
386 Southern Properties (WA) Pty Ltd v Executive Director of the Department of Conservation and Land Management [No. 2] (2010) WASC 45 (Supreme Court of Western Australia, Australia).
387 Ibid.
389 Ibid.
390 Personal Communication.
391 Personal Communication.
problems of admissibility, actions of this kind can taint a case, increasing judicial scepticism of evidence in other areas of the case as well.

5.55 Expert witnesses needed to give a demonstration in court linking their scientific evidence to what has taken place on the ground. Some Government experts found that relating the act with other everyday occurrences helped the court make sense of the clearing. One Government expert said that in one case where he showed the court imagery, he told them that the clearing had taken place in a similar fashion to using a lawnmower in a garden. The time-series imagery showed that the farmer had first cleared the outside and the middle last (similarly to how many people mow their lawns at home). The expert found that this helped the judge better understand what had occurred.

5.56 All of the remote-sensing experts interviewed recommended using PowerPoint images with time-series analysis. They considered that court benefited from a step-by-step explanation using PowerPoint, showing exactly how and when the clearing took place. This could show the court how an offence ‘fitted together like a jigsaw.’

5.57 Government scientists could be offered training on what to expect in court. For example, moot courts and training are already successfully organised in New South Wales. Potential expert witnesses might be advised on how to write and structure affidavits or how to effectively demonstrate their findings in court. It is recommended that they present the satellite evidence in a manner that a lay person (i.e. someone with no spatial information expertise) can easily understand the evidence.

Resolution of the imagery

5.58 A number of Government officials and one judge commented that the resolution of imagery from some satellites was often not good enough for use in court to demonstrate the clearance adequately in a visual ‘before-and-after scenario’. Imagery from the Landsat satellite was specifically mentioned in this regard. This had caused difficulties in court, because it was hard to convince a judge that a blurry image showed that, beyond reasonable doubt, ‘something meaningful had taken place’ (e.g. a number of trees were missing). One Government remote sensing expert said ‘never in a million years would they think of just showing a blob of clearing in the middle of a Landsat twenty-five metre image in court alone.’

As discussed earlier, the Government response to this in each State has been to also collect high-resolution imagery or aerial photography if cases look set to proceed to court.

Complacency

5.59 Feedback from some Government officers and other sources indicated that they considered that a degree of complacency might have set in within Government once satellite imagery had been routinely used for some time. One Government official commented that there was an element of truth that his Department ‘got lazy with successes.’ A further Government official commented, ‘it is dangerous to become too over reliant on one form of evidence.’ In one prosecution, a Government official commented that ‘there was human corroboration available from witnesses, but the investigators did not bother to chase up witness statements’, as they considered that ‘they could rely on the satellite imagery and aerial photographs alone.’ A defence lawyer also thought that Government often considered satellite imagery to be ‘irrefutable evidence’, and in some cases ‘abandoned their sense of reality of proofage [sic] and proving beyond reasonable doubt.’

392 Personal Communication.
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404 Personal Communication.
5.60 A key lesson learnt from Australia is that it can be problematic for Governments to develop a complacent attitude when using satellite technologies as evidence. While satellite imagery has been infrequently challenged when it has been used in court, Governments do not know when a challenge might come, so they should be very much aware that they need to proceed in a manner that is always defensible in court. It is obviously better for Government that no cases are lost, but if this does happen, an observation is that they should always use this as an opportunity to ‘hold a mirror up to their own attitudes or procedures and learn from their mistakes.’ One Government official commented that it was sometimes good to have defence lawyers testing the legislation in court as it gave them opportunities to improve their techniques, which made them sharper.

Need for supporting evidence

5.61 A further lesson learnt from Australia is that the success of admitting satellite imagery also depends on supporting evidence. It is the current policy of all State Governments not to use satellite imagery as stand-alone evidence. There do not appear to be any reported court decisions in Australia where satellite imagery was used alone, with no supporting information, except in those cases where a landholder pleaded guilty following a letter from Government asking them to explain the clearing on the land. To date, a minimum of ground-based evidence has been used to support the satellite evidence and the prosecution still has to demonstrate what the images show and the connection to this on the ground. Whilst satellite data can be compelling evidence that there has been clearing, there are other issues such as how it was cleared and who removed it. The judiciary in each State also like to see that there have been physical inspections, GPS evidence, photographs on the land and other corroborating local knowledge if available.

5.62 Whilst satellite images are considered accurate, they are not 100% reliable as a form of evidence. A Government official commented that you can ‘sometimes get tripped up by the reflection of the under-soil if it’s particularly dry, or after rain on an image’. They were, therefore, reluctant to bring criminal action against somebody on the basis of satellite imagery alone.

5.63 Most Government officials recognise it is unlikely that a judge would accept satellite imagery on its own. A trio of case law from New South Wales supports this view. In the first case, a court found that the satellite imagery was not reliable in the absence of ground-checks (also known as ‘ground-truthing’), and especially not if it contradicted the ground-truthing that had taken place. In the second case, a court found that there could be limitations with the expert scientific evidence submitted, especially with ‘aspects of their evidence where they had either not visited the site at all or had only been in a position to view certain parts of the local topography’. In the third case, the judge considered that this level of evidence could only be used as an ‘indicator or guideline of clearing activity and not on a determinative basis’. However, the consistency of the findings of the satellite imagery when considered with aerial photographs and ground-truthing were held to provide clear indications that some of the clearing was not done by the former owner of property and could not be regrowth.

5.64 The Queensland Government were looking at testing a non-ground truth approach in court in 2006, but they have now backed away from this tactic. This approach was considered for cases where there was a smaller amount clearing to allow for greater numbers of enforcement action to be undertaken. However, the Queensland Government decided that there was no need to go down this evidentiary avenue and that the evidence was probably not ready to be tested in court this way. There has been a recent case in

405 Personal Communication.
406 Personal Communication.
407 Personal Communication.
408 Personal Communication.
409 Personal Communication.
410 Personal Communication.
413 Dalmien P/L v Director General Department of Infrastructure Planning and Natural Resources (2005) NSWLEC 204 (Land and Environment Court of New South Wales, Australia).
414 Ibid.
415 Personal Communication.
416 Personal Communication.
417 Personal Communication.
Queensland which provides a few clues on the judiciary’s thinking in relation to this. In *Witheyman v Simpson*, no field inspections for botanical assessment had been undertaken and the botanist did not go on the property; instead, the botanist did their analysis through stereo-scoping using the aerial and satellite assessment. The defence had criticised this for being ‘modern’ and not ‘relying on old-fashioned techniques of the botanist going out to the land’. The Court suggested that remote sensing evidence might be sufficient without ground-truthing depending on the ‘reliability of the methodology and techniques employed.’ However, this case was not on corroborating evidence, rather whether ground assessment is always required. The courts in some other countries, including the UK, are similarly reluctant to permit the use of only one source of evidence as a basis for identification, and would be unlikely to convict anyone on the basis of a satellite image alone. Most courts prefer collaborative evidence.

5.65 A useful analogy to the future use of satellite photographs as stand-alone evidence is the use of automatic speed cameras – this is normally prescribed in legislation, provided they meet reasonable standards of accuracy and reliability. Legislators in most countries will be unlikely to accept this with satellites until the technology is shown to be nearly foolproof and the margins of error extremely low.

**Recommendation 10**

Evidence from satellite technologies does not appear to have reached a stage yet where it should be used alone as evidence. It is recommended that, wherever possible, it should always be accompanied by other forms of corroborating evidence, such as witness statements from ground inspections, so as to give a young technology more credibility in the eyes of the judiciary and the public.

**Internal communications**

5.66 There have been instances in Australia of defence lawyers submitting freedom of information requests to Government concerning cases where satellite imagery has been used. A barrister in Queensland carried out a freedom of information request to look at Government emails mentioning the defendant and this nearly discredited the whole of the satellite evidence and expert witness. There was dispute in court as to whether a grain shed was built on a particular section of land, and the defence lawyer claimed that Department staff manipulated the imagery to move the shed and boundary road by 100 metres. The investigator denied this in court and the defence used emails, obtained via a freedom of information request, to suggest otherwise. On appeal, the Department convinced the court that the ‘manipulation’ was just part of a technical procedure.

5.67 In New South Wales, a farmer also brought an action against DECCW following a failed freedom of information request. In this case, the farmer wanted to know whether a relation had tipped off the Department about his clearing, but was denied because it had a system of anonymity of complainants. The court refused the application.

5.68 A lesson learnt in respect of the Queensland case, was that moving objects on satellite images could make them more susceptible to challenge in court. In this prosecution, there appears to have been a legitimate process of realignment taking place, and the court were eventually convinced of this, but in other cases it might appear to the court that something more sinister was taking place. Governments should be aware that internal communications can be subject to freedom of information requests, and so may be used by the defence to seek to discredit how the satellite data was handled.

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419 Ibid.
421 Personal Communication.
423 Ibid.
425 Ibid.
The judiciary and satellite imagery

Government assessment of judicial reactions to imagery

5.69 The reaction of Government officers in Australia when asked whether they thought that judges understood and accepted the satellite imagery was varied. A small number of Government officials said that they considered there to be a huge gap in the awareness and understanding of judges in relation to satellite imagery. One commented that ‘courts are uncomfortable with accepting imagery’ and that there was a ‘problem of judges trusting science’. There is no doubt that there have been a handful of cases where judges have been hostile to evidence from satellite imagery, but this has often been in small local Magistrates’ Courts. A number of Government officials commented that some Magistrates’ were not so much anti satellite imagery, but had difficulties with the vegetation clearing legislation itself. It was claimed by Government that after dealing with hundreds of criminal matters, some Magistrates’ had the attitude that cases concerning ‘just clearing a little bit of scrub’ did not deserve to be treated seriously. Other Government officials had a completely different impression of the judicial acceptance of satellite imagery. For example, a lawyer acting for a Government department commented that ‘it is a massively impressive evidentiary tool and in the cases where I have used it, it had a massive impact on the judges.’

The reaction of the judges

5.70 Australia has witnessed technology having a massive impact in the courtroom. One judge commented that defence lawyers used to argue that confessions were forced, but because they now taped all police interviews and these could be played in court, there were far fewer challenges of undue influence. Technology was permeating many different parts of the Australian legal system. The judiciary in Australia, therefore, seemed to have a general openness towards new technologies and felt that satellite images could be easily assimilated with similar forms of evidence derived from digital security, speed cameras and digital facial mapping. A judge commented that he saw little difference between satellite imagery and these other technologies: ‘tampering is an issue with any sort of digital images; you can manipulate digital cameras as well.’ As long as the imagery was both accurate and relevant, judges considered it to be useful in court.

5.71 One judge interviewed was surprised that a Government official had commented that judges might be uncomfortable with satellite imagery as evidence. He remarked, ‘there has not been a single case where I have not understood the facts. I can join the dots and see whether I agree with one side’s expert opinion or not.’ It was mentioned that courts are used to dealing with far more complex pieces of evidence, such as analysis from DNA material. Not all of the judges interviewed had, however, come across satellite imagery in the courtroom, although most of them had experience with GoogleEarth being used as evidence in court proceedings. Where they had experience of it being used as evidence, this was only in a small number of cases. Its authenticity or accuracy had only been an issue in one case they had been involved in. One judge who had experienced satellite imagery in a number of cases commented how he appreciated high-resolution imagery more than the ‘older images’, which ‘were less photo-like and more like a blur in colours.’

5.72 Whether the judges consulted as part of this project had experience with satellite imagery or not, they could all see the value of this form of evidence. The judges particularly liked two aspects of the technology.
One was that, similarly to the position with ordinary photographs, a satellite image let the judges see for themselves what the problem was, without having to rely on witness statements. Multiple satellite images, each taken at different times, could show the changes that had taken place over a given period and allow these to be compared quickly. Secondly, satellite images let the judge see evidence of a problem that would otherwise probably not have surfaced if it had not been for the availability of the data and someone knowing how to use it. A judge commented how useful he found GoogleEarth in a planning case he had presided over.\textsuperscript{441} A developer agreed to build a tunnel to allow fauna to travel under a road to get from one area they habitd to another. An environmental group overlaid a Google Earth image to a map of the development proposal to demonstrate to the judge that the tunnel would exit onto a different piece of land than contained in the plans.\textsuperscript{442} Without this image, the judge considered it unlikely that this problem would have been picked up and, whilst in the end it did not change the judge's decision, it meant that he could make the developer change the plans and put further safeguards in place.\textsuperscript{443}

Comment Box 1.

<table>
<thead>
<tr>
<th>Digital imaging allows people to see for themselves, rather than relying on conflicting witness statements from the past, or statements that happened so long ago that the witness is not totally sure. It cuts down disputes over what is reliable evidence and what is not. Technology allows the judges to see for themselves – they don't have to rely on recollections of witnesses what they saw, said, or heard. They can just press the rewind button and see for themselves. That's what makes a big difference.</th>
</tr>
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<tr>
<th>Judges like to see the site – to touch and feel, to fully understand the evidence. Seeing a site themselves gives a better appreciation of the overall case. With digital imaging they can do the visual analysis themselves of the site, with the added bonus of having historical records showing the site.</th>
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</table>

Judge, Queensland Planning and Environment Court

Comment Box 2.

<table>
<thead>
<tr>
<th>The combination of maps and satellite photos was useful and technology also allowed these to be transposed over one another. This allowed a new-against-old comparison over time. In terms of vegetation clearing I found this to be a valuable evidential tool. It made the whole legal situation as to what had happened a lot easier to understand than just using maps alone. The imagery was of considerable assistance, like any form of photograph – whether from a normal camera or from a satellite.</th>
</tr>
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<table>
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<tr>
<th>Satellite imagery is a very valuable tool. I am a proponent of using this and other assisting evidentiary aids mainly because as a Judge I have a clearer understanding of what has taken place.</th>
</tr>
</thead>
</table>

Judge, District Court of Queensland

What judges want?

5.73 Judges appear to be strongly persuaded by the facts and context of issues when these are presented visually. Many are impressed by visual evidence in building a picture in a case which could then be complemented by other written and oral evidence. The judges that were interviewed thought that if satellite imagery were entered as evidence in court, they would find it useful to have it shown to them on a screen in the court and also printed out as an exhibit.\textsuperscript{444} One judge commented how much she appreciated the use of visual aids and PowerPoint slides explaining processes.\textsuperscript{445} She recently presided over a complex trial which was hard to understand, but an expert witness showed on PowerPoint the processes involved and gave simple...
visual breakdowns of each one of the processes which had taken place. This was very useful to her and she could see instances where evidence from satellite imagery should be demonstrated in a very similar way.

5.74 A small number of judges also seemed receptive to the idea of Government organising training events for the judiciary. This had been discussed before by the Queensland Government and the Magistrates’ Association in the State, but as yet nothing formal has been arranged.

Programmes on standardisation or best practice

Background

5.75 Although different rules of admitting evidence exist in every country, admission of evidence is in basic terms mechanical and in most instances all the person adducing the evidence has to do is jump through the procedural hoops necessary. It can be anticipated that more problems will arise when using satellite data in court at the interpretation of the image stage, rather than regarding authenticity. One Government official in Australia commented that he thought ‘in the future, what the image shows is not going to be attacked in most cases, but the processes and procedures that were used to arrive at the image.’

5.76 Evidence from satellite imagery differs from traditional analogue photography because there is no original on which to rely. Many technical processing stages are required after receiving the raw binary data before the evidence could be considered useful. It is these processing elements that potentially diminish the weight given to the image as evidence and could even render it being treated as hearsay. A court will be particularly concerned that this processing does not lead to an image being altered in a misleading manner (whether accidentally or on purpose). They will require further evidence that the satellite image came from the original data and had not been mistakenly or maliciously changed in a way that could affect its probity. However, the processing of a satellite image in practice is dependent very much on what the image is intended to show. Different interpretations by different operators can result in different conclusions in practice (e.g. objects can be removed, positions altered and different colours used). It is critical that the defence has access to each stage in the development of the photograph to ascertain the reliability and fairness of the process that has taken place.

5.77 Courts would welcome audit trails with satellite data, as they have encountered past problems with other forms of evidence like DNA samples. There should be a chain of evidence showing information such as (i) where the data comes from; (ii) the scientific accuracy of the data; (iii) where the data has been processed; (iv) whether the processing of the data was in accordance with any accredited or well-tested process; (v) who worked on or had access to the data; (vi) where it has been relied upon in other cases and accuracy proven; and (vii) confirmation of the record of dates where changes had been made to the data. In the event that an audit trail could not be provided to the other parties, the evidence would almost certainly be excluded. If an audit trail is provided and any differences in interpretation were raised, the role of expert witnesses would be crucial.

5.78 An example of why this is necessary was seen in a recent US case where appellants sought at trial to dispute the size of a lot on the basis of an image from GoogleEarth. The court could not consider this as evidence of the lot size because there was a lack of transparency as to where the image had actually come from, and it was dismissed as evidence for not reaching the required levels of evidential proof.

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446 Personal Communication.
447 Personal Communication.
448 Whilst I was in Australia, I was invited to talk about satellite imagery as evidence at a judicial development session, run by the South Australian Courts (which I gave with a remote sensing expert from the South Australian Government). The aim of this session was to give judicial officers a basic understanding of the technology, how their provenance might be tested and the limits of their usefulness as an evidentiary tool. Similar events might be encouraged in other Australian States (and wider afield) in the future.
449 Personal Communication.
450 Personal Communication.
451 See, John Nominees Pty Ltd v Dixon (2003) WASC 151 (Supreme Court of Western Australia, Australia).
453 Ibid.
Standards

5.79 It would seem impractical to champion the technology as a monitoring and enforcement tool only for it to encounter problems with its actual weight as evidence. It is clear that the legal sector would benefit from the introduction of guidelines demonstrating that satellite images were generated in a way that reflected the state of the art in the technical satellite community. Greater experience and confidence has to be built up amongst the legal sector before satellite imagery can be fully considered as a reliable form of evidence in court. The scientific community is also starting to recognize the importance of the pedigree of data, since they too sometimes find themselves with data and no information about how it was processed before they received it. The advantages of commonly accepted digital spatial data standards could include timesaving reduced costs, improved ability to use the data for multiple purposes, standardisation of technical training and quality assurance.454

5.80 A 'standard' is generally considered to be a published document that contains a technical specification or other precise criteria designed to be used consistently as a rule, guideline or definition.455 It will often incorporate the views and expertise of a wide range of interests from consumers, academia, special interest groups, government, business and industry.456 As a result, standards represent a consensus on current best practice. These standards and codes of practice are generally designed for voluntary use and do not impose any regulations.457 Although these have no legal status, if the evidence was prepared in accordance with a code, this would assist a court in determining and the veracity of the processed data.458 However, laws and regulations may also refer to certain standards and make compliance with them compulsory.459 Complying with the recommendations of a standard should be of value to organisations even when the trustworthiness of the stored information is not being legally challenged. Generally, it should be considered useful to adopt procedures and good operational management practice. A further advantage of these codes is that their non-legal status means they can be periodically updated to reflect best practice in light of changing business needs or technological development.

Standards in Australia

5.81 Each of the three sample Australian States have increasingly recognised that there are issues as to how they show the chain of evidence and the proof of the raw data. They do not want there to be misunderstandings in court about what scientific work has been carried out on the imagery.

5.82 Some States have developed internal procedures and guidelines for handling satellite images and how they should be stored and used as evidence in court, whilst others have not. The South Australian Government and the Federal Department of the Environment, Water, Heritage and the Arts have begun developing linkages with Geoscience Australia to produce guidance and procedures for using imagery as evidence. The Federal Government have also been in discussions with the Intergovernmental Committee on Surveying and Mapping in order to consider a validation programme for spatial information, although as yet nothing formal has emerged.

5.83 Presently there are, therefore, no national standards in Australia which deal either directly or indirectly with satellite imagery as evidence. Standards Australia is the national body which develops standards related to activities in the country.460 It has already published standards and codes of practice for CCTV

455 See the British Standards Institution website; ‘What is a standard?’ <http://www.bsieducation.org/Education/about/what-is-a-standard.shtml> last accessed October 29, 2010.
457 Ibid.
458 Ibid.
459 Ibid.
460 Standards Australia was established in 1922 and is recognised through a Memorandum of Understanding with the Australian Government as the peak non-government standards development body in Australia. It is a company limited by guarantee, with 72 members representing groups interested in the development and application of standards and related products and services. Through its Memorandum of Understanding with the Australian government, it is Australia’s member of the two major international standardising organisations, the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC).
operation, some of which presumably comes from digital imagery), digital compression and coding of continuous-tone still images and electronic manuscript preparation and markup.

Impact of not having standards

5.84 Australia is not alone in not having developed standards in this area. There do not appear to be any developed national or international standards in place as to the specific use of satellite imagery as evidence in the courtroom. However, some studies have suggested that this lack of any established guidelines or standards has caused uncertainty in the legal sector and hence affected the development of the use of satellites. A European Commission sponsored project report from 2000 published results of interviews with a large number of judges who were shown satellite-derived evidence. This report concluded that judges were disappointed with the lack of standardised processing methods, and argued that such rules were desirable in order to avoid prolonged disputes over methodology, authenticity, data interpretation and accuracy. A British National Space Centre report from 2001 similarly concluded that as the use of satellite data increased, the data would come under increasing scrutiny. As such, it was considered advisable to establish standards for the certification of the data, processing, audit trails and methods of verification. A discussion paper from a United Nations Workshop in 2004 also found that: ‘[T]he use of satellite data as evidence before national and international courts has been characterized as a matter of concern in the legal world, particularly in certain instances in court proceedings...the use of satellite data in international litigation will become a matter of routine in a not distant future [therefore], some kind of basic rules ought to be developed to smoothen the transition to the new technology.’

5.85 The lack of international rules or standards is not an insurmountable barrier in using satellite images in court as, in practice, many courts have a general openness to considering new forms of evidence. Although some degree of standardisation is important, the lack of standards should not be seen as a barrier for the use of satellite imagery in court, in that the production of such images could be explained and scientifically verified in each single case. In the absence of standards, the commonly accepted good practice by the scientific community would apply.

Relevant standards in other jurisdictions

5.86 Whilst not specifically relating to satellite imagery per se, common standards for digital data products are slowly beginning to emerge at both national and international level. In the United States, a certification process has been introduced where exhibits derived from digital data can be certified and admitted as evidence during legal proceedings on a more formalised basis. Images are assigned with unique numbers which can be then used to verify the validity and authenticity of the image. The process focuses on evidential admission and does not implicitly introduce procedures concerning what takes place in these interpretation stages. A court might need to see that reliable and transparent methods or principles were used in developing raw data into more useful (visual) information. The American National Standards Institute and the Association for Information and Image Management have also developed standards for the legal acceptance of records produced by

465 Ibid.
467 Ibid.
470 The American National Standards Institute (ANSI) is a private non-profit organization that oversees the development of voluntary consensus standards for products, services, processes, systems and personnel in the United States. The organization also coordinates U.S. standards with international standards so that American products can be used worldwide.
information technology systems. This technical standard covers such issues as digital alteration, derivation, privacy and security. The first section of the report contains a summary of some basic legal evidentiary principles and their application to electronic records. The second section has a set of general performance guidelines to help ensure admissibility and trustworthiness of electronic records. The third section together with the Annex contain a self-assessment process and a checklist by which those using data can evaluate their internal processes for electronic record keeping.

5.87 In the UK, the British Standards Institution has similarly published technical guidance which advises on procedures and the documentation required for submitting computer-generated documents as evidence (though not satellite images specifically). They cover the evidential weight and legal admissibility of information and recommend the use of audit trails and other procedures demonstrating the stages of data processing and security of the image. They come in five separate documents, including the British standard itself, supported by three codes of practice for implementing the standard and a compliance workbook.

5.88 It is unclear whether the national standards in the US and UK are scientifically compatible with the requirements of satellite imagery. A cursory look at them suggests they are, because they apply to all digital data, but this is a question for remote sensing scientists to answer. If they are, then Australia might use them as a foundation for introducing new national standards/codes of practice specifically covering satellite technologies.

International Standards

5.89 The International Organization for Standardization (ISO) has also introduced a standard on information that is stored electronically. ISO standards are technical agreements which provide the framework for compatible technology worldwide. They are designed to be globally relevant – they apply to ISO member countries everywhere in the world. The ISO standards on information that is stored electronically were based on the British standards above.

5.90 The current standard, ISO/TR 15801, came out in October 2009, replacing and revising an earlier standard from 2004. It defines recommended practices for electronic storage of business or other information in an electronic form. It covers image capture, image quality control, indexing, authenticated output procedures, file transmission, document retention, information preservation, information destruction, backup and system recovery, system maintenance, security and protection, use of contracted services, workflow, date and time stamps, version control and maintenance of documentation. There is also an ISO standard on geographic information, defining the framework for imagery, gridded and coverage data.

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472 The BSI Group in the UK is the world’s largest certification body. It audits and provides certification to companies worldwide who implement management systems standards. BSI also provides a range of training courses regarding implementation and auditing to the requirements of national and international management systems standards.
476 The International Organization for Standardization (ISO) is a worldwide federation of national standards bodies. The work of preparing International Standards is normally carried out through ISO technical committees. The main task of the committees is to prepare International Standards.
5.91 Like the position in relation to national standards, it is not fully clear whether these international standards are compatible with satellite imagery. From a legal perspective it would appear that they are. None of the Australian sample States were aware of the ISO guidance (or guidance in other countries). Australia is a member of the ISO, so the ISO standards apply in Australia. If they are compatible with the requirements of satellite imagery, Government bodies could follow the practice in standard ISO/TR 501, for example, and include details of this in affidavits when submitting the evidence. Although these standards have no legal status, if the evidence was prepared in accordance with them, this would assist a court in determining the level of trust it should have in the people who have access to and processed the data.

5.92 If, however, the ISO standards are not directly applicable for dealing with satellite imagery, then Governments in Australia could ask the ISO to introduce a new international standard which specifically covers satellite technologies.

### Recommendation 11

It would seem sensible for national bodies, such as Geoscience Australia and Standards Australia, to work together in order to develop national standards or codes of practice, dealing specifically with using satellite imagery in a legal context. It is further recommended that Governments should liaise with the International Organization for Standardization, in seeking to develop an international best practice scheme in this area.
Chapter Six
The effectiveness of satellite monitoring for vegetation compliance

Can you measure the impact that satellite monitoring has had on compliance?

Introduction

6.1 It is important to stress that, while legal restrictions were in place before the use of satellites, Governments primarily relied on tip-offs. They started using satellite technologies to monitor vegetation clearing because this offered new levels of monitoring coverage, not available before. Governments were not saving money by using satellite technologies, because there was very little regulatory monitoring taking place beforehand. It is therefore difficult to provide hard evidence as to whether this form of regulatory monitoring is producing more cost-effective regulatory outcomes, because there is not really a before position for purposes of comparison. Without satellite monitoring in Australia they would still be enforcing vegetation clearance, but there is a general recognition within Government that this would be nowhere near as efficient or effective.\textsuperscript{480}

6.2 Governments in each State consider that there had been progress towards achieving the policy objectives for vegetation clearing management as a result of using satellite monitoring. However, all commented that it was extremely difficult to measure the impact, or any quantifiable affects, that satellite monitoring has had in terms of compliance with the vegetation clearing legislation in Australia.\textsuperscript{481}

Comment Box 3.

\begin{quote}
Satellites must have had some effect on compliance. We just don’t know how much!
\end{quote}

Anonymous Government Official

What information is available?

6.3 Satellite monitoring has been a significant information tool for Government, because it can provide a baseline from which to measure vegetation clearing. Prior to the satellite monitoring programmes there was lots of ‘guessing’ at rates of clearance. Satellite data enabled Governments to have access to (ostensibly more) ‘objective’ information.

6.4 The scale of illegal clearance since the implementation of native vegetation legislation is not well documented.\textsuperscript{482} Governments have detailed information from the satellite data as to levels of vegetation clearing taking place. With regard to illegal clearing of native vegetation, Governments are not able to effectively measure that, as it would require every instance of vegetation change identified by satellite, or reported to Government, to be investigated at ground-level to determine if a breach of the legislation had occurred. No State Government has the resources to be able to check every report of potential non-compliance.

6.5 States, therefore, have not looked at the specific impacts of the satellite monitoring on compliance. Where there has been data collected that might be considered useful, this has often been incomplete, or the reference framework used to monitor compliance has changed.\textsuperscript{483} States also collect data in different ways so it is not easy to compare experiences across the country.

6.6 This absence of compliance indicators has also been due, in part, to periods of departmental reorganisation that have been taking place within State Governments in Australia during the last decade. Some of the new Government departments have only taken over responsibility for native vegetation relatively recently. They are still building up experience in this area and some have only recently introduced a compliance

\begin{flushright}
\textsuperscript{480} Personal Communication. \\
\textsuperscript{481} Personal Communication. \\
\textsuperscript{482} S Bricknell, ‘Environmental crime in Australia’ (Research and public policy series no. 109, Australian Institute of Criminology, Canberra October 2010). \\
\textsuperscript{483} Personal Communication.
\end{flushright}
component to their reporting. Collecting data with a compliance component would also appear to not be on every State’s agenda, as some do not have the time and resources to collect it. An official from one State Government commented that ‘there is little tracking of compliance over time, it is simply not on the Government’s radar and there is limited interest in the wider department.’

6.7 There was awareness within Government that there were data gaps on measuring compliance and the effectiveness of the satellite monitoring, and some States hoped to resolve this in the future. For example, a Government official in Queensland commented, ‘measuring compliance was an area of potential improvement [to the current regime].’ In New South Wales, a 2002 report by the States Auditor-General could not elicit information on illegal clearance rates as the clearance register maintained by the Government simply did not record the data. A more recent report from New South Wales concluded that ‘significant activity has been stimulated under the NV [Native Vegetation] Act, but its effectiveness has not been monitored systematically at fine scales, although coarse-scale monitoring of overall performance is in place.’ This report from New South Wales sensibly recommended a framework to support better collection of information to ensure that short-term activity translates to more effective outcomes in the longer-term.

6.8 It seems beneficial for all States to give greater attention to compliance indicators, so that they can measure the long-term effectiveness of the vegetation clearing programmes and more generally their monitoring and compliance actions.

Can the information that is available measure compliance?

6.9 There has been some data collected by State Governments which could potentially indicate the impact of the satellite monitoring, although this may be difficult to fully rely upon. How do you measure compliance and impact, apart from comparing one year to the next? Even comparison of this kind could be affected by so many things in reality and is, therefore, hard to interpret for a number of reasons.

6.10 A key influence in comparing statistics in this field is permitted clearing. For example, until December 2006, broad-scale clearing was still allowed in Queensland if assessed and permitted by Government. In Queensland, such permits still allowed for an upper limit for vegetation clearing of 2000 hectares. Similarly, New South Wales also only ended broad-scale clearing, with limited exemptions, under the Native Vegetation Act 2003 (New South Wales). Legislation in all States restricting broad-scale clearing has made it harder to clear large areas of vegetation, so one would expect to see a noticeable decline in clearing rates for the period after the sunset time for permits (i.e. after the last permits were issued). There might also be an increase in clearing before the legislative changes came into force because of people ‘panic clearing’ in anticipation of tougher controls. It is, therefore, very hard to quantify whether statistical changes could be down to monitoring programmes, or the impact of new or amended legislation.

6.11 Historically, there have been tensions within the rural community in Australia regarding the vegetation clearing laws (e.g. Chapter Seven considers this in greater detail). A significant number of Australian farmers see the law in this area as being fundamentally wrong, with some possibly of the opinion that because of this, it can be disregarded. If the legitimacy of the law itself is under question and even potentially challenged, then the satellite monitoring, itself, might not be a major factor in terms of compliance in this group.

6.12 Government does not look at the satellite imagery in ‘real-time’ during the monitoring process. The imagery is historical and can be a year or two behind enforcement. Prosecutions can then, in practice, sometimes take place four to five years after the clearing occurred, because the regulator needs time to obtain the imagery, target the breach, fully investigate an incident and, of course, of the considerable time in the legal system whilst the case is prepared and awaiting a court date. This means that there is a time-lag between the initial breach and knowledge of the prosecution within the regulated community and any potential greater

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484 Personal Communication.
485 Personal Communication.
486 Personal Communication.
489 Ibid.
acceptance of the law. This makes it very difficult to measure compliance in the short-term, and it will take time for the impact of regulatory action to filter through to compliance statistics.

6.13 Another relevant factor in measuring compliance in Australia is climatic conditions. It is likely that there would be less clearing in Australia in times of drought. More clearing would usually take place when it rains, as farmers can grow more crops and need extra land for grazing to fatten cattle. During 1998-2006, there was severe drought in parts of Australia (climatic conditions vary considerably from State to State) and this would have influenced some farmers’ decisions to clear. Climatic conditions and the economic drivers that are linked to these are likely to also have a significant influence on compliance with vegetation clearing.

6.14 Analysis of before and after satellite pictures of vegetation change might indicate that the satellite monitoring has made an important contribution to a reduction in vegetation clearing, but there are also other factors which could be connected. Changes could be the result of varying market conditions, farmers not having the finances to clear, or even some farmers stopping clearing now, because they have cleared the land in the past. Alternatively, it could be because of growing environmental awareness and understanding in the farming sector, influenced by better education and publicity through the media and the Governments own policy work.\footnote{Ibid.} There could, therefore, be more than one reason for any increase or decrease in terms of statistics showing compliance impact. There could be different reasons for different farmers, or variations between different States. In short, it is difficult to isolate conclusively the effect of clearance legislation and associated satellite monitoring on compliance behaviour from other influencing factors. This chapter will, however, consider some of the key available indicators which might provide some evidence of the impact and effectiveness of the satellite monitoring programmes in Australia.

**Reduction in cleared vegetation**

6.15 The clearest method of analysing at the impact of clearance legislation and monitoring is to see if there have been any changes in levels of vegetation-loss over time.

**Queensland**

6.16 Since the Vegetation Management Act 1999 commenced in September 2000, woody vegetation clearing rates in Queensland have fallen from around 750,000 hectares per year (ha/yr) in 1999-2000 to 235,000 ha/yr in 2006-2007. Graph 1, below, demonstrates how the trends in clearing and associated carbon dioxide emissions have coincided with legislative reforms.

6.17 In 2009, the first full year of reporting since the Queensland Government’s commitment to end broad-scale clearing of remnant vegetation by December 2006, rates declined by nearly a half again to 123,000 ha/yr (for 2007-2008). This represents a 48% decrease in the clearing rate compared to the previous reporting period (2006-2007). The amount of woody remnant clearing in the 2007-2008 period has reduced the total extent of remnant vegetation remaining in Queensland by only 0.07%. This is the lowest recorded rate of woody vegetation clearing since the first satellite clearing estimates.\footnote{See, for example, Auditor-General New South Wales, ‘Auditor-General’s Report Performance Audit: Regulating the Clearing of Native Vegetation. Follow-up of 2002 Performance Audit’, (Report of the Auditor-General, New South Wales, July 19, 2006), p19. ‘After ten years of discussion there has been some change in farmers’ attitudes to clearing of native vegetation. Many farmers now have a strong appreciation of the importance of native vegetation in the landscape and accept the need to regulate. Farmers’ complaints now are often about aspects of the administration of the legislation.’} The above represents a decline in greenhouse gas emissions from this one-policy approach of 60%, falling from an estimated 60 mega tonnes (Mt) of emissions when this end to broad-scale clearing was first mooted in 2003-2004 to an estimated 24Mt in 2007-2008.\footnote{See (i) Department of Environmental and Resource Management, ‘Analysis of vegetation clearing rates in Queensland. Supplementary report to Land cover change in Queensland 2007-08’ (State of Queensland, Department of Environment and Resource Management, January 2009); (ii) Department of Environmental and Resource Management, ‘Land cover change in Queensland 2007-08. State-wide Landcover and Trees Study Report’, (State of Queensland, Department of Environment and Resource Management, October 2009).}
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6.18 According to figures published by the Queensland Government, the total clearing rate of woody remnant vegetation for the 2007-2008 period was 56,000 ha/yr (the other 67,000 ha was for what is classed as non-remnant vegetation i.e. 123,000 ha/yr total). Of this 56,000 ha total of cleared remnant vegetation, about 23,500 ha/yr occurred under a permit; approximately 20,000 ha/yr was estimated to be exempt clearing; and 12,500 ha/yr was unexplained clearing. This latter figure is a relatively low amount, particularly compared to earlier clearing levels (both permitted and illegal).

**New South Wales**

6.19 Declines in clearing of woody vegetation have not been as dramatic in New South Wales, where clearing stabilised at around 20,000 hectares per annum. As Graph 2, below, shows, the long-term record appears to fluctuate cyclically between a maximum of just above 30,000 ha and a minimum of just below 15,000 ha, prior to the flattening trend since 2006.

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493 Figure taken from Department of Environmental and Resource Management, ‘Analysis of vegetation clearing rates in Queensland. Supplementary report to Land cover change in Queensland 2007-08’ (State of Queensland, Department of Environment and Resource Management, January 2009); p2.


495 Ibid.

496 Figure taken from Department of Environmental and Resource Management, ‘Analysis of vegetation clearing rates in Queensland. Supplementary report to Land cover change in Queensland 2007-08’ (State of Queensland, Department of Environment and Resource Management, January 2009).

Graph 2: Annual woody vegetation clearing rates, New South Wales, 1988–2008

6.20 A coarser analysis of the remote sensing data since 2003 also reveals that despite the ongoing levels of clearing, the overall extent of woody vegetation recorded has not changed significantly during this time. There was a total reduction in the area of woody vegetation in New South Wales from 2007–2008 of 48,193 hectares (0.06% of the area of the State). The current methodology also only measures the decrease in woody vegetation cover. It is recognised that there are areas where the woody vegetation cover is increasing, in particular within forestry areas. The monitoring of revegetation is inherently more complex than the monitoring of clearing, and further work is needed to fully understand these results, though it appears that the overall level of clearing over this period has been in balance with the overall extent of revegetation and restoration.

Have there been changes in the number of cases of potential illegality detected?

6.21 At the time of the introduction of vegetation clearing legislation in Australia, it is clear that the numbers of cases of potential illegality detected grew, not declined. This is because most clearing would go unnoticed and unreported if there was no satellite monitoring in rural areas which were hard to access on the ground. In the early stages of enforcement with satellite monitoring, Governments often found that activity numbers in reporting ('tip-offs') also went up because of the publicity in the initial phases of regulation. Figures made the levels of clearing appear to be worsening, because Governments did not have a handle on what the true offending rates actually were before the satellite monitoring.

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498 Figure 7.1 taken from NSW Government, Environment Climate Change & Water, ‘New South Wales State of the Environment 2009’ (Department of Environment, Climate Change and Water, Sydney December 2009), p231.
499 Revegetation is the process of replenishing trees and plants in bare or disturbed areas. This may be a natural process produced by plant or tree colonisation and succession, or an artificial (manmade), accelerated process designed to repair damage to a landscape.
500 Personal Communication.
501 Personal Communication.
6.22 Satellite monitoring has, however, now been used for between five and ten years in each of the three States, and it might be possible now to show the impact this has had in the number of cases of potential illegality detected. In most States, the volume of cases is not going down and Government is still identifying a high number of possible crimes.

6.23 To give an example from one State, during 2008/2009 the compliance program within the Native Vegetation, Biodiversity and Land Management Unit, South Australian Government, received 223 reports alleging clearance of native vegetation contrary to the Native Vegetation Act 1991 (South Australia). As can be seen from Table two, below, this was the second highest number of reports since the satellite monitoring programme began (2002/2003 was the next highest with only one more report). There had been an increase in reports across all regions in South Australia in 2008/2009 except one, representing an increase of 39% more reports than the previous year. However, this increase in reports received in South Australia must be considered in the context of climatic conditions (as discussed in paragraph 6.13 above). A high proportion of these increases were just after the devastating Melbourne fires and many could be related to bush fire protection and safety issues associated with dwellings.

Table 2: Reports Received In South Australia 1999/200 to 2008/2009

<table>
<thead>
<tr>
<th>YEAR</th>
<th>99/00</th>
<th>90/01</th>
<th>01/02</th>
<th>02/03</th>
<th>03/04</th>
<th>04/05</th>
<th>05/06</th>
<th>06/07</th>
<th>07/08</th>
<th>08/09</th>
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<tbody>
<tr>
<td>TOTAL</td>
<td>141</td>
<td>120</td>
<td>152</td>
<td>224</td>
<td>137</td>
<td>163</td>
<td>229</td>
<td>157</td>
<td>161</td>
<td>223</td>
</tr>
</tbody>
</table>

6.24 However, in Queensland, the number of reports of potential illegality detected appears to be going down. They have approximately 700 unexplained cases of clearing a year now. This has levelled out in the last few years. When satellite monitoring was first being used, this figure was around 2000-3000 (see paragraph 4.28). However, the Queensland Government is now using a new methodology for presenting the figures and numbers of cases.

Cleared land size in the cases detected

6.25 Although the raw statistics from Queensland of 700 unexplained cases of clearing each year sounds like there is still a considerable problem with compliance, there are noticeable compliance changes taking place. Queensland has statistics showing clearing based on size in each of these unexplained cases. Whilst the volume of cases is not necessarily going down, the State is certainly seeing less broad-scale and gross clearing occurrences. In the unexplained cases of clearing each year, 1000ha might now be the biggest clearance that is recorded in Queensland. In 2007/2008, only one prosecution was for a clearing over 700ha. The Government mentioned that in previous years many illegal clearings were thousands of hectares in size. To put this into further context, it was only four years ago that Queensland had a permit system which provided an upper limit for vegetation clearing of 2000 hectares. The legislation, therefore, in part appears to be working, because Queensland has very few large clearings now. However, this does not mean the regulatory body is less busy, it just means that they are investigating smaller potential breaches.
prioritisation policies (see paragraph 4.34) mean that other cases of potential illegality are moving towards the top of the lists for investigations. Their compliance programme has, therefore, had what appears to be a significant impact, but it has not reduced cases of smaller clearing.

6.26 Although there is evidence that broad-scale clearings have been significantly reduced in some States, it is unknown whether it is the satellite monitoring that accounts for this. It would appear that a combination of issues, including the satellite monitoring and the legislation, probably influenced this.

Sanctions

6.27 It can be inferred from the analysis above that unauthorised clearing of native vegetation has continued in Australia. Although prosecutions, or other sanctions, are undoubtedly at the crude end of the enforcement chain and could be considered to be a sign of regulatory failure, they might still provide some compliance indicators.

Table 3: South Australia – Compliance Actions 2006 - 2009

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Education/Warning Letter</td>
<td>14</td>
<td>18</td>
<td>97</td>
</tr>
<tr>
<td>Formal Caution</td>
<td>N/A</td>
<td>17</td>
<td>34</td>
</tr>
<tr>
<td>Enforcement Notice</td>
<td>15</td>
<td>11</td>
<td>12</td>
</tr>
<tr>
<td>Expiation</td>
<td>14</td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td>Expiation and Enforcement Notice</td>
<td>N/A</td>
<td>N/A</td>
<td>5</td>
</tr>
<tr>
<td>No Further Action</td>
<td>N/A</td>
<td>N/A</td>
<td>40</td>
</tr>
<tr>
<td>Pending Further Information</td>
<td>N/A</td>
<td>N/A</td>
<td>11</td>
</tr>
<tr>
<td>Refer for Formal Investigation</td>
<td>N/A</td>
<td>11</td>
<td>16</td>
</tr>
<tr>
<td>Refer for Legal Advice to Crown Solicitors Office</td>
<td>5</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Criminal prosecution (Finalised)</td>
<td>6</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Criminal prosecutions (Ongoing)</td>
<td>11</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Civil proceedings (Finalised)</td>
<td>3</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Civil proceedings (Ongoing)</td>
<td>5</td>
<td>9</td>
<td>6</td>
</tr>
<tr>
<td>Total</td>
<td>73</td>
<td>92</td>
<td>248</td>
</tr>
</tbody>
</table>

6.28 Table 3, above, shows the number of various forms of compliance action in South Australia for the last three financial years. It is clear that the number of compliance actions has more than tripled between 2006/2007 and 2009/2009. There appears to be a new regime of deterring people through compliance actions.

However, much of this appears aimed at coaxing changes in behaviour, hence the notable increase in education/warning letters.

6.29 The position in South Australia appears to be replicated in other States. In New South Wales, there were 523 compliance actions undertaken in 2002-2006. In 2008 alone, there were 127 compliance actions. This looks set to continue, particularly as the Government begins its letter writing campaign in 2010/2011 (see paragraph 4.44). The Queensland Government also expect to see an increase/spike in the number of cases where compliance actions are undertaken, especially as they increase their ability to work on them.

6.30 A significant factor in deterring breaches of the legislation is the penalties for non-compliance (a credible sanction). The level of fines and other penalties for vegetation clearing have traditionally been extremely low, and this is the case (at least in the UK) for environmental offences more generally. The maximum penalties have been raised in each of the States and are now quite high, but the fines which have been handed down in court have often been low. To a small farmer who receives a small fine, this is often enough of a deterrent. But the penalties historically handed down in the Magistrates’ Courts have not worked for the larger farms. Some farmers take a commercial decision to carry out clearing and will ‘happily’ pay the fines, as they bring far greater financial benefit in the long term. As one Government official commented, ‘in some cases it would be cheaper to pay a fine than pay a consultant to advise them how to do it properly.’ It was remarked in two States that Government officials were aware of some landowners who factored in fines into their yearly accounting and put away money in case enforcement action was taken at a later date. In such circumstances, fines become more like fees, and it is clear that the level must be calculated so as to remove the potential for financial gain of non-compliance; otherwise, it makes rational economic sense to flout the law.

6.31 The cost of paying fines versus the economic outcome has meant in Australia that the deterrent impact of the fine was minimal, historically at least. The satellite monitoring itself has therefore not been a major factor in the decision whether to clear to some in rural communities. In each of the States, there was some recognition that the legal teams had not pressed hard enough for large fines in the past. This has been a significant thorn in their sides; because fines were very low in the beginning ‘over a sustained period this became self-perpetuating’ and it was difficult to get them to rise to a level that could deter wilful contravention. It is noticeable that in recent years, courts in Australia have imposed much heavier fines and other sentences. There has been a change in the attitude of the judiciary and in some cases fines have doubled or...

517 Personal Communication.
518 Personal Communication.
519 Maximum penalties for vegetation clearing offences:
(1) South Australia – Native Vegetation Act 1991 (South Australia)
  s.26(1) unauthorised clearance offence – sum calculated at prescribed rate for each hectare (or part of) land in relation to which offence committed or AUS $100,000 whichever is greater
  s.26(2) offence of failure to comply or contravene clearance conditions – as above.
(2) Queensland – Vegetation Management Act 1999 (Queensland)
  s.60B offence against a vegetation clearing provision – AUS $2,250 for each hectare in remnant endangered regional ecosystem or declared area, AUS $1,800 for each hectare in remnant of concern regional ecosystem, AUS $1,350 for each hectare in remnant not of concern regional ecosystem.
  s.55 failure to comply with compliance notice – AUS $124,875.
Queensland – Integrated Planning Act 1997 (Queensland)
  s.4.31 – 4.3.5A - AUS $124,875.
(3) New South Wales – Native Vegetation Act 2003 (New South Wales)
  s.12 clearing without approval offence – AUS $1.1 million.
  Above figures taken from S Bricknell, ‘Environmental crime in Australia’ (Research and public policy series no. 109, Australian Institute of Criminology, Canberra October 2010).
520 Personal Communication.
521 Personal Communication.
522 Personal Communication.
523 Personal Communication.
524 Personal Communication.
525 Personal Communication.
quadrupled. In New South Wales, an electronic sentencing database has also had a big impact on local courts, allowing judges to see comparative sentences.

Comment Box 4.

We are now seeing higher fines in Queensland and people now are starting to say, well wait a minute. So it’s improved deterrence.

Queensland Government Official

6.32 Governments are still not sure if the fines are a big enough deterrent when compared with profits which could be made, but, nonetheless, the increase in penalties is seen as significant. There is also now a broader ‘toolkit’ of penalty options available to regulators, including penalty notices and remediation notices. What is available varies from State to State. It seems clear that in some States, enforcement authorities have been more inclined to press for restoration remedies, to compel parties to restore an area by regrowth or planting. Having to replant vegetation is usually far more costly than a fine would be. The fact that legal arms of Government are now more prepared to go to court and to press for more applicable sentences/penalty options might improve enforcement outcomes and should, it is hoped, have a greater deterrent impact.

The regulators view of the overall impact of the legislation and satellite monitoring

6.33 The vegetation clearing legislation has been in force in each State for many years now. It appears that the majority of farms in Australia are complying with the legislation and only a small minority now deliberately break the law. However, it appears that many of the clearances which are still being detected by satellite are the result of pre-meditated decisions rather ignorance. These farmers will often have a clear understanding that what their doing is illegal. It is the Government’s impression in most States that there are only a handful of farmers or other landowners who deliberately clear large amounts of vegetation (‘the major offenders’). The rest are ‘crimping a little’ and hoping that this is not detected. Some will be repeat offenders because they have never been subject to compliance action. The Government are justified in targeting the offenders deliberately flouting the law by clearing major areas of vegetation. However, they should not forget about the large numbers of other smaller farmers who are pushing the boundaries of the legislation. The smaller farmers, ‘crimping a little,’ need to see the ‘major offenders’ being visibly prosecuted, but they also need to be aware that Government is monitoring all of them and that there is a strong chance of detection and sanction. Satellite monitoring in the future will be key in both of these respects.

6.34 It is, however, extremely difficult to quantify the impact satellite monitoring has had. This was a clear message from those Government officials interviewed. Whilst no clear measurable differences had been noted, it was obvious that Government officials did think that satellite monitoring had played an important role. One Government official referred to it as a ‘very effective audit tool’. Another went further and said that ‘without satellite imagery to target potentially unlawful clearing and use as evidence there would be little if any vegetation compliance [in his State]. A further Government official commented that ‘since using satellite monitoring there has been a lot more regualtional [sic] compliance.’

526 Personal Communication.
528 Personal Communication.
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531 Personal Communication.
532 Personal Communication.
533 Personal Communication.
534 Personal Communication.
**Recommendation 12**

The impact of satellite monitoring is extremely difficult to measure. The evidence available so far from Australia suggests that it has probably improved compliance. However, satellite monitoring does not produce instantly quantifiable results and it is a little early to reach a conclusion either way. Compliance research should, therefore, be revisited in five years time, to see if there are any clearer indicators that satellite monitoring has had a major compliance impact effect in Australia.

**Evidence from elsewhere**

6.35 There appears to be more convincing evidence from Brazil as to the impact of satellite monitoring. The Brazilian Environment Agency announced in July 2010 that an increase in the use of satellite data and new tactics to deter loggers had led to dramatic drops in large-scale deforestation in the Amazon rainforest. The figures for deforestation appear to have fallen to between 5000-6000 km$^2$, down from 7,500km$^2$ the previous year and 27,000km$^2$ in 2004. The Brazilian Environment Agency commented that this decrease appeared to be down to two key reasons. First, the satellite data was making the work of officers more effective. The satellite imagery also enabled them to target their ground-based monitoring with more precision; ‘Before [satellite data] we were looking blindly. But in 2010, all 244 actions were based on smart geo-processed data.’ A second key development from was that in the past, only visible light satellite images were taken. Those involved in illegal logging came to know that the satellites monitoring of this type could only be done in daylight hours and was poor in cloudy conditions. This meant that operating in the night, or under cloud cover, could provide a shield for their activities. The Brazilian Environment Agency is now using radar satellite surveillance which means that the ‘felling of trees can be spotted from space, rain or shine, day or night.’

6.36 Again, the impact of the satellite monitoring could be considered to be anecdotal here, but taken with other research it can be considered to be further evidence of the possible positive impact of satellite monitoring.

**Recommendation 13**

A further recommendation would be for international or regional initiatives like the Global Earth Observation System (GEOSS) and Global Monitoring for Environmental Security (GMES), or even the European Environment Agency, to begin to record instances of satellites being used in a compliance context. One of these bodies should take ownership of collecting data from other jurisdictions to share and educate. The data could be used and compared by regulatory bodies within the European Union or other jurisdictions that might wish to incorporate satellite monitoring into regulatory programmes.

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537 Ibid.
Chapter Seven
Attitudes towards vegetation clearance and the legislation

Attitudes of farmers to legislation and regulation

7.1 In order to understand the impact that regulatory satellite monitoring has had, it is necessary to consider attitudes towards the legislation itself and the historical significance of vegetation clearing in Australia. It is a more complex and delicate situation underneath the surface than appears at first sight.

7.2 Vegetation clearance laws have been contentious since State Governments first proposed them and generating acceptance of them has proved to be a challenge in Australia. There has been considerable angst amongst certain sections of regulated farming communities in Australia about legislative controls and the subsequent enforcement activities of Government departments charged with ensuring compliance. Whilst it is difficult to generalise, it seems that it has been hard for some farmers to have restrictions placed on their own farms through vegetation clearing laws. This has taken many of them some getting used to. A significant number have since embraced (with varying degrees) environmental concerns and agreed with steps protecting vegetation and making farming practices sustainable. At the same time, while many of them might agree with the environmental objectives of vegetation clearance under the legislation, many still disagree with the nature of the law and how it has been implemented on the ground.

7.3 There are many different types of farmer in Australia and attitudes towards the legislation and regulation could be influenced by a wide number of factors, including what farming industry they belong to, their location and their age. There are different frames of reference, from organic farms or large wineries to small family run farms at the other end of the spectrum (some of which are struggling to survive on harsh farming land.) It is clear that not all farmers in Australia are anti-Government or anti-legislation. However, of all the environmental laws recognised in Australia, arguably the most difficult to generate widespread acceptance of and compliance with are those governing native vegetation clearance. This chapter provides a brief background to the political controversy surrounding vegetation clearance legislation in Australia, so that we might place farmers responses in the surveys in context.

Reversal of long established policy

7.4 The introduction of regulation for vegetation clearing signalled a major reversal in Australian Government policy. Clearing had been part of the Australian psyche for nearly 200 years, starting with the first free-settlers who cleared native vegetation and replaced it with British flora and fauna. For generations after this, when settlers and soldiers were given Royal land grants and leases, or given parcels of land in regional ballots, they were expected to clear the land: sometimes, clearing was imposed as a condition of land ownership. In the second half of the twentieth century, tax breaks were sometimes available for clearing, sending a signal that this was a favoured Government policy and a means of actually improving the land. When it was realised that vegetation should be protected, and legislation was introduced in Australian States, this marked an enormous shift in policies that had favoured farmers for almost two centuries.

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540 Personal Communication.
541 Personal Communication.
542 Personal Communication.
543 Personal Communication.
544 S Bricknell, ‘Environmental crime in Australia’ (Research and public policy series no. 109, Australian Institute of Criminology, Canberra October 2010).
545 Personal Communication.
546 Personal Communication.
547 Personal Communication.
548 Personal Communication.
Significant regulatory controls for the first time

7.5 Farmers in Australia have traditionally not had the same planning constraints imposed upon them as those living in urban areas.\(^{549}\) One judge that was interviewed, considered that it was an anomaly that rural lands were exempt from planning laws in parts of Australia for many years.\(^{550}\) Many States originally had rural zoning where any rural activities could be carried out without any form of Government consent. This meant that prior to the introduction of vegetation clearance legislation, many farmers were not used to regulation and did not expect any constraints from Government.\(^{551}\)

7.6 There have also been changes to the traditional ways that vegetation clearing is carried out. ‘Improving the land’ meant clearing vegetation with an axe, or by ring-bark, where a farmer would kill a tree and leave it standing.\(^{552}\) As farming practices developed over time, farmers cut down vegetation manually with a rope or chain saw.\(^{553}\) In more recent times, Australia has seen a sustained period of intensification of farming and changes in technology.\(^{554}\) Farmers began clearing with large bulldozers and introducing industrial agricultural cropping. Technology allowed satellite controlled ploughing and harvesting, with equipment operating sometimes 24 hours a day.\(^{555}\) Agriculture became a corporate industry in parts of Australia with hundreds of road trucks and semi-trailers a day carrying grain off some properties.\(^{556}\) To accommodate agricultural intensification, some farms constructed huge installations to hold agricultural supplies and equipment.\(^{557}\) Some farms also constructed enormous private dams, like the one at Cubbie Station, which held 460,000 mega-litres of water, enough to fill the whole of Sydney Harbour.\(^{558}\) This was the equivalent of all irrigation entitlements in northwestern New South Wales and impacted on all downstream States.\(^{559}\)

7.7 In the past, no consent was required from Government for the conversion of these farms to industrial style cropping, or for the large-scale clearing which followed.\(^{560}\) Many associated developments were also able to proceed without Governmental review. After a while, however, there began a creep of planning instruments which were applicable outside of urban areas.\(^{561}\) Part of this was down to local Government reorganisation, with shire, rural areas and municipalities being introduced with greater controls.\(^{562}\) When vegetation clearing legislation was introduced, it was the first time that many country people were subject to regulation in Australia.\(^{563}\) They had accepted earlier laws that they considered legitimate, such as those tackling diseases, but land clearing was seen as different, largely because it halted or reduced production.\(^{564}\) It is not an understatement that many Australian farmers were furious that Government decided to regulate aspects of the farming industry.\(^{565}\) Feedback from farmers in Australia suggested that a number thought it was unfair that they were regulated more than people in the cities.\(^{566}\) Many seemed unaware that if such clearing or development on a similar scale was taking place in an urban area that this would likely require development consent from Government.

7.8 In Australia, there appears to be a nostalgic picture of farmers and farms, and it is sometimes seen by some as un-Australian to regulate the farming industry.\(^{567}\) There is an image in Australia of the ‘Aussie-battler’ farmer, fighting to overcome adversity and survive on rough terrain and, importantly, whom Government should leave alone.\(^{568}\) Part of the problem is that a minority in the farming community vehemently believe in this

\(^{549}\) Personal Communication.  
\(^{550}\) Personal Communication.  
\(^{551}\) Personal Communication.  
\(^{552}\) Personal Communication.  
\(^{553}\) Personal Communication.  
\(^{554}\) Personal Communication.  
\(^{555}\) Personal Communication.  
\(^{556}\) Personal Communication.  
\(^{557}\) Personal Communication.  
\(^{558}\) Australian Broadcasting Corporation, ‘Bitter water feud grows in Qld, NSW’, TV programme transcript, February 24, 2004 http://www.abc.net.au/7.30/content/2004/s1052459.htm  
\(^{559}\) Ibid.  
\(^{560}\) Personal Communication.  
\(^{561}\) Personal Communication.  
\(^{562}\) Personal Communication.  
\(^{563}\) Personal Communication.  
\(^{564}\) Personal Communication.  
\(^{565}\) Personal Communication.  
\(^{566}\) A conclusion from comments in the survey which was undertaken by UCL as part of this study.  
\(^{567}\) Personal Communication.  
\(^{568}\) Personal Communication.
A great deal of the negative reaction by farmers to the vegetation clearing laws could, therefore, be explained by the fact that they were left alone and were not subject to any Government regulation for so long, and that it came as a ‘shock’ when it did eventually happen.\textsuperscript{570}

**Being classed as criminals**

7.9 For many years, farmers were told to clear vegetation by Government and that by doing this that they were part of a productive process and a benefit to society. They were feeding a growing nation. An increase in environmental and conservation awareness meant that this policy was flipped completely, and they were suddenly then told to do the opposite. Instead of providing a major service to society, it seems that farmers suddenly felt a little unwanted and that they were not consider such a benefit to society as before.

7.10 Farmers were generally unhappy that clearing vegetation became a ‘criminal act’ and that they could be considered ‘criminals’. One farmer commented that he was now classed in society in the same bracket as murderers.\textsuperscript{571} It seemed unfair to many farmers that their industry became much maligned practically overnight, and they became criminally culpable for doing something they were actively encouraged to do before.\textsuperscript{572} To combat this perception, one State farming organisation started a campaign at the time of the introduction of vegetation clearing laws called ‘everyone needs a farmer’.\textsuperscript{573} Some States also had a policy whereby farmers could be convicted for clearing offences and receive fines but not the stigma of a criminal record.\textsuperscript{574}

7.11 It is clear that the vast majority of farmers are law-abiding citizens, many of whose farms have been in their families for generations, and they naturally did not like being investigated by Government (and in some circumstances convicted of breaking a law). Even when investigators would just visit properties to try and ascertain facts about clearing, not allege offences, this created tensions, because farmers were not used to being investigated, let alone being interviewed formally. This undoubtedly made some farmers more resistant to vegetation clearing regulation.

**My land and I can do what I want on it**

7.12 As noted above, property rights are very strong in Australian culture. There is no tradition in Australia of rights of way or passage across private land, open commons, or rambling, as is the case in some other countries such as the UK. A significant number of Australian farmers are very protective of their land and from interference with it from outsiders, including Government.\textsuperscript{575} Queensland, for example, appears to have a frontier mentality, similar to the United States, where many landholdings were originally illegally squatted on until settlers were given the land.\textsuperscript{576} There is a small proportion of Australian farmers who are very isolationist and many do not appreciate outside interference.\textsuperscript{577} It is culturally predictable that some farmers will look upon Government and regulation as an intrusion into their private lives.\textsuperscript{578} Many will see regulation as taking away their freedoms, by restricting their right to live away from cities and laws. Some land will also be significant social distances away from State capital cities, often with generations of the same family on it.\textsuperscript{579}

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\textsuperscript{569} Personal Communication.
\textsuperscript{570} Personal Communication
\textsuperscript{571} Personal Communication
\textsuperscript{572} Personal Communication
\textsuperscript{573} Personal Communication
\textsuperscript{574} Personal Communication
\textsuperscript{575} Personal Communication
\textsuperscript{576} Personal Communication
\textsuperscript{577} Personal Communication
\textsuperscript{578} Personal Communication
\textsuperscript{579} Personal Communication.
7.13 A leading State farming association commented that it was frustrating that there were still a proportion of farmers who considered they had certain property rights under the law when they did not. Some of these thought that because they owned the freehold to the property that they had a free rein to do what they want on their land and should not be subject to any outside interference. However, these attitudes are gradually changed in Australia, with significant numbers of farmers now accepting the need for Government regulation.

7.14 There have been a number of cases in Australian courts where freehold rights in respect of vegetation clearing legislation have been contested. In Queensland, for example, applicants’ legal arguments have included whether the State parliament has the legislative power to enact requirements related to a proposed change in the appearance of the land, if the Government lacks the legal power to prevent the owner clearing his land because he owns an estate in fee simple in the land, and whether the legislative scheme for the regulation of land clearing only applies to Government-owned land not privately-owned freehold land. None of these cases were successful.

7.15 It is clear that vegetation clearing laws have had a detrimental impact on the relationship between some farmers with Government. There has been a notable resentment of authority by a few. The extent of these impacts has varied from State to State. For example, farmers in South Australia seem to have been more accepting of vegetation clearing laws when compared to those farmers in Queensland or New South Wales (see Graph 3 later in this chapter). However, it appears that there is a proportion of farmers in each of the sample States who would question the legitimacy of vegetation clearance laws, or even the State Government itself, when they felt them to be in conflict to their property rights. This could have an impact on compliance with the legislation, or even how they perceive inspection methods, including satellite monitoring.

**Being told what to do**

7.16 A significant number of Australian farmers also appear to dislike any form of regulation; many farmers commented that they did not like being dictated to by people in cities who know nothing about the land – and particularly their land. During this study, a number of farmers complained that ‘city people’ had a different conception of what it was like to look after land, and different metrics of measuring the health of the land. Some of these commented that they did not see the need for regulation of vegetation clearing, as there was not a problem with the way they were looking after the land. Others commented that they had generations of experience of working on their own land and knew what was right for it. The vegetation clearing legislation itself is seen by some farmers as a way of being told by urban people that, ‘they are doing a bad job managing the land.’ In some situations, this might also have caused resistance to laws and have been counterproductive to the aims of the legislation.

Comment Box 6.

<table>
<thead>
<tr>
<th>As a third generation farmer (88 years in family) there is now more regrowth and remnant [vegetation] than when grandfather first took over. I object to a government telling me how to manage my own farm when they have no experience in the area.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farmer from Queensland [respondent ID Pa299]</td>
</tr>
</tbody>
</table>

580 Personal Communication.
581 Personal Communication.
582 See the following cases: *Burns v State of Queensland & Croton* (2006) QCA 235 (Queensland Court of Appeal, Australia); *Bone v Mothershaw* (2003) QCA 120 (Queensland Court of Appeal, Australia); *Wilson v Raddatz* (2006) QCA 392 (District Court of Queensland, Australia).
583 *Watts v Ellis* (2006) QDC 056 (District Court of Queensland, Australia).
585 A conclusion from comments in the survey which was undertaken by UCL as part of this study.
586 Ibid.
587 Ibid.
588 Ibid.
589 Personal Communication.
The law is unworkable and the balance of regulation is wrong

7.17 Aside from resenting being told what to do, it is clear that a high proportion of farmers think that vegetation clearing laws are unreasonable and wrong. Many consider that it has stopped them from doing their job properly. Some farmers think that clearing should be allowed under law in areas where production could be greatest and that this could work alongside tough environmental measures or protection applying elsewhere on the land. Or to put in another way, a sensible balance should be struck between growth and the environment. As things stood, many farmers thought that balance was too far towards environmental measures and conservation and there was too little thought for food security and production.

7.18 Some farmers also considered the legislation on vegetation clearance to be unworkable. It is fair comment that parts of the legislation in some of the Australian States have been complex and drafted in a manner that could cause both confusion and inconvenience to farmers. Some provisions might be considered overly-prescriptive, particularly if it seems to a farmer that the removal of a single tree or weeds from a gully can be a criminal act. However, it seems that some farmers have seized on some of the negative drafting aspects of the legislation to justify their opposition to vegetation clearing laws as a whole.

Financial Implications of regulation

7.19 There is a perception amongst a significant number of Australian farmers that through the vegetation clearance legislation, Government has taken away certain rights with serious financial implications for their livelihoods. This point is complex and multi-faceted, as different impacts of the legislation have affected different farming interests.

7.20 One example of a proportion of farmers suffering financial loss through legislative changes was through the sale of freehold land to them by the Government predating the vegetation clearing legislation. At the time of the purchase of land, the Government calculated that they owned the trees on the freehold land, and they also factored in the price of timber into the selling price. Farmers were understandably upset later, when Government withdrew the right to clear this timber, or to do anything with those trees, without any form of compensation, even though this clearly (and unilaterally) devalued the land.

Comment Box 7.

I agree that there should be some limits on clearing but strongly believe that landholders should be compensated for not clearing their land. At present they are paying the price for conservation of the environment on behalf of the community at large – the present legislation does not provide compensation.

Farmer from Queensland [respondent ID Pa215]

7.21 A further example where vegetation management legislation impacted on the livelihoods of farmers is the lost opportunity for industry expansion. Many farmers would have had a long-term view of clearing the land. It was not common for families who owned farms to clear all at once; instead, they made inter-generational plans to clear sections of land at certain points in time. They also staggered clearing because it was an expensive thing to do. Some farmers had made investments with expansion in mind, such as putting rail or tramlines in place covering planned expansion areas. If some had known that expansion would not happen, they would have planned differently. The basic problem appears to be that farmers did not think they were given enough notice of policy and legislative changes, although it would have been hard to have a long enough lead-in time to satisfy everyone, given that some farmers were planning a generation ahead. Moreover, had they been given more warning then it is entirely possible that there would have been more panic clearing.

7.22 Many farmers were also upset with the introduction of legislation because they considered it inequitable and unfair in terms of its financial consequences. This perceived unfairness and inequality exists on a number of different levels. There was a belief by some farmers in Queensland that they were being penalised because

590 A conclusion from comments in the survey which was undertaken by UCL as part of this study.
591 Ibid.
592 Ibid.
593 Ibid.
594 Personal Communication.
other Australian States had been allowed to clear their land historically, whereas Queensland farmers, who had historically cleared very little vegetation in their State, were now being prevented from clearing by legislation.\footnote{A conclusion from comments in the survey which was undertaken by UCL as part of this study.} One farmer commented that this stopped their competitiveness and expansion plans, because Queensland had 70\% of their vegetation left, unlike South Australia, who only had approximately 10\% of theirs left after years of expanding the State’s farming industry.\footnote{Ibid.} One farming association said Queensland farmers had unfairly ‘copped it’ from the Commonwealth Government in order to protect the national interests of the country.\footnote{A conclusion from comments in the survey which was undertaken by UCL as part of this study.} Other farmers were aggrieved that this issue of inequality also applied within their own State.\footnote{Personal Communication.} There were some farmers in each State who wanted to collaborate with the Government in terms of environmental conservation.\footnote{Personal Communication.} These farmers did not do pre-emptive ‘panic clearing’ before the vegetation clearing legislation, because they wanted to do the ‘right thing’ and behave in a responsible way.\footnote{Ibid.} Some reflected that farmers who cleared land before legislation prohibiting certain clearing activities had obtained an advantage over those who managed their property in a responsible manner.\footnote{Personal Communication.} This is a classic free-riding problem. Closely connected is the fact that some farmers also felt aggrieved at the perceived inequity of Government rates. One farmer pointed out that at least 20\% of his farm was natural bush, but he still had to pay rates for the whole of the property. He commented that other farmers who had cleared 95\% of their land in the past, before regulation, now had a commercial and financial advantage over him and other farmers who did not clear.\footnote{Personal Communication.} This was because rates are based on size of property rather than area of useable land. These farmers felt a sense of injustice and were supportive of the system being changed, so that rates paid were based on the proportion of the land used.

7.23 To address some of the above concerns, it seems, a scheme was implemented for the funding by the Commonwealth of a financial package, operated by State Governments, for the purchase of certain properties, and/or the provision of financial assistance to owners of properties, affected by certain environmental legislation. The Commonwealth Acts giving effect to this agreement are the Natural Resources Management (Financial Assistance) Act 1992 and the Natural Heritage Trust of Australia Act 1997. Further statutes were also promulgated at State level for the implementation of the agreement between States and the Commonwealth. Under this legislation some farmers were given money to offset the fact that they could not use forest land any more, while other money was spent on the acquisition of land for use as national parks.

7.24 However, it seems that the money spent on these compensation programmes was not considered nearly enough by some of those who were affected by the legislation. Some farmers have gone to court on numerous occasions to challenge awards under these schemes. The New South Wales farmer, Peter Spencer, brought the most high profile of these cases contesting the right to adequate compensation. He has argued continually in court that his farm was affected by Government policies and alleged it caused his business to lack viability. This was because he considered that the vegetation clearing legislation imposed significant restrictions on the use of his farm for grazing. His objections to the unfairness of the vegetation clearing legislation and the money available under the Government assistance packages have received some judicial sympathy. Rothman J, in the New South Wales Supreme Court noted, ‘the overall effect of the different pieces of legislation seems grossly unfair and unconscionable.’\footnote{Personal Communication.} However, despite this view, in this and other cases which have contested the validity of the legislation or compensation amounts available under Commonwealth and State schemes, the courts have found in favour of the Government on points of law.

7.25 It is clear that some landholders were affected more than others by legislation on vegetation clearing. A minority of these appear to have slipped through the net in terms of receiving adequate compensation and their positions should be sympathised with. However, there are others who just believe that those in the city should not take their freedoms away and if this does happen they should be fully compensated. The issue of compensation is one of the major reasons for opposition to the legislation, and moreover, if farmers disagree with the law itself, it is possible that they will be less likely to comply with it.

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\footnote{A conclusion from comments in the survey which was undertaken by UCL as part of this study.}{A conclusion from comments in the survey which was undertaken by UCL as part of this study.}{Ibid.}{A conclusion from comments in the survey which was undertaken by UCL as part of this study.}{Ibid.}{Personal Communication.}{Personal Communication.}{Personal Communication.}{Personal Communication.}{A conclusion from comments in the survey which was undertaken by UCL as part of this study.}{See also Auditor-General New South Wales, ‘Auditor-General’s Report Performance Audit: Regulating the Clearing of Native Vegetation. Follow-up of 2002 Performance Audit’ (Report of the Auditor-General, New South Wales, July 19, 2006).}{Personal Communication.}{Spencer v NSW Minister for Climate Change, Environment and Water (2008) NSWSC 1059, October 10, 2008 (New South Wales Supreme Court, Australia).}
Political motivations for regulation

7.26 Since vegetation clearing was first regulated, it has become a highly politicised and contentious issue in Australia. Farmers have traditionally been seen as a cultural icon and State Governments have been keen to be seen as valuing them.604 At the same time, large numbers of the electorate in cities have been keen to stop widespread tree clearing.605 Government and regulatory bodies commented that they felt they had at times been stuck between a rock and a hard place of contrasting views of green groups and farming lobbies,606 the latter of which are much more powerful in Australia than many other countries. There has always been antipathy between country and city, but this is more than that. In Queensland it was alleged by a wide range of sources that the actual motive behind the legislation on vegetation clearing was that it was given as a concession by one of the major political parties attempting to pick up votes from the Green Party in order to form a coalition Government.607

7.27 Opposition to the vegetation clearing legislation and dissatisfaction with the levels of compensation provided has been particularly raised in the context of climate change. This stems mainly from the fact that the Australian Government successfully negotiated for avoided deforestation to be included in the Kyoto Protocol in 1997.608 This is sometimes known as the ‘Australian clause’, as it applies almost solely to Australia alone amongst industrialised countries that signed this treaty. It sets the baseline emissions for land use, land use change and forestry (LULUCF) at 1990 levels, which was the year that Australia’s greenhouse gas emissions increased by 30% through LULUCF. It is clear that this provision benefits Australia enormously, as it meant that any subsequent measurements for Australia’s emissions would very likely be far less than 1990 levels if they managed to reduce vegetation clearing. Every farming association consulted for this report argued that the Kyoto Protocol commitments were the main reason behind vegetation clearing legislation in their country. However, this is not as clear at it seems, because, although, Australia signed this international agreement in 1998, they did not ratify it until 2007. The farming associations considered that, although Kyoto was not binding on Australia during this period, the Australian Government decided to meet the Kyoto commitments and acted as though it had been ratified. Farmers and the associations representing them argue that to meet these climate targets, the Government deliberately targeted (and singled out) farmers and vegetation clearance activities.

7.28 The legislation on clearing vegetation obviously now has advantages for reduced emissions from deforestation avoidance under Kyoto. However, it is clear that some of the native vegetation laws pre-date the climate change negotiations. For example, legislation in South Australia to control the clearing of native vegetation was first introduced in 1985, and seem to be more motivated by concerns pertaining to biodiversity, conservation, soils and agricultural runoff. Whilst one can see the link between clearing and climate change, this is not necessarily supportable in each Australian State. However, it is easy to see why farmers have made the link and why they might feel that that are being unfairly required to bear the brunt of Australia’s collective climate change emission reduction obligations.

7.29 Some farmers have also been angry with how the legislation is applied at ground level in terms of perceived cases of double standards. In the words of one farmer, ‘the attitude of Government is often ‘do as we say, but not do as we do.’609 A number believe that vegetation clear clear laws are discriminatory towards farmers when compared with private companies undertaking industrial mining who are permitted to clear substantial areas of vegetation. They consider that there is a political preference for mining over agriculture, and that as a result the activities of mining operations are less closely scrutinised and regulated than their own. It should be borne in mind, however, that farming accounts for approximately 99% of the vegetation clearing that has taken place.610

7.30 The legitimacy of the legislation and Government has been undermined to a certain extent because of the concerns of the farmers outlined above. This could have significant impacts on regulator/regulated relationships, how the legislation is viewed by some and so compliance with that legislation.

604 Personal Communication.
605 Personal Communication.
606 Personal Communication.
607 Personal Communication.
608 Article 3.7 of the Kyoto Protocol to the United Nations Framework Convention on Climate Change.
609 Personal Communication.
Change in relationship between government and farmers

7.31 State legislation on vegetation clearing appears to have been a catalyst for a breakdown in how the Government and regulators are perceived by those in the farming community. It was not always like this. There used to be better relationships between the Government and farmers before vegetation clearing legislation.\(^\text{611}\) Originally, many Government bodies dealing with farmers were ‘universally loved’.\(^\text{612}\) This was because they were seen to be helping improve the land and pasture and were considered friends of the farmers.\(^\text{613}\) The reversal of Government policies on vegetation clearing turned these bodies from being ‘a friend of the farmer’ to ‘rural policemen’.\(^\text{614}\)

7.32 Problems in the relationship between farmers and Government also seemed to occur because the laws were seen to be reactive and confrontational because they were politically motivated. They provoked a strong reaction from the farmers and some farmers took their frustrations with the law out on the regulatory bodies. In Queensland and New South Wales, there were quite serious breakdowns in relationships between Government and farmers. There were isolated examples of Government officers having guns pointed at them, or farmers staging road-blocks to prevent inspections of properties.\(^\text{615}\) Tensions were heightened by some stories in the rural press depicting inspectors as ‘jack-booted’ or the ‘tree police’ and they were sometimes pitched as enemies of the farmers.\(^\text{616}\) The relationship between farmers and Government could therefore be described as one with some antagonism in the first few years of regulation. It seems this generally destroyed trust between both sides and for a substantial period.

7.33 The perceived unfairness of the legislative changes was not helped by the fact that some of the original Government departments charged with the compliance role under the legislation did not have any experience as regulators. Some of the departments struggled to adapt to this new role.\(^\text{617}\) It was commented that some of these bodies went about investigation and enforcement in an amateur manner and mistakes were made.\(^\text{618}\) This led not only to problems with prosecutions themselves, but also with how the farmers viewed these bodies.\(^\text{619}\)

7.34 The Government departments responsible for vegetation clearing regulation in all three sample States appear recently to have worked managing their relationships with those they are regulating. There had been a realisation that, in some jurisdictions, inspectors might have been too heavy handed in the early days of the legislation. There is now greater regulatory experience and focus, with Government bodies now also trying to ‘manage interaction’ between them and the farmers better now.\(^\text{620}\) Interviews in the three States revealed that many Government officers thought animosity towards the regulatory bodies had dissipated over the last few years. Generally, Government officials still considered that most farmers did not approve of, or like, the legislation, but thought that most had now accepted it.\(^\text{621}\) One Government investigator in Queensland, for example, described the farmers as ‘not happy, but cooperative and not hostile’.\(^\text{622}\) He thought that only about three out of nine hundred landholders had gone out their way to be obstructive during investigations in his State.\(^\text{623}\)

7.35 Farming associations corroborated the opinions of the Government officers above, although some painted a slightly worse picture. This was particularly so in Queensland, where they considered that there was still a great deal of resistance from the regulated towards regulators, particularly since the latest amendments to the vegetation clearing legislation. One interviewee commented that with each amendment to the legislation things had got steadily worse and the rural community in Queensland ‘was about to burst.’\(^\text{624}\)

\(^{611}\) Personal Communication.
\(^{612}\) Personal Communication.
\(^{613}\) Personal Communication.
\(^{614}\) Personal Communication.
\(^{615}\) E.g. see (i) L Skuthorp ‘Native veg: Nyngan farmers continue blockade’, The Land (North Richmond, NSW), April 25, 2006; (ii) L Skuthorp, ‘Nyngan to raise barricades’ The Land (North Richmond, NSW) 27 April, 2006.
\(^{616}\) Personal Communication.
\(^{617}\) Personal Communication.
\(^{618}\) Personal Communication.
\(^{619}\) Personal Communication.
\(^{620}\) Personal Communication (from one State).
\(^{621}\) Personal Communication.
\(^{622}\) Personal Communication.
\(^{623}\) Personal Communication.
\(^{624}\) Personal Communication.
Survey results on attitudes to vegetation clearing legislation

7.36 The survey asked farmers for their opinions on the vegetation clearing legislation in their State (Question nineteen (ii) of the survey). The question asked them to consider if there were problems with the legislation that might influence the attitudes and perceptions of farmers to satellite monitoring. It was expected in advance that many farmers would be against the legislation, because of the negative publicity and reaction recorded in a large number of media stories, and through interviews with both Government officials and farming unions. Graph 3, below, shows the responses.

Graph 3: Attitude to legislation

<table>
<thead>
<tr>
<th></th>
<th>South Australia (n = 159)</th>
<th>Queensland (n = 154)</th>
<th>New South Wales (n = 104)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly in favour</td>
<td>7.5%</td>
<td>1.3%</td>
<td>0.0%</td>
</tr>
<tr>
<td>In favour</td>
<td>26.4%</td>
<td>9.1%</td>
<td>18.3%</td>
</tr>
<tr>
<td>Neutral</td>
<td>31.7%</td>
<td>9.2%</td>
<td>40.9%</td>
</tr>
<tr>
<td>Against</td>
<td>31.2%</td>
<td>18.2%</td>
<td>27.9%</td>
</tr>
<tr>
<td>Strongly against</td>
<td>48.7%</td>
<td>6.9%</td>
<td>22.1%</td>
</tr>
</tbody>
</table>

7.37 Farmers in Queensland were most opposed to vegetation clearing legislation. Only 10.4% of farmers were in favour or strongly in favour of the legislation, 9.7% were neutral, and 79.9% against or strongly against. Nearly half of all farmers in Queensland were strongly against the vegetation clearing laws in their state. Farmers in New South Wales were also quite opposed to vegetation clearing legislation. Only 18.3% were in favour of the legislation, 31.7% were neutral, and 50% against or strongly against it. Farmers in South Australia were most supportive of vegetation clearing legislation, although the response from farmers was quite mixed; 33.9% of farmers were in favour or strongly in favour of the legislation, 40.9% were neutral and 25.1% were against or strongly against it.

7.38 There were a number of reasons for the opposition to the legislation. Some farmers just objected to being told what to do on their own land, whilst many of these were also angry that vegetation clearing was subject to regulation because of the influence of green groups in their State. There was a strong sense that they were doing the right thing yet were being unfairly targeted by Government. Others who commented on this question considered that some of the legislation was unworkable and failed to consider some of the practicalities of farming.
8. Land clearing of vegetation should be left to responsible farm groups who have a knowledge of the land and how to care for it, not environmentalist green groups and the activists who have nothing else to do but ensure you bring in draconian legislation that impacts on the viability of farms and the sustainability of good farm management. Nearly all farmers are very focussed on good common sense land clearing and sustainable agriculture; we are not all destroyers as the activists [say we] are.

Farmer from New South Wales [respondent ID Pa316]

7.39 The survey also found that Australian farmers that had undertaken vegetation clearing in the previous decade were, notably, more likely to be against the legislation. In Queensland, 85.6% of those that had cleared previously were against or strongly against the legislation, as compared to 61.8% of those that had not cleared. There were similar differences in the other two States (New South Wales – 65.7% who had cleared were against or strongly against the legislation, as compared to 43.1% who had not cleared; South Australia – 35.3% who had cleared were against or strongly against the legislation, as compared to 22.8% who had not). Similar results were also recorded when examining the answers of those that planned some form of vegetation clearance in the future. The farmers surveyed who had cleared were more likely to be against the legislation, as they felt that it impinged on their livelihoods.

7.40 Respondents from larger Australian farms (2,500 hectares or more) were also generally more likely to be against vegetation clearing legislation. In New South Wales, 68.4% of large farms were against or strongly against the legislation, as compared to 38.5% of smaller farms. Queensland also had a similar difference (84.8% and 65.9% respectively).
Chapter Eight
Awareness of satellite monitoring and impact on behaviour

Introduction

8.1 Environmental compliance is sometimes measured by comparing the number of inspections with the number of enforcement actions in order to garner insight into relative success of enforcement strategies. However, this does not paint a full picture as to the success of a given compliance strategy, and probably underestimates the impact on environmental performance in practice. Although inspections open up the possibility of non-compliance being detected, it is likely that the threat of detection also encourages compliant behaviour. Some incidents of non-compliance might be more effectively deterred if those regulated thought that they were being permanently monitored. With this in mind, an aim of this project was to see if satellite monitoring could act so as to increase levels of deterrence, in particular by enhancing the probability of detection (or at least the perception thereof) when compared with conventional, ground-level inspection, thus representing a creative and powerful tool to motivate compliance.

Compliance behaviour

8.2 Although standard deterrence theory would indicate that satellite monitoring could ‘press the right buttons’ in terms of having a greater deterrence effect than conventional methods, this remains unproven because there does not appear to be any published research in this area. Satellites could, however, have a greater deterrent effect than some other technology-based enforcement approaches, such as CCTV, because they are, by their nature, covert. Regulators could have a tool where the regulated can be made aware that they could be watched at any time, but they cannot actually tell whether in fact they are being monitored. Regulators could create the impression of a substantial capability to detect non-compliance with only very limited regulatory resource commitment (at least in terms of manpower). As those subject to satellite monitoring cannot tell when they are being monitored, a regulatory body could be imaginative and play on their image as all seeing. Exploiting the gap between ‘perception and reality’ could lead those regulated to believe that they might be continuously monitored by satellite. There are many other areas of regulation where Government has already changed perceptions and successfully used what can be best described as a ‘bluff’, for example, with speed cameras (which do not always contain film).

8.3 Legal theory often dictates that regulated communities will comply depending on: how greatly they fear detection; if they think it is the right thing to do, and how they consider their neighbours are being treated. Economists like Thaler and Sunstein have most recently championed ‘libertarian paternalism’ (i.e. giving people freedom to choose but trying to direct their choice by various psychological means). They give the example of tax officials in Minnesota telling taxpayers that more than 90% of Minnesotans had complied, in full, with their obligations under the tax law, which significantly increased tax compliance. In this case it seemed that rectifying the misconception that compliance levels were low led people to change their behaviour (i.e. because they could see that the majority were complying). Governments could use satellite monitoring in a similar way; for example, if they publicised figures each year showing how many farms in their state were in compliance with the law this could nudge people towards changing their behaviour (as long as the proportion of farmers who comply is large enough— which, at present, it seems to be). Achieving higher compliance rates with legislation for less regulatory effort is plainly attractive to Government. The US and UK, for example, are extremely supportive of economic psychological initiatives which successfully influence compliance.


628 (i) S Stradling and M Campbell, ‘The Effects of Safety Cameras on Drivers’ (an address to the 67th Road Safety Congress, 4-6 March 2002, Stratford-upon-Avon, Conference - Safer Driving the Road to Success); The Scottish Office, ‘The Deterrent Effect of Enforcement in Road Safety’ (Development Department Research Programme Research Findings No 34, The Scottish Office, January 27, 1999).

A ‘behavioural insight team’, known colloquially as the ‘nudge unit’, is currently reported to be growing in influence amongst members of the current Conservative Government in the UK.  

8.4 Basing a whole regulatory strategy on a ‘bluff’ can be problematic. There is a clear difference between ‘nudging’ people into compliance and ‘bluffing’ them into compliance. The ‘bluff’ can be very effective, but some people will find a strategy based on the latter amoral, deceptive and an abuse of Government power (depending on whether or how far the Government misleads the subject group). There is also a question of how long a bluff can last, given its vulnerability; a leak to a newspaper can expose true monitoring levels and cause a regulatory programme built around such surveillance techniques to be drastically reduced in its effectiveness. ‘Nudging’ is not going to change the behaviour of all, but used in combination with other regulatory techniques could have an impact on compliance.

8.5 To test whether satellite monitoring has had an impact on behaviour, or could be used to change people’s behaviour, the survey in Australia was particularly aimed at looking at the awareness and perceptions of landholders of the satellite monitoring programmes in their respective States. A key element of this exercise was to see what information they had received on the subject and from whom, as well as what they considered the actual monitoring levels and threat of detection to be.

**Awareness of satellite imagery**

**Had farmers seen a satellite image of their own farm?**

8.6 The farmers were asked whether they had seen a satellite image of their own farm (Question 8 of the survey). Over two thirds of the survey respondents in each State had already seen a satellite image of their own farm. Graph 4, below, shows that the figure was as high as 87.9% in Queensland.

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8.7 The survey results indicated that there was a very good awareness of satellite monitoring in Australia, and the majority of farmers might know what level of detail a satellite image could show on their own farms. The responses to this question in Australia were very similar to the results from the earlier survey undertaken in the United Kingdom (UK), where 78% of farmers had seen a satellite image of their farm. There was a noticeably higher proportion of Australian farmers aged 55 years or under who had indicated that they had seen a satellite image of their own farm. However, the figure for those respondent farmers aged above 55 years who had seen a satellite image of their farm was still quite high (South Australia – 57.1%; Queensland – 84.3%; New South Wales – 68.3%). Across the three States, respondents who had undertaken vegetation clearing in the last ten years were more likely to have seen a satellite image of their farm (South Australia – 85.7% who had cleared vegetation in the last ten years had seen a satellite image of their land, compared to 63.8% of farmers who had not cleared; the figures for Queensland are 92.4% and 72.2%, respectively, and for New South Wales the figures are 80% 68.1%, respectively). The figures in each State for those who intended undertaking clearing in the future show a similar pattern: farmers who intended to clear in the future were more likely to have seen a satellite image of their own farm. It is unknown why the figures for those with experience of clearing are higher. There is a possibility that farmers who have seen satellite imagery are maybe just more active in their farm management. This is supported by the fact that the larger size farms in New South Wales and Queensland were statistically more likely to have looked at satellite imagery than smaller farms, although there was little difference in terms of farm size in South Australia.

**Sources of the satellite imagery**

8.8 Those respondents who had answered that they had seen a satellite image of their farm were also asked where they had seen this (Question nine of the survey). Graph 5, below, illustrates that many of the survey respondents had seen satellite imagery from freely available data on GoogleEarth.

Graph 5: Source of satellite image

<table>
<thead>
<tr>
<th>Q9: Where did the satellite image come from?</th>
<th>South Australia (n = 110)</th>
<th>Queensland (n = 135)</th>
<th>New South Wales (n = 77)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Google Earth</td>
<td></td>
<td></td>
<td>64.4%</td>
</tr>
<tr>
<td>State Government department</td>
<td></td>
<td></td>
<td>37.2%</td>
</tr>
<tr>
<td>The farm purchased it</td>
<td></td>
<td></td>
<td>20.9%</td>
</tr>
<tr>
<td>State library archive/Other</td>
<td></td>
<td></td>
<td>1.8%</td>
</tr>
</tbody>
</table>

8.9 Farmers in South Australia were, for example, more likely to have seen their farm from GoogleEarth than any other source. This was a little bit surprising, because a major farming association in one State had
commented in an interview that they considered most farmers would not have seen GoogleEarth. They thought that most farmers would have been slow to use internet technologies, as there was “limited access to communication and bandwidth in the bush” whereas it seems that over two thirds of those surveyed had access to digital data. What was more surprising was that a high percentage of farmers in New South Wales and Queensland who had seen a satellite image had seen one which had been supplied by a State Government department (71.9% of farmers in Queensland, and 63.6% in New South Wales). The position in South Australia was notably different, where only a third of farmers who had seen a satellite image had seen one from a Government department. Satellite data also appears to be entering into mainstream farm management in Australia, with nearly a fifth of all farmers who had seen satellite imagery purchasing satellite data themselves (66 farms in total). The majority of farms buying satellite imagery themselves were unsurprisingly farms in the larger size bracket (2,500 hectares or over in size), although some of the smaller ones (less than 2,500 hectares) were also found to be purchasing imagery.

What a satellite can identify

8.10 Respondents were given examples of objects and asked whether they thought that these could be identified by a satellite (Question ten of the survey). This was to test what they considered the limits of the technology to be. What can and cannot be seen depends in practice on the technical specification of each individual satellite, what resolution levels it is operating at, and weather conditions. A high-resolution satellite operating in good environmental conditions could almost certainly identify paddock fence lines, a house, a patch of wild vegetation (over a couple of metres long), a single tree and a tractor. It is also quite likely that it could identify an individual cow, dumped waste (although this would depend on type and quantity) and the amount of water used for irrigation. Again, it is worth emphasising these identifications depend on certain circumstances and operating conditions. It is quite unlikely that a satellite could see individual clothes on a washing line, although there is a possibility it could make out that there were some objects there, just not specifically what. Commercially operated satellites would definitely not be able to see a number plate on a car. They would likewise not be able to make out a person’s identity. You might be able to make out a blur on an image to be a human, but this would still not enable positive identification at current commercially operational levels.

Graph 6: What a satellite can see

<table>
<thead>
<tr>
<th>Q10: As far as you know, which of the following things can be identified by a satellite?</th>
<th>South Australia (n = 160)</th>
<th>Queensland (n = 153)</th>
<th>New South Wales (n = 104)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paddock fence lines</td>
<td>93.6% (94.4%)</td>
<td>93.1% (93.3%)</td>
<td>81.5% (91.0%)</td>
</tr>
<tr>
<td>A house</td>
<td>77.3% (77.0%)</td>
<td>83.2% (82.5%)</td>
<td>70.6% (71.5%)</td>
</tr>
<tr>
<td>A patch of wild vegetation</td>
<td>95.0% (94.0%)</td>
<td>88.2% (89.5%)</td>
<td>81.4% (81.3%)</td>
</tr>
<tr>
<td>A single tree</td>
<td>95.9% (96.2%)</td>
<td>77.5% (78.8%)</td>
<td>82.8% (83.0%)</td>
</tr>
<tr>
<td>A tractor</td>
<td>82.0% (81.5%)</td>
<td>80.5% (80.8%)</td>
<td>70.0% (70.0%)</td>
</tr>
<tr>
<td>A cow</td>
<td>63.5% (63.5%)</td>
<td>47.1% (47.3%)</td>
<td>49.3% (49.3%)</td>
</tr>
<tr>
<td>Illegally dumped waste</td>
<td>36.6% (36.5%)</td>
<td>46.3% (46.3%)</td>
<td>46.3% (46.3%)</td>
</tr>
<tr>
<td>Clothes on a washing line</td>
<td>40.6% (40.3%)</td>
<td>32.3% (33.3%)</td>
<td>34.2% (34.2%)</td>
</tr>
<tr>
<td>The amount of water used for irrigation</td>
<td>16.9% (16.9%)</td>
<td>16.9% (16.9%)</td>
<td>16.9% (16.9%)</td>
</tr>
<tr>
<td>A number plate on a car</td>
<td>13.8% (13.8%)</td>
<td>17.2% (17.2%)</td>
<td>17.2% (17.2%)</td>
</tr>
<tr>
<td>A person’s identity</td>
<td>5.6% (5.6%)</td>
<td>4.1% (4.1%)</td>
<td>4.1% (4.1%)</td>
</tr>
</tbody>
</table>

632 Personal Communication (with New South Wales Farmers Association).
633 Personal Communication.
8.11 Graph 6, above, shows that, overall, the survey respondents had quite accurate knowledge of what could and could not be seen by a satellite. This was probably because over two thirds of them had already seen a satellite image of their own farm from various sources and knew the capabilities and limits of current satellite technologies.

8.12 In Queensland and New South Wales, farmers aged 55 years and over were more likely to think that the technology was more capable than was the case in practice. For example, 50% of farmers aged over 55 in Queensland thought that satellites could see clothes on a washing line, and 23% of farmers aged over 55 in New South Wales thought that satellites could read number plates on cars. One explanation why some respondents thought that satellites could identify humans or number plates might have been because they were in the category of farmers that had never seen a satellite image before, and were relying on knowledge from popular culture or Hollywood films. Some farmers were similarly under the impression that satellite imagery on Google Earth was significantly different from other, commercially-available, imagery. There was a mistaken impression that the imagery used by Government was more advanced than freely-available satellite data. One Government official commented that some technical aspects of satellite technology were ‘greatly overestimated’ by some farmers and had gone down in ‘folklore’. They gave the example of one farmer claiming to have shut the door on his outside toilet, so the satellite could not see inside. 634

Comment Box 9.

*If I can see my cow, trees and vehicles on a Google image for free, it is a bit scary to think what info you could buy.*

Farmer from Northern Territory (respondent ID op172947)

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### Awareness of satellite monitoring of vegetation clearing

#### Awareness of monitoring programmes in Australia

8.13 Satellite monitoring is unlikely to have an additional deterrent effect if those being monitored do not know about it, so farmers were questioned in the survey about their awareness of satellite monitoring of vegetation clearing. Farmers were firstly asked to indicate whether they had heard of being monitored by satellites or aerial photography in relation to vegetation clearing in Australia (Question eleven of the survey). The survey results in Graph 7, below, demonstrate that there is a high level of awareness of both satellite monitoring and aerial photography programmes in Australia.

8.14 As this question covers Australia as a country, it is not clear whether the responses relate to their individual States (but this is covered later in question thirteen). These figures illustrate that a clear majority of farmers in the three States were aware that there was monitoring of vegetation using satellites in Australia (South Australia – 88.4%; Queensland – 97.4%; New South Wales – 89.7%). The above figures suggest that there has probably been publicity and awareness-raising of vegetation clearing monitoring programmes in each of the three States. This seems particularly true in Queensland, where nearly all of the farmers surveyed were aware of the existence of satellite monitoring programmes for vegetation clearing (Queensland – 97.4%).

8.15 In the other two States, knowledge of satellite monitoring amongst farmers was fair, but could obviously be improved upon; 1.6% of farmers in South Australia, and 10.3% of farmers in New South Wales, had not heard of satellites being used. In South Australia, the majority of farmers who had not heard of satellite monitoring were still under the impression that monitoring was done by aerial photography alone (South Australia – 9.1%). Interestingly, 8.4% of the respondents in New South Wales were not aware of any vegetation monitoring programmes involving aerial photography or satellites in Australia, which was much higher than the proportions from other States. Closer analysis reveals that these responses were all from smaller farms, of a size less than 2,500 hectares. If farmers were unaware of any form of monitoring programme, then perceptions as to the probability of detection amongst this group could be reduced. The survey also found that 7.7% of farmers in New South Wales who were planning some form of future vegetation clearing had, similarly, not heard about any satellite or aerial monitoring programmes in Australia. This figure

634 Personal Communication.
635 Personal Communication.
was 0% for the other two States. So there is certainly scope for raising awareness of satellite monitoring programmes amongst farmers in New South Wales, and particularly farms of a size less than 2,500 hectares.

Graph 7: Awareness of Methods of Monitoring

<table>
<thead>
<tr>
<th>Q11: Have you heard of either of the following being used to monitor vegetation clearing in Australia?</th>
</tr>
</thead>
<tbody>
<tr>
<td>South Australia (n = 164)</td>
</tr>
<tr>
<td>Satellites (alone)</td>
</tr>
<tr>
<td>15.2%</td>
</tr>
<tr>
<td>Aerial photography (alone)</td>
</tr>
<tr>
<td>9.1%</td>
</tr>
<tr>
<td>Both satellites and aerial photography</td>
</tr>
<tr>
<td>73.3%</td>
</tr>
<tr>
<td>Neither of the above</td>
</tr>
<tr>
<td>2.4%</td>
</tr>
</tbody>
</table>

8.16 Farmers in Australia were generally more aware of being monitored by satellite than their UK counterparts. Although satellites have been used for monitoring farmers longer in the UK (to monitor subsidy payments under the single farm payment scheme), only 71% of those surveyed in the UK had heard of this satellite monitoring programme.

Sources of this awareness

8.17 Respondents were asked by what means they had heard about the satellite monitoring of vegetation clearing in Australia (Question twelve of the survey). As can be seen in Graph 8 below, farmers who had heard of satellite monitoring had obtained information in relation to this from a wide variety of sources.

8.18 The three top answers in all three States were the general media, specialist farming press and other farmers. All of these were acknowledged as a source by at least 50% of the respondents who had heard of satellite monitoring in Australia. This was in part expected, because of the large number of articles published in the general media and farming press (that were sourced for this study and are listed in the bibliography in Annex C). The questionnaire results confirmed that, in every State, the Government or regulator being a source of information about satellite monitoring was not in the top three of answers given in the survey. The survey showed that only 18.1% of farmers in South Australia and 30.4% of farmers in New South Wales who had heard about satellite monitoring taking place in Australia had obtained this information from State or Federal Government. The figures for Queensland were higher, where 54.5% of farmers had indicated that they had received information from Government.
8.19 Respondents in all three Australia States were more likely to have received information on satellite monitoring from Government if they had undertaken some vegetation clearing in the last ten years. To illustrate this, 25% of those that had heard about satellite monitoring and cleared vegetation in South Australia had received information from Government. This figure was 56.9% in Queensland and 43.3% in New South Wales. This increase is to be expected, especially if lawful clearing was undertaken and advice sought from Government officials, or if an application to clear had been made to a Government body. These figures are, however, still lower than anticipated, and one would have expected those clearing vegetation to have received more information about the satellite monitoring from Government directly.

8.20 There were mixed messages in some States about the quality and amount of information on satellite monitoring provided to farmers. There have clearly been awareness campaigns in each of the States, both at State level and local level. Information about satellite monitoring has been published on Government information sheets and Government officials have presented information to farming associations. Many Government officials considered their information supply line to farmers on this subject matter to be extremely good. One Government official, for example, commented, ‘there had been lots of Government publicity about satellite monitoring and it is clearly advertised to them.’ Other Government officials (sometimes in the same State as those that thought that thought their information campaigns to be a success) recognised that there were major weaknesses in their communication strategies and that these had not been effective enough. Whilst there have clearly been efforts to provide information to farmers on this subject, it seems that much of this work was done historically and it is difficult to gauge how effective it was. The fact that the survey showed that less than 20% of farmers in South Australia claimed to have received information on this subject from Government illustrates that the answer to this is probably not very effective.
Comment Box 10.

If there is a fault in the system, it’s that the Department don’t tell them [farmers] enough. They are not ‘continually’ publicly putting the message out there. They did back at the start when they first started using it. The feedback we receive from properties now is that some farmers say ‘I thought the tree police had shut down’, because it was no longer getting the same degree of publicity. They have lost the momentum of previous years, and it has not been re-gathered.

Anonymous Government Official.

Comment Box 11.

The Department doesn’t like to put out pro-active information about satellite monitoring. The remote sensing people put some information on a fact sheet on the web, but this is the only Government information really out there. The biggest communication out there is through the rural press, which is sometimes selective about what it chooses to report. They [Government] should have more confidence in promoting the monitoring as it can monitor all of the farmers in the State.

Anonymous Government Official.

8.21 More recent approaches to putting information out to the community have in the words of one Government official been in the form of ‘a scattergun approach’.640 It is noticeable, for example, that two of the States did not appear to mention satellite monitoring at all on their Government websites. One Government official claimed there actually seemed to be an active policy in their State not to put out pro-active information about satellite monitoring.641 This was because they did not want to generate publicity for fear of upsetting the farmers.642 Education about the use of satellite imagery for monitoring and enforcement should be a key part of each State Government’s communication strategy. It can play an enormously important role in influencing compliance. It is clear from the survey results that information relating to monitoring programmes, produced by Government, is not reaching all of the farmers in each of the Australian States.

8.22 There were also similar results in the UK survey: farmers, who were also asked what sources they had heard of satellites being used to monitor single farm payments, also placed union/trade association (54%) and other farmers (37%) higher than information from regulators. Some 24% of UK farmers were aware of satellite monitoring through the subsidy paperwork and 19% through information given by regulators. So communication has also been an issue elsewhere.

8.23 If only about a third of the total number of farmers surveyed in Australia were receiving information on satellite monitoring from Government directly, this could affect their opinion and perception of the monitoring programme itself and of the frequency and extent of any monitoring. Whilst there is a strong argument that Government uses the media and farming press to get information out and their message across, there could undoubtedly be improvements in information management and dissemination by State Governments.

Recommendation 14

If a satellite monitoring programme is undertaken, it is clearly in the interest of Government to let those who may be monitored know that this is happening. Knowledge of monitoring on the part of regulated communities is likely to alter their behaviour, potentially towards enhanced compliance. Any monitoring programme should be accompanied by a strong information dissemination strategy.

640 Personal Communication.  
641 Personal Communication.  
642 Personal Communication.
Awareness of state satellite monitoring

8.24 The survey respondents were also asked whether satellite monitoring was specifically taking place in their State, rather than just Australia (Question thirteen (i) of the survey). It was expected that most farmers would know the true answer, that satellite monitoring was definitely being used in each of the three Australia States surveyed.

8.25 Of the respondents who answered the question (because they thought that satellite monitoring of vegetation clearing was taking place in Australia), Graph 9, below shows that only 26.4% in South Australia; 77.9% in Queensland; and 58.5% in New South Wales thought that satellite monitoring was ‘definitely’ happening in their own State. It was assumed that following the earlier answers given above, that these figures would be significantly higher. When combining those who thought that satellite monitoring was ‘definitely’ taking place with those who thought satellite monitoring was ‘probably’ happening, the figures show a significant increase (to 100% of farmers in Queensland who believed satellite monitoring was being used to monitor vegetation clearance; 93.6% of farmers in New South Wales; and 92.4% of farmers in South Australia). It should be noted that those who did not answer that it was ‘probably’ or ‘definitely’ taking place responded that they had no opinion either way (except one farmer who thought it was definitely not happening). As all these farmers had indicated in the results in Graph 7, above, that they believed satellite monitoring was taking place in Australia, one can only assume that those who answered ‘no opinion either way’ to this question thought that it was happening, but in another State and not theirs.

Graph 9: Knowledge of State satellite programme

8.26 It was also noticeable that farms where vegetation clearing had taken place over the last ten years, or where they intended to clear in the future, had a greater knowledge that satellite monitoring had taken place than those who had not cleared, or did not plan to clear. The proportion of those respondents who answered ‘definitely’ in each State increased if they had cleared, or planned to clear in the future, native vegetation. This suggests that there is a better awareness amongst the group of farmers that most need regulating under the vegetation clearing laws. However, because large numbers of farmers only considered satellite monitoring in their State to be ‘probable’ (this is particularly so in New South Wales and South Australia), Governments might wish in the future to have further awareness campaigns (which might potentially improve compliance outcomes).
Awareness of satellite monitoring of their own farm

8.27 All farmers who had heard of the use of satellite monitoring of vegetation clearance in Australia were asked whether they thought their own farm had been subject to satellite monitoring (Question 13(ii) of the survey). In each of the three surveyed States, Government has a policy of checking all farms in their State. So in theory 100% of all the farms, in each State, should be checked each year (at least once). It is clear from the responses to this question that large numbers of farmers in each State did not know this. As can be seen from Graph 10 below, the number of farmers who considered that their own farm had been monitored was well below the 100% mark. In two States, less than half of respondents thought that their own farm had ‘definitely’ or ‘probably’ been monitored by satellite (South Australia – 40.1%; New South Wales – 46.7%). The response in Queensland was notably different, with 77% of respondents answering that they thought their own farm had been monitored by satellite.

Graph 10: Knowledge of satellite monitoring of their own farms

8.28 In the UK survey, when asked if they thought they had been monitored by satellite, 45% of farmers replied yes and 48% replied that they did not know. Although Australian farmers had similar levels of awareness of satellite monitoring to their UK counterparts (except in Queensland), the Australian survey did reveal that there was still quite a substantial number of farmers in New South Wales and South Australia who thought they had not been monitored. In New South Wales, 27.2% of respondents answered that they did not think they had been personally monitored by satellite (27.2% answered ‘probably not’ and 0% ‘definitely not’) and 26.7% of respondents in South Australia also considered that they had not been checked by satellite (23.9% ‘probably not’, 2.8% ‘definitely not’). The figures for Queensland were a lot lower and only 7.7% of farmers thought they had not been checked by satellite. This suggests that there might have been more, or better, publicity and awareness raising in Queensland than the other two States as, notably, more farmers there are aware that this form of monitoring takes place. The fact that there is more awareness in Queensland would seem to affect attitudes towards satellite monitoring when compared to other States, and this is reflected in responses to other questions.

8.29 When analysing the responses of farmers who had cleared vegetation and those that had not, a number of observations could be made. In all three States, none of those that had cleared vegetation from their properties, or planned to clear in the future, answered that they thought they had ‘definitely not’ been monitored by satellite.
monitored. The percentage of farmers who thought that satellite monitoring had ‘definitely’ or ‘probably’ taken place notably increased amongst those farmers who had cleared vegetation over the last ten years, or planned to clear vegetation in the future (South Australia – 50.1% of those that had cleared in the previous ten years believed they had been checked by satellite, as opposed to 38% of those that had not cleared; the figures for Queensland are 80.9% and 61.3%, respectively; and the figures for New South Wales are 63.4% and 38.7%, respectively). These are pretty clear differences, suggesting that many of those engaged in clearing activities are better informed about the satellite monitoring that takes place.

8.30 However, there is still a significant number of farmers who are clearing and do not think their own property has been checked by satellite. Many of the farmers surveyed did not have a clear idea whether they have been checked by satellite or not. In South Australia, 59.8% of farmers either did not think they had been checked by satellite or had no opinion either way. The corresponding figure for New South Wales was 53.3%. For those farmers that had cleared in the last ten years, 49.9% in South Australia either had no opinion, or were unaware of satellite monitoring of their own farm; in New South Wales 36.5% either had no opinion or were unaware of satellite checks of their farm; and 19.1% in Queensland either had no opinion or were unaware of satellite checks of their own farm. There are similar figures for those farmers planning to clear in the future: 50.0% of this group in South Australia either had no opinion or were unaware of satellite checks of their own farm; 34.3% in New South Wales and 21.4% in Queensland, respectively.

8.31 An examination of responses based on farm size reveals a contrasting picture. Landholders with larger farms (2,500 hectares or over) in Queensland and New South Wales were more likely to be aware of satellite checks of their own farms (85.9% of farmers in Queensland with larger farms thought that their farms had been checked by satellite, as compared to 62.8% of smaller farms (less than 2,500 hectares); in New South Wales, 63.1% of larger farms thought they had been checked by satellite, as compared to 34.0% of smaller farms). The larger farms in Queensland and New South Wales were presumably more likely to know about this form of regulatory monitoring because of having more manpower, professionalism, desire to uphold their reputation, and maybe because they are also using these technologies themselves to monitor land-use change on their own farms. Strangely, these results were not replicated in South Australia, where 37.3% of farmers in larger farms thought that their farms had been checked by satellite, as compared to 43.6% of smaller farms.

8.32 One can conclude that whilst many more farmers are aware that satellite monitoring is taking place, a large number do not think they have actually been monitored by this method themselves. Responses to this question could simply be influenced by a lack of information, or misinformation, concerning monitoring in their State. Alternatively, it might be because some of those have actually non-complied with vegetation clearing laws (from very small clearing upwards), but because they do not think the satellite has detected this, they are assuming that satellite monitoring is random. In practice, satellite programmes detect significant numbers of potential breaches in each State, but many of these are not followed up because of a need to target resources. For example, there might only be resources to investigate 50 out of 1000 potential breaches a year. Whilst having policies that target the most serious offences is understandable, this can mean that some of those in regulated communities who break the law do not actually know that this clearing has been detected in such a way.

8.33 The use of satellites to monitor compliance with vegetation clearing laws can be expensive. One would expect that the running of such monitoring programmes would be accompanied by awareness-raising, which in itself could act as a deterrent. South Australia is the only State that currently has a compliance campaign, where all potential breaches identified by satellite are followed-up (although New South Wales is planning a similar scheme to be introduced in 2010/2011). The South Australian Government formally investigate only a small proportion of breaches, but for the rest of those identified as possibly non-complying with the vegetation clearing legislation, they send a letter to each individual farmer asking them to explain what the satellite has detected. It is therefore unclear why respondents in South Australia were the least likely out of any State to consider that their own farm was ‘definitely’ or ‘probably’ monitored by satellite.

**Time the satellite monitoring had been taking place**

8.34 Farmers were requested to indicate the length of time that they thought satellite monitoring of vegetation clearing had been taking place in their State (Question fourteen of the survey). The first satellite monitoring programme in South Australia was trialled in 2001; in Queensland it was based on satellite imagery during the period 1999–2001; and in New South Wales it was based on satellite imagery collected in 2004–2006. Satellite monitoring had taken place before these dates, but not in a legal-monitoring context. Graph 11, below, presents the results of the farmers in each of the three States.
8.35 Government officials considered that there were still many in the rural community that were surprised by how long the satellite monitoring had been taking place and the extent of the programmes. It appears from the surveys, however, that farmers in all three of the Australian States surveyed had a pretty good idea as to how long the satellite monitoring programmes in their States have been running for. The most popular response was to think it was between five and nine years. Only 14.1% of farmers in South Australia, 11.8% of farmers in Queensland, and 9.9% of farmers in New South Wales, thought that satellite monitoring had been going less than five years. Ironically, farmers in New South Wales who were subject to compliance monitoring by satellite the shortest amount of time out of all the States had the highest proportion of farmers who thought this monitoring had been ongoing for over ten years (45.1%).

Percentage of farms monitoring annually

8.36 The survey participants were asked to estimate the percentage of farms in their State they thought were monitored annually under vegetation clearance laws (Question fifteen of the survey). The results in Graph 12, above, show that farmers in all three States, generally, did not know the correct percentage of farms that were monitored annually. As mentioned earlier, it is the aim of all three States to check 100% of their farms annually. Consistent with their answers to other questions, Queensland farmers had the best awareness of the true extent of the monitoring (56.2%) and farmers in South Australia had the worst. Only 29.1% of farmers in South Australia thought that more than 80% of them were monitored annually. This figure was 38% for New South Wales.
8.37 Those farmers in Queensland with experience of clearing had far greater knowledge of the true monitoring extent. In this State, 60.7% of farmers that had cleared believed that monitoring by satellite was carried out on 80% or more of farms, as compared with 43.8% of those that had not cleared. Larger farms (2,500 hectares or more) were also more likely to have answered ‘80% or more’ than the smaller farms in all three States (Queensland – 62.4% of larger farms compared to 46.7% of smaller farms; New South Wales – 43.6% and 34.6%, respectively; South Australia – 31.7% and 26%, respectively). A high percentage of Australian farmers are significantly underestimating the true extent of the satellite monitoring programmes in their own States.

8.38 The results in the UK when farmers were asked this question were starkly different, with UK farmers significantly overestimating the true extent of satellite monitoring. In the UK survey, 14% of farmers thought that less than 10% of farms were monitored annually; 27% answered ‘10–30%’; 16% answered ‘30–50%’; 12% answered ‘50–70%’; 26% answered that they thought this number was over 70%. The true monitoring extent in the UK is approximately 5%, as this is the minimum percentage that must be monitored each year under European Union legislation. It is understandable that the UK Government would not want to publicise their monitoring rates of 5%, because of the perception of much more satellite monitoring amongst farmers. However, the Australian States where all farms are monitored each year should be telling the farmers, through an effective awareness campaign, about the true extent of the monitoring. Knowledge of the true extent of monitoring extent should influence the compliance behaviour of some of those monitored.

Frequency of monitoring

8.39 Farmers in each of the Australian States were also asked to estimate how often they thought each farm in their State was monitored using satellites (Question sixteen of the survey). As explained above, the true position is that each State aims to monitor each farm once a year. Graph 13, below, shows what the farmers thought the frequency levels of the satellite monitoring were.
8.40 It is clear that a large number of farmers surveyed in Australia did not know the true extent of the monitoring that is taking place in their State. Only about a quarter of all farmers surveyed answered correctly that they were monitored once a year. Approximately half of respondents in Queensland and New South Wales did not underestimate the true extent of the monitoring, believing they were monitored at least once a year (Queensland – 52.9%; New South Wales – 48.3%). This number dipped in South Australia, where only 37.2% of respondents thought that they were monitored at least once a year. Most of the farmers surveyed thought they were monitored every two to three years. A possible explanation why this was the most popular estimate was that two years used to be the monitoring frequency in South Australia and Queensland, with this position only changing in recent years. The figures in the chart support this reasoning, meaning that many farmers might be under the impression that they are still monitored every other year, rather than each year. Again, it would seem beneficial to publicise in each State the true extent of the monitoring in order to fully benefit from any enhanced deterrent effect.

8.41 In the UK survey, respondents also did not have a clear idea of monitoring frequency. In that survey 18% of farmers thought that there was satellite monitoring more than once a year; 25% thought it was annually; 38% thought it was every two to three years; and 15% thought it was every three years. The true figure when this survey was conducted in 2008 was that each farm in the UK was likely to be monitored on average once every 23 years.643

8.42 The UK survey illustrated that satellite monitoring can influence the perception of monitoring extent; with farmers massively overestimating the monitoring that had taken place. The Australian experience shows that this can also go the other way, with large numbers of the Australian farmers significantly underestimating monitoring frequency. Clearly it is not in the interest of the UK regulators to publicise how much monitoring takes place in practice, but a key lesson learnt is that it would seem that countries such as Australia, where there is extensive monitoring using satellite technologies, should be considering informing regulated communities of the true monitoring levels.

Level of monitoring compared to other Australian States

8.43 Survey participants were asked how they thought the level of monitoring of vegetation clearance in their State compared to other states (Question seventeen of the survey). It was not known whether other Australian States not included as part of this survey have different levels of monitoring activity, but in the three States examined in this survey the levels of monitoring should be about the same. The responses to this question are summarised in Graph 14 below.

**Graph 14: Comparative monitoring levels**

<table>
<thead>
<tr>
<th>Q17: In your opinion, how does the level of satellite monitoring of vegetation clearing in your state compare to other Australian states?</th>
</tr>
</thead>
<tbody>
<tr>
<td>South Australia (n = 140)</td>
</tr>
<tr>
<td>We have more monitoring checks by satellite</td>
</tr>
<tr>
<td>We have about the same number of monitoring checks by satellite</td>
</tr>
<tr>
<td>We have fewer monitoring checks by satellite</td>
</tr>
</tbody>
</table>

8.44 The majority of respondents in each State considered that they did have the same levels of monitoring checks (South Australia – 72.1%, Queensland – 57.4%, New South Wales – 65.9%). Farmers in Queensland were the most likely to think that they might have more checks than other States. This might be explained by the fact that in the other questions in this survey, farmers in this State had higher expectations of how regularly they were monitored than the other two States. There has similarly been a greater number of prosecutions and media coverage of these issues in Queensland than in other States.

Knowledge of prosecutions

8.45 Farmers were requested to indicate whether they had heard of any farmers who had been prosecuted for vegetation clearing after being detected by satellite monitoring (Question eighteen). Knowledge of (successful) prosecutions could act as a deterrent to breaking the law. Graph 15 below presents the survey results for this question.

8.46 There have been prosecutions in all of the three States. However, only 42.5% of South Australian farmers had heard of a prosecution in their own State. A small number (9.9%) had heard of prosecutions in other States, these mostly (seven out of nine) coming from reports in Queensland. The figures for South Australia do seem low in comparison to the other two States. In Queensland, 81.9% of farmers had heard of a prosecution in Australia. A similar figure of 81.2% had heard of a prosecution in their own State. Eight farmers in Queensland were aware of prosecutions taking place in New South Wales, but only one Queensland respondent had heard of a prosecution in South Australia. In New South Wales, 75% of farmers had heard of a
prosecution in Australia. A similar figure again of 72.6% of New South Wales farmers had heard of a prosecution in their own State. Four respondents from New South Wales were aware of prosecutions in Queensland and none were aware of any prosecutions in South Australia.

Graph 15: Knowledge of prosecutions

Q18: Have you heard of any farmers who have been prosecuted for vegetation clearing after being detected by satellite monitoring?

- South Australia (n = 141) 47.5%
- Queensland (n = 144) 18.1%
- New South Wales (n = 92) 25.0%

- Yes, but only in my own state
  - South Australia 39.0% 71.5%
  - Queensland 64.1%
  - New South Wales 9.9%

- Yes, but only in another state
  - South Australia 9.9%
  - Queensland 6.5%
  - New South Wales 0.7%

- Yes, in both my own state and another state
  - South Australia 3.5%
  - Queensland 9.7%
  - New South Wales 43%

8.47 People’s compliance behaviour is sometimes influenced by perceptions of whether their neighbour is ‘getting away with it’ as well as whether they agree with the law. Often cited in this context, Bowles considered that ‘twenty percent of the regulated population will automatically comply with any regulation, five percent will attempt to evade it, and the remaining seventy-five percent will comply as long as they think that the five percent will be caught and punished.’

8.48 Chapter seven of this report demonstrated that since the inception of the vegetation clearing legislation, there has been a fundamental lack of support for it amongst many in the farming communities in Australia. Although many farmers’ ‘morals’ have changed over time and some now recognise illegal vegetation clearing as wrong, there still appears to be a disparity of views between the regulatees and the regulators. There appears to be a significant group who would still challenge the legitimacy of the legislation and the credentials of the Government to enforce the law in their State. If there is a problem of regulated communities dismissing the law because they do not agree with it, it seems incredibly important to have visible prosecutions to change behaviour. If farmers see, or hear of many other neighbours breaking the law, and these do not appear to be prosecuted, then they might dismiss or disregard the vegetation clearing laws further. Prosecutions should, therefore, be highly publicised to let farming communities know that those caught breaking the law will be punished and that there is not a substantial amount of people ‘getting away with it’.

Comment Box 13.

The biggest form of promoting the technology to the farming community and deterrence has been advertising wins in the court. They want to show they are a credible regulator. They want to show that they are responding to land clearing. They want to show that they are monitoring what is going on, on the ground. It is the Department’s policy to publish information on court cases. They do use publicity to a great effect. This is in major newspapers, TV and overall sends out a powerful message.

Anonymous Government Official.

8.49 Two of the Australian States encouraged media reporting if there had been a prosecution. These States communicated how important this was to both influencing compliance and publicising the use of satellite technologies in the monitoring process. They considered that greater awareness of prosecutions in each State should, in theory, have an increased deterrent effect. The third State I examined had a policy of not publicising prosecutions, because the Government did not like ‘giving bad news’. Interviews suggested that this was because they did not want to be seen as a ‘policing agency’ and because the topic of vegetation clearing was considered to be highly sensitive. A policy of not publicising enforcement successes would appear to be counterproductive as an effective enforcement strategy and deterrent (as outlined above).

8.50 A lack of Government publicity (in the State that had a policy of not publicising prosecutions) meant that some successful prosecutions were not reported in the media, whereas prosecution failures were more likely to be covered in the rural press. If Bowles’ theories above are correct, then this State’s policy had the potential to send out the wrong message to the 75% of farmers who would comply if they thought that people were being caught and punished. It also seemed that this (non-communication) policy was a major issue amongst managers and investigators of that State’s regulatory body, who wanted publicity of their successes and for these to act as a deterrent. A Government official commented that ‘If they knew they could possibly get prosecuted, monitored, fined or punished, they would probably undertake a due diligence process to make sure they were doing the right thing’.

8.51 Surprisingly, the numbers of farmers aware of prosecutions were actually the highest in the State that did not publicise prosecutions. One can only assume that because this State has had the most vegetation clearing prosecutions out of the three States that farmers must have heard about these prosecutions from sources other than the Government.

Deterrent impact of the monitoring

8.52 The survey aimed to discover whether farmers considered that satellite monitoring was acting as a deterrent against illegal vegetation clearing in Australia (Question twenty-three, statement v, of the survey). It is clear from Graph 16, below, that many farmers did consider that the satellite monitoring was having an effective deterrent impact on illegal vegetation clearing (South Australia – 69.7% of farmers agreed it was acting as a deterrent; Queensland – 56.2%; New South Wales – 60.9%). This can be supported by the results of the UK survey, which were similar: 52% of farmers agreed that they thought that it was acting as a deterrent against overestimation of land cover under the single farm payment scheme. If the farmers feel that the monitoring is having a deterrent effect, then this is a reasonable indication that it is doing so, given that they are themselves the intended targets. Having a deterrent effect is key to making the vegetation clearing legislation work, so it is good that this aspect of its use appears to be working, or at the very least, having an impact on large numbers in the farming community.
8.53 Satellite monitoring appears to have a strong influence on the compliance behaviour of those being monitored, particularly as they cannot tell when or whether they are being watched. In some circumstances, it might act as a smart deterrent method to be utilised by Governments. The Government officials interviewed in Australia had mixed views of its success as a deterrent. Some were convinced it had a major influence in affecting compliance whilst others thought, ‘in respect of behaviour changes it was still ‘earlyish’ days.’

Comment Box 14.

The success of the programme is not perhaps how many are caught, but the fact it is working. On Kangaroo Island, in particular and other places deterrence is working. It has deterred a very large number of landholders – there is no doubt about that.

Anonymous Government Official.

Chapter conclusion: communication is key

8.54 Satellite monitoring will have limited success as a deterrent if those who are being monitored do not know about it, or do not know enough about it. Likewise, if regulated communities are not continually provided with greater persuasion and education about the underlying purpose and benefits of the vegetation clearing laws, State Governments cannot expect an easy ride in converting existing barriers into supports. Communication on a number of fronts is therefore key. State Governments say that they have recently attempted to develop better relationships with those that they are regulating. This should be built upon and there should be greater communication and consultation between both sides. Vegetation clearing is obviously a sensitive topic in Australia, but at the very least there should be a new publicity campaign aimed at drawing attention to the positive aspects of satellite monitoring (see Chapter Nine) and the extent and frequency of the monitoring taking place. Currently, there is too little information out there and it is not reaching all of the farmers.

649 Personal Communication.
650 Personal Communication.
Chapter Nine
Acceptance of satellite monitoring by regulated communities

Were they in favour or against satellite monitoring?

Attitudes towards the vegetation clearing legislation

9.1 Before examining the attitudes of survey respondents to satellite monitoring, it is worth revisiting their attitudes towards the vegetation legislation itself. This was discussed in Chapter seven, which also contained the results of the survey on this question (paragraphs 7.36 – 7.40). Overall, 20.9% of farmers surveyed were in favour or strongly in favour of the legislation; 27.4% were neutral about the legislation; and a majority of 51.7% were against or strongly against the legislation. This might place their opinions on satellite monitoring into context.

Attitudes to satellite monitoring

9.2 Farmers were asked to indicate their attitude to the use of satellites for monitoring vegetation clearing (Question nineteen (i) of the survey). Graph 17 contains a summary of the results.

Graph 17: Attitudes to satellite monitoring

Q19(i): What is your attitude to the use of satellites for monitoring vegetation clearing?

<table>
<thead>
<tr>
<th></th>
<th>South Australia (n = 164)</th>
<th>Queensland (n = 155)</th>
<th>New South Wales (n = 107)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly in favour</td>
<td>3.2%</td>
<td>11.6%</td>
<td>32.3%</td>
</tr>
<tr>
<td>In favour</td>
<td>4.7%</td>
<td>24.5%</td>
<td>32.7%</td>
</tr>
<tr>
<td>Neutral</td>
<td>32.3%</td>
<td>35.5%</td>
<td>40.2%</td>
</tr>
<tr>
<td>Against</td>
<td>9.8%</td>
<td>19.4%</td>
<td>15.9%</td>
</tr>
<tr>
<td>Strongly against</td>
<td>6.1%</td>
<td>12.1%</td>
<td>17.4%</td>
</tr>
</tbody>
</table>

9.3 Many of the farmers surveyed were either positive or ambivalent about satellite monitoring taking place in their state. In South Australia, 84.1% of respondents were either strongly in favour, in favour, or neutral about satellite monitoring. The corresponding figures for Queensland and New South Wales were 63.2% and 72% of respondents, respectively. Whilst the highest proportion of farmers in each state were neutral, of the others surveyed in South Australia and New South Wales, more were in favour of satellite monitoring than against it. The exception to this was Queensland, where 36.8% of farmers were against or strongly against satellite monitoring, as opposed to 27.7% of those that were in favour or strongly in favour of the use of satellite monitoring.
9.4 There were comparable results in attitudes from the UK survey. The UK farmers who were also asked to describe their attitude to satellite monitoring answered: strongly in favour (1%); in favour (20%); neither in favour nor against (42%); against (20%); and strongly against (17%). One interesting difference when comparing the Australian and UK surveys was that the UK farmers who indicated they were in favour of satellite monitoring tended to be from larger farms (in the UK size categorisation). Only 13% of farmers from larger farms in the UK were opposed in some way to satellite monitoring. Those Australian respondents who indicated that they were strongly in favour of satellite monitoring tended to be from smaller farms, less than 2,500 hectares in size. At the other end of the scale it was the larger farms, 2,500 hectares or more in size, who were the most strongly against satellite monitoring.

9.5 In Australia, the figures show that a lot of landholders supported the use of satellite monitoring, or at the very least were neutral about its use. This might be interpreted as encouraging to enforcement agencies wishing to use this technology (unless the farmers liked satellite monitoring because they think it makes no difference as to whether they are more likely to get away with non compliance).

**Preferred method of monitoring**

9.6 Farmers were asked to choose how they would prefer to be monitored under the vegetation clearing legislation (Question twenty of the survey). The results are shown in Graph 18 below.

9.7 Interestingly, only approximately a quarter of farmers in all states wanted to be monitored by site visits only (South Australia – 22.6%; Queensland – 27.2%; New South Wales – 25.7%). Farms that were larger in size (2,500 hectares or over) were more likely to choose site visits by inspectors only than smaller farms (South
Australia – 30.8% of larger farms compared to 17.6% of smaller farms; Queensland – 26.6% and 20%, respectively; New South Wales – 31.6% and 22.7%, respectively).

9.8 By far the most supported method in each Australian state surveyed was monitoring by both satellite and site visits (South Australia – 50.3%; Queensland – 46.3%; and New South Wales – 55.2%). Approximately three quarters of all farmers surveyed, therefore, wanted some form of satellite monitoring incorporated into the regulatory regime. This was a slightly higher figure than under the UK survey. In the UK, 39% of respondents answered that they wanted site visits by inspectors only, 20% wanted satellite monitoring alone, and 38% wanted satellite monitoring and site visits by inspectors.

9.9 Older farmers, those over 55 years, were more likely to prefer site visits by inspectors only (South Australia – 27.4% of over-55-year-olds compared to 18.5% of those farmers that were aged 55 years or lower; Queensland – 31.7% and 21.9%, respectively; New South Wales – 30.6% and 19.0%, respectively). This position was actually reversed in respect of those who preferred satellite monitoring only, where farmers aged 55 or under were more likely to prefer this option than farmers in the older age group (South Australia – 33.3% compared to 19.2% of over-55-year-olds; Queensland – 28.1% and 24.4%, respectively; New South Wales – 30.6% and 19.0%, respectively). This position was actually reversed in respect of those who preferred satellite monitoring only, where farmers aged 55 or under were more likely to prefer this option than farmers in the older age group (South Australia – 33.3% compared to 19.2% of over-55-year-olds; Queensland – 28.1% and 24.4%, respectively; New South Wales – 30.6% and 19.0%, respectively). This position was actually reversed in respect of those who preferred satellite monitoring only, where farmers aged 55 or under were more likely to prefer this option than farmers in the older age group (South Australia – 33.3% compared to 19.2% of over-55-year-olds; Queensland – 28.1% and 24.4%, respectively; New South Wales – 30.6% and 19.0%, respectively). This position was actually reversed in respect of those who preferred satellite monitoring only, where farmers aged 55 or under were more likely to prefer this option than farmers in the older age group (South Australia – 33.3% compared to 19.2% of over-55-year-olds; Queensland – 28.1% and 24.4%, respectively; New South Wales – 30.6% and 19.0%, respectively). This position was actually reversed in respect of those who preferred satellite monitoring only, where farmers aged 55 or under were more likely to prefer this option than farmers in the older age group (South Australia – 33.3% compared to 19.2% of over-55-year-olds; Queensland – 28.1% and 24.4%, respectively; New South Wales – 30.6% and 19.0%, respectively). This position was actually reversed in respect of those who preferred satellite monitoring only, where farmers aged 55 or under were more likely to prefer this option than farmers in the older age group (South Australia – 33.3% compared to 19.2% of over-55-year-olds; Queensland – 28.1% and 24.4%, respectively; New South Wales – 30.6% and 19.0%, respectively). This position was actually reversed in respect of those who preferred satellite monitoring only, where farmers aged 55 or under were more likely to prefer this option than farmers in the older age group (South Australia – 33.3% compared to 19.2% of over-55-year-olds; Queensland – 28.1% and 24.4%, respectively; New South Wales – 30.6% and 19.0%, respectively). This position was actually reversed in respect of those who preferred satellite monitoring only, where farmers aged 55 or under were more likely to prefer this option than farmers in the older age group (South Australia – 33.3% compared to 19.2% of over-55-year-olds; Queensland – 28.1% and 24.4%, respectively; New South Wales – 30.6% and 19.0%, respectively). This position was actually reversed in respect of those who preferred satellite monitoring only, where farmers aged 55 or under were more likely to prefer this option than farmers in the older age group (South Australia – 33.3% compared to 19.2% of over-55-year-olds; Queensland – 28.1% and 24.4%, respectively; New South Wales – 30.6% and 19.0%, respectively). This position was actually reversed in respect of those who preferred satellite monitoring only, where farmers aged 55 or under were more likely to prefer this option than farmers in the older age group (South Australia – 33.3% compared to 19.2% of over-55-year-olds; Queensland – 28.1% and 24.4%, respectively; New South Wales – 30.6% and 19.0%, respectively).

9.10 In the UK survey, the group least in favour of satellite monitoring alone were those aged under 25 (11%). Those in this age group were also most likely to want site visits by inspectors only (50%). The farmers in the oldest age group (the over-55-year-olds) were, surprisingly, most likely to want satellite monitoring alone out of the three age groups (28%). What was also surprising in Australia, was the fact that approximately 70% of all farmers in the older age bracket (over-55-year-olds) chose to have some form of satellite surveillance if they had to choose a method of monitoring.

9.11 The preference for satellite monitoring shown by a large number of farmers was a little unexpected. One explanation for this is that there has been a growing divide between many Australian farmers and state regulatory bodies to a point where there has been a relationship breakdown. Many farmers did not want government officials entering or ‘snooping’ on their land, and appeared to see satellite monitoring as a way of avoiding contact with the regulators.

Comment Box 16.

*I am not happy to have the inspectors/tossers on my property.*

Farmer from South Australia [respondent ID Pa128]

9.12 There was a substantial number of comments given by Australian farmers as to the reason for their monitoring preferences. Many of those surveyed indicated that they would accept satellite monitoring being the initial method of monitoring vegetation clearing legislation, but if something was detected in these satellite checks, they would want any subsequent investigation to be done on the ground by human inspectors. Many farmers remarked that they could explain things to a human, which they could not do with a satellite. There was also recognition that there could be anomalies or inaccuracies with the results from satellite technologies.

9.13 It does not seem likely that any form of fixed penalty system based on satellite checks alone would be acceptable to most farmers. The combination of satellite monitoring and follow-up on-the-ground investigations is the norm in all three Australian States. Current practice is, therefore, the most attractive regulatory model for farmers.

Comment Box 17.

*SATellite monitoring is 99% accurate. Site visits rectify any anomalies in the satellite systems.*

Farmer from Queensland [respondent ID Pa174]
Comment Box 18.

Satellite images have proved to be inaccurate in many cases.

Farmer from Queensland [respondent ID Pa262]

Comment Box 19.

If satellites detect a problem I think ground inspections are required to verify a problem and contact with a personal approach is necessary as sometimes people are not necessarily aware they may be doing the wrong thing.

Farmer from South Australia [respondent ID Pa091]

Comment Box 20.

Satellite monitoring is more efficient and allows better planning for regional ecosystem diversity planning, but onsite inspections allows the opportunity for understanding property differences e.g. weed control, level of management, etc.

Farmer from Queensland [respondent ID Pa277]

Comment Box 21.

“On-site inspection would help resolve disputes over the accuracy of the image. Some snaps have been showing up as regrowth.

Farmer from Queensland [respondent ID Pa290]

Comment Box 22.

I feel there is only a need for an inspection after a satellite has spotted an irregularity.

Farmer from New South Wales [respondent ID Pa402]

Comment Box 23.

If the data is misinterpreted it would be ideal if the landholder had an opportunity to point that out.

Farmer from Queensland [respondent ID Pa225]

Comment Box 24.

Satellite monitoring is cost effective, but ‘ground-truthing’ is essential – without it satellites images can be (and are) used improperly.

Farmer from Queensland [respondent ID Op182154]

Comment Box 25.

Whilst I think satellite monitoring is a good starting point, I believe on [sic] ground inspections are needed to sort out disputes.

Farmer from Queensland [respondent ID PA273]
Satellite Monitoring of Environmental Laws – Lessons to be Learnt from Australia

Comment Box 26.

If there was a choice between a 4x4 land visit or satellite monitoring then farmers would prefer satellites, no question.

Official from the National Farmers Federation

9.14 Some Government officials also recognised that satellite monitoring could be the preference of many farmers. One Government official commented that ‘the most underrated advantage to satellite monitoring is that it is non-invasive’.651 A further Government official commented that ‘it helps with relationships with farmers, as it has less of a big stick approach than a 4x4 truck poking around on their land asking questions; they don’t want to piss the farmers off’.652

9.15 Nearly three quarters of farmers surveyed either supported, or did not mind, satellite monitoring. Whilst it is possible that this could reflect unique circumstances in Australia, it is clear that satellite monitoring is not necessarily considered to be a bad thing by those regulated. However, following the survey work in Australia and the UK, it is clear that Governments should not completely lose human contact with regulated communities by letting the use of such technologies totally take over traditional (human) monitoring techniques. It is likely that there will only be an acceptance of these technologies as long as human information channels also accompany them, particularly if the satellite reveals a potential problem. A lesson learnt is that both the technology, as well as regulated communities, are not ready for an automatic monitoring system like that which exists for speed cameras.

What the farmers liked about satellite monitoring

Satellite monitoring could stop dishonest people giving the law-abiding majority a bad name

9.16 Survey participants were asked whether they thought satellite monitoring could stop dishonest people in the farming industry giving the law-abiding majority a bad name (Question twenty three, statement ii of the survey). The results are contained in Graph 19, below.

9.17 The majority of farmers surveyed agreed with the statement. In South Australia, 84.5% agreed, as compared with 5.5% who disagreed; Queensland – 64.9% compared with 19.2%, respectively; New South Wales – 68.5% compared to 8.6%, respectively. It is not known why farmers in South Australia polled higher to the question than the other two States. The fact that a clear majority of farmers held the above opinion is clearly one of the reasons why regulatory satellite monitoring is supported by a high number of farmers in Australia.

9.18 Studies from other countries have also found that those regulated can actually welcome oversight from space. For example, in the United States the Georgia Pacific Corp. and other big timber concerns have in the past supported the Georgia Department of Revenue’s forest survey by satellite, saying that this helps to disprove accusations that they have secretly cut trees without paying taxes.653

651 Personal Communication.
652 Personal Communication.
9.19 Farmers were asked to comment on the statement that satellite monitoring allows farmers to operate on a more fair and equal basis, assuming every farm was monitored (Question twenty three, statement vi of the survey). The results are contained in Graph 20, below. The most commonly selected option to this question was that they agreed it did allow farmers to operate on a more fair and equal basis (South Australia – 56.8% of farmers agreed or strongly agreed; 37.5% in Queensland; 55.2% in New South Wales). Farmers in Queensland were more likely to disagree with this statement than those in other states (35.6% of farmers in this State disagreed to some extent). Several farmers commented that the satellite monitoring put everyone on an equal footing, and that only those who were not complying with the law should be worried by it.

9.20 In Queensland and New South Wales those that had cleared vegetation in the past were more likely to have disagreed with the statement (Queensland – 40.5% of those that cleared disagreed to some extent, as compared with 17.6% of those that had not cleared; New South Wales – 34.3% compared with 20.0%, respectively). There were similar figures in relation to the opinion of those farmers who planned to clear vegetation in the future. Farms in the larger size category (2,500 hectares or more) were also more likely to disagree with the statement, particularly so in Queensland and New South Wales (Queensland – 37.7% of larger farms disagree to some extent, as compared with 27.1% of those farms in the smaller category; New South Wales – 33.3% compared with 18.4%, respectively).

9.21 In the UK survey, farmers were also asked if they thought that satellite monitoring allowed for farmers to operate on a fairer and more equal basis. 36% agreed, 43% disagreed, and 19% of farmers were neutral in their opinion. As such, Australian farmers might be said to be more likely to consider this a benefit of satellite monitoring than their UK counterparts. The UK survey found that those in the UK classification of larger farms were also more likely to agree with this statement. This opens up a question as to why the larger Australian farms seem more against satellite monitoring, in general, compared to smaller farms.
Graph 20: Importance of level playing field

Q23: ‘It allows farmers to operate on a fairer and more equal basis, assuming every farm is monitored.’

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<tr>
<th></th>
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<td>Strongly disagree</td>
<td>3.7%</td>
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<td>10.5%</td>
</tr>
</tbody>
</table>

Comment Box 27.

Farmers who comply with the law have nothing to fear from satellite monitoring.

Farmer from South Australia [Respondent ID Pa096]

It is a more consistent and accurate method of monitoring

9.22 Farmers were asked whether they thought that satellite monitoring was a more consistent and accurate method than other means of checking vegetation clearing compliance (Question twenty three, statement vii of the survey). Graph 21, below, shows that the majority of farmers surveyed did agree with this statement. In South Australia, 65.9% of farmers agreed to some extent it was a more consistent and accurate method of checking; 39.8% in Queensland; and 56.8% in New South Wales.

9.23 Queensland, again, had the highest number of farmers who generally disagreed to some extent (39.7%), and this position was more evident amongst those that had cleared vegetation in the past (42.6%). This was consistent with the response of Queensland farmers to other questions, where they seemed more against both satellite monitoring and regulation in general than other States. It was also notable that many of those who had no vegetation clearing planned in the future were more likely to agree with the statement (Queensland – 49% who did not plan to do any future clearing agreed to some extent, as compared with 36.2% that did plan to clear in the future; South Australia – 68.5% compared with 53.4%, respectively). This position is not the same in New South Wales, where there was very minimal difference based on whether they planned to clear in the future or not.
It is a more cost-effective method of monitoring

9.24 Respondents to the survey were asked if they considered satellite checks to be a more cost-effective method of monitoring than ground inspections (Question twenty three, statement viii of the survey). The results to this are contained in Graph 22, below.

9.25 The majority of respondents who answered this question agreed, to some extent, that satellite monitoring was a more cost-effective method of monitoring than ground inspections (South Australia 67.5% of farmers agreed to some extent; 56.3% in Queensland; 65.4% in New South Wales).

9.26 Satellite monitoring can, however, be expensive in practice, as Chapter two illustrated. It might, therefore, be assumed that either the farmers do not know the price of monitoring this way, or that they consider that this method of monitoring is probably more cost-effective than sending inspectors in on the ground to monitor such a vast land-mass, as is the case in Australia.
Graph 22: More cost-effective method of monitoring

<table>
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<tr>
<th>Survey Response</th>
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</tbody>
</table>

**Recommendation 15**

Regulated communities were in general more supportive of satellite technologies being used if they considered this offered a fairer, more equitable and more consistent form of monitoring than by other available methods. Governments wishing to use satellite technologies in a regulatory/legal process should emphasise these benefits when introducing such a monitoring programme.

**What the farmers disliked about satellite monitoring**

**Data handling and trust in government**

9.27 The survey respondents were asked whether they had trust in the Government and also believed in the competence of Government staff when handling satellite data. They were specifically asked to comment whether they agreed that ‘the data will only be handled and interpreted correctly by adequately qualified personnel’ (Question twenty three, statement iii of the survey). The results are contained in Graph 23, below.
9.28 Concerns were raised by a significant number of respondents. In Queensland, 46.7% of respondents disagreed with the statement that the data would be handled and interpreted correctly by adequately qualified Government staff. In New South Wales, this figure was 35.3%, and in South Australia it was 26.4%. It was noticeable that farms over 2,500 hectares were more likely to disagree with the statement than smaller farms. In New South Wales, 52.6% of the bigger farms disagreed with the statement, as opposed to 25.4% of the smaller farms; Queensland – 50.5% compared with 35.4%, respectively; South Australia – 31.3% compared with 21.6%, respectively.

Comment Box 28.

There appears to be so many errors in the interpreting of satellite images, I feel there must be on ground inspections to verify suspect cases.

Farmer in Queensland [Respondent ID Pa262]

Comment Box 29.

Based on past performance I have no confidence in the accuracy of the data or its interpretation.

Farmer in Queensland [Respondent ID Pa292]
Comment Box 30.

From experience, the reading from the satellite of particular soil and grass type was proved incorrect.
Farmer in Queensland [Respondent ID Pa186]

9.29 It is not known whether the key objection here was with actually trusting the Government, or concerns over their competence. There seems to have been a mini-breakdown in relations between farmers and Government in Australia, and this survey question seems to reinforce this problem. This might have influenced the perception of the farmers as to whether Government bodies can be trusted when checking farms with new technologies like satellites. What does appear to be the biggest problem for farmers highlighted by the survey is the fact that many farmers have concerns about the accuracy of satellite data and its interpretation by Government experts. The comment boxes above show that such issues appear to have affected quite a number of survey respondents directly.

**Recommendation 16**

For there to be confidence in this form of monitoring, the farmers have to trust that the satellite imagery is interpreted correctly. The satellite image will nearly always be accurate; it is the human element (i.e. how the image is processed, interpreted and secured) that can cause problems. Following best practice procedures on data handling and security could increase reliability and trustworthiness. In order to establish confidence in the technology it would be advisable for information management procedures to be introduced and followed by Government, and that these are made publicly available.

**Notification that the satellite monitoring is taking place**

9.30 Landholders were asked whether they thought they should be informed each time their farms were monitored by satellite (Question twenty-one of the survey). It is clear from Graph 24, below, that large numbers of respondents were of the opinion that they should be informed if their farm was monitored by satellite. Approximately two thirds answered that they wanted to be informed. This response was largely consistent for those that had cleared and those that had not cleared, as well as the different age groups of farmers.

9.31 There were similar results obtained in the UK survey, where 84% of farmers thought that they should be informed if they were monitored by satellite. Only 10% of farmers did not think that there was any need to be told.

9.32 Whilst many Australian farmers seemed to be inclined to chose some form of satellite monitoring over ground inspections only, it is clear that some did feel uncomfortable with the covert nature of satellites. Lots of farmers made reference to ‘1984’ and ‘Big Brother’ and were concerned that the satellite would be ‘peeping’ or ‘spying’ on them. It would seem that informing them would go some way towards alleviating the negatively perceived stealth nature of the technology. Many respondents also thought it should be simple courtesy that they be informed.
Graph 24: Informing Farmers of Satellite Monitoring

Q21: Should you be informed each time your farm is monitored by satellite for possible vegetation clearing?

- South Australia (n = 163)
- Queensland (n = 157)
- New South Wales (n = 106)

Yes
- South Australia: 61.3%
- Queensland: 73.2%
- New South Wales: 71.7%

No
- South Australia: 17.8%
- Queensland: 17.9%

No opinion either way
- South Australia: 20.9%
- Queensland: 17.2%
- New South Wales: 10.4%

Comment Box 31.

*All land managers have a right to know when they are being monitored – by what means, how frequently, in what detail – and to be informed of the purposes and consequences of that monitoring.*

Farmer from South Australia [respondent ID Pa046]

Comment Box 32.

*Common sense, courtesy, due process, good management! Which has been left out of this debate.*

Farmer from Queensland [respondent ID Pa208]

Comment Box 33.

*I would expect to be informed prior to a visit by an inspector so this should also apply to a satellite.*

Farmer from Queensland [respondent ID Pa226]

Comment Box 34.

*It is fair to monitor by satellites providing people know its happening. Sometimes people act thinking they are doing the right thing – but in fact are not. In this case education is better than litigation.*

South Australian Farmer [respondent ID Pa143]
9.33 Farmers were also asked when they thought they should be informed about the satellite monitoring (Question twenty-two of the survey), and the results of this are contained in Graph 25, below.

Graph 25: Timing of informing farmers of monitoring

9.34 Respondents were much more likely to want to be informed before the monitoring took place than afterwards, although approximately a third of farmers wanted to be informed both before and after. It is unsurprising that a regulated group would like to be notified of when they will be checked. However, a potential problem with having a notification system is that it is not each State Government in Australia which is actually operating the satellite. Governments buy archived data from commercial operators and it is virtually impossible, therefore, for Government to tell farmers in advance the exact day they will be monitored; Governments do not know this themselves, and will just be given a list of dates (from the past) by the satellite provider of when imagery covers a particular area, what is available to buy, and information about the quality of the data (particularly in light of environmental conditions on the particular days).

9.35 It is therefore easier to inform farmers after they have been monitored, although again this could also be subject to a significant time lapse if the image was not purchased straight away. Similarly, the Government will not know the day the satellite monitoring took place until they actually buy the data. Some respondents thought that satellite monitoring should have a system in place, similar to that for ground based inspections, with farmers being informed in advance of a date for inspection.\footnote{Note of course that many environmental inspections by Governments are ‘surprise’ inspections – this is the whole point of some of them. However, in Australia many farmers inspected under the native vegetation laws are notified in advance – this is because once an offence has been committed it is impossible to hide (i.e. hundreds of hectares cannot be replaced in days); and also because the inspectors do not want to treat the farmers as ‘criminals’, and would appreciate their assistance showing them around what can be extremely large properties [Personal Communication].} It would be useful to be straight with farmers, and explain to them the reasons why this is not possible, so they can properly understand why they might not be informed of the exact day of the satellite monitoring. Again, communication and education is extremely important in this respect.

9.36 It is also questionable whether enforcement agencies would have the resources to contact farmers – either before, after, or both before and after, each time they were monitored. There are approximately 43,268 farms in New South Wales, 28,905 farms in Queensland and 14,901 farms in South Australia.\footnote{Farm Facts: National Farmer’s Federation <www.nff.org.au/farm-facts.html> accessed 23 June 2010.} Notification of
individual monitoring to all of these farms would entail significant coordination and costs. Interviews with Government officials suggested that resources were already stretched, and it seems unlikely they would consider accommodating the farmers in this regard.

9.37 A form of compromise might be for all farmers in each State to be informed annually by government that they will definitely be monitored this way (as many do not know the frequency of the monitoring), although the actual date will not be disclosed. Instead of sending individual letters this could be done through press releases or with the cooperation of State farming associations. Some farmers were quite pragmatic and thought that the timing of the satellite monitoring was not so much an issue as whether it was used reasonably.

9.38 Having some notification system in place for the farmers does, however, involve some risks. There is a potential scenario of some farmers knowing definitely they have been monitored, but thinking they have got away with it. Sometimes, those charged with examining satellite data will miss potential breaches, for example. More relevant is the fact that satellite monitoring can detect more illegal activities than regulators, because of resource constraints, are able to follow up or prosecute (see paragraphs 4.27 – 4.30 for numbers of reports of illegal clearing, and 4.37 for numbers of prosecutions). This could lead farmers who break the law to presume (falsely) that satellite monitoring does not have the capacity to detect certain types of non-compliance. On the flipside, and equally problematic, is that a failure to follow up cases which farmers believe might have been detected through satellite monitoring reduces perceptions as to the existence of a credible sanction for non-compliance. Either scenario has the potential to limit the deterrence potential of satellite monitoring as an enforcement tool.

It invaded their privacy

9.39 Farmers were asked whether they thought satellite monitoring of vegetation clearing was an invasion of a farmer’s privacy (Question twenty three, statement i, of the survey). The results to this question are contained in Graph 26, below.

9.40 Privacy was an important and sometimes emotive topic for many of the Australian respondents. Farmers were much more likely to consider that satellite monitoring was an invasion of their privacy than not (South Australia – 49.1% agreed it was an invasion of privacy, compared to 23.6% who disagreed; Queensland – 67.6% compared to 15.2%, respectively; New South Wales – 58.1% compared to 12.4%, respectively). The UK survey in 2008 revealed that UK farmers were even more sensitive to issues of privacy, with 75% agreeing that satellite monitoring could be an invasion of a farmer’s privacy. Only 15% of UK farmers disagreed with this statement.

Comment Box 35.

The timing should not matter, as we should not have anything to hide (and we can’t hide anyway). What is critical is that the satellite image is used sensibly.

Farmer from Queensland [respondent ID Op182154]

656 Personal Communication.
Graph 26: Privacy and satellite monitoring

Q23: ‘It is an invasion of a farmer's privacy.’

<table>
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<tr>
<th>Country</th>
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<th>Neutral</th>
<th>Disagree</th>
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<tbody>
<tr>
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<td>21.9%</td>
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<td>Queensland (n = 151)</td>
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<td>New South Wales (n = 105)</td>
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<td>29.5%</td>
<td>29.5%</td>
<td>37.1%</td>
</tr>
</tbody>
</table>

Comment Box 36.

This is the beginning of the end for a liberal society. ‘Remember, big brother is always watching you!’ Orwell

Farmer from New South Wales [Respondent ID Pa316]

Comment Box 37.

Permits to enter are required to enter privately held land. What is so different with digital technology?

Farmer from Queensland [Respondent ID Pa174]

Comment Box 38.

This is an attack on civil liberties.

Farmer from New South Wales [Respondent ID Pa393]

Comment Box 39.

Invades privacy. How would you like your backyard of your residence monitored?

Farmer from South Australia [Respondent ID Pa050]

Comment Box 40.

I do not approve of outside parties looking over my shoulder when managing my land for ANY reason. This technology is useful but also very intrusive.

Farmer from New South Wales [Respondent ID Op189089]
9.41 In New South Wales and Queensland, there was a noticeable difference in attitudes towards privacy depending on farm size. Larger farms (2,500 hectares or more) were much more likely to consider satellite monitoring an invasion of privacy. In New South Wales, 74.3% of large farms agreed that it was an invasion of privacy, as compared to 47.7% in the smaller farm category. There were similar results in Queensland, with 72.9% of larger farms agreeing that it was an invasion of privacy, as compared to 53.2% in the smaller farm category.

9.42 There were also some notable differences in responses depending on whether a farmer had cleared in the previous ten years. In Queensland, 71.3% of those who had undertaken some form of clearing thought it was an invasion of privacy, as compared to 55.9% of those who had not cleared. In New South Wales, the figures were 67.6% and 53.5%, respectively. There did not seem to be clear evidence that attitudes to privacy were affected by age, although respondents in the older age category (over-55-year-olds) were a little more likely to strongly agree that it was an invasion of privacy. The survey in the UK replicated these results and the group that most likely to think that satellite monitoring was an invasion of privacy was also those aged over 55 years old (82%).

9.43 Of those farmers who did not think that satellite monitoring was an invasion of privacy, a number of them considered that those who were not doing anything wrong had nothing to fear.

Comment Box 41.

Anyone can monitor it by looking at Google or buying satellite imagery so who cares? I think the ‘privacy’ complaints are just nonsense from people who have something to hide.

Farmer from Queensland [Respondent ID Op184987]

9.44 Many countries are signatories to international laws which recognise privacy as a fundamental human right. The right to privacy is protected at international level by of the Universal Declaration of Human Rights (1948) and the International Civil Covenant on Civil and Political Rights (1976). These state that ‘no one shall be subject to arbitrary interference with his privacy, family, home or correspondence, nor to attacks upon his honour and reputation’. Australia is a signatory to both of these international laws. In Europe, the European Convention on Human Rights (ECHR) is also similar in form, guaranteeing that ‘everyone has the right to respect for his private and family life, his home and his correspondence. There shall be no interference by a public authority with the exercise of this right except such as in accordance with the law and is necessary in a democratic society in the interests of national security, public safety or the economic wellbeing of the country, for the prevention of disorder or crime, for the protection of health and morals, or for the protection of the rights and freedoms of others.’ Many countries also have national legislation or Constitutional provisions that protect privacy rights. For example, there is legislation protecting privacy under both Federal and State legislation in Australia, and there have been recent moves to strengthen these. There can also be privacy protection in civil law. In the Australian context a new tort for the invasion of privacy has also arisen.

9.45 Although there is privacy protection in many countries, stemming from national and international legislation, the question of how much privacy people are entitled to in relation to satellite monitoring appears

657 Article 12 of the Universal Declaration of Human Rights (1948); Article 17 of the International Civil Covenant on Civil and Political Rights (1976).
658 Article 8 of the European Convention on Human Rights.
659 For example, the Privacy Act 1988.
660 The Australian Law Reform Commission recently recommended significant changes be made to national legislation, as well as the introduction of a statutory cause of action for breach of privacy in circumstances including where there had been an interference with an individual’s home or family life, or where an individual has been subjected to unauthorised surveillance. See further, Australian Law Reform Commission, ‘For Your Information: Australian Privacy Law and Practice’ (ALRC Report No.108, 2008).
661 In Grosse v Purvis (2003) QDC 151, 16 June 2003, a judge recognised a common law right to privacy for the first time in a stalking case. In awarding damages the judge found that the essential elements of the emerging tort of the invasion of privacy were present. These were that the willed act of the defendant intruded upon the plaintiff’s privacy in a manner which would be highly offensive to a reasonable person of ordinary sensibilities; and which caused the plaintiff detriment or distress. See further, G Cho, ‘Privacy Conflicts from High Resolution Imaging’, in ‘Current Legal Issues for Satellite Earth Observation: Treaty Verification and Law Enforcement Through Satellite Observation, Privacy Conflicts from High Resolution Imaging’, Sánchez Aranzamendi, M., Sandau, R. and Schrogl, K. (eds) (Report 25, European Space Policy Institute, Vienna 2010) 36.
presently untested in courts across the world. Satellite imagery is being used as evidence in the Australian courts more than any other jurisdiction in the world. Therefore, it seems likely that issues of privacy and admissibility of evidence will be raised in the Australian courts at some stage. This has already been close to happening. In two prosecutions in Australia, the defence team, representing the same defendant in both cases, seriously considered arguing that the satellite imagery was a breach of the defendants privacy. They examined the rules on privacy in relation to CCTV and speed cameras and thought that these forms of surveillance were ‘different than evidence from satellites, which was stored and reconstructed to be used in the case against the defendants’. The defence team in the end chose not to run the argument, as they believed they had stronger alternative arguments against the evidence, but this does illustrate that this legal argument could be raised again in Australia in the future and is actively being considered.

9.46 The surveys of farmers show that there is a lot of concern that satellite monitoring is eroding personal privacy. However, it was extremely difficult to pinpoint the exact reasons why farmers considered satellite monitoring to impact on their privacy. One of the most characteristic and striking facts about privacy is that it is a concept that easily escapes any precise definition. Different perspectives on privacy rights also means that what might be seen as legally permissible or socially acceptable in one country might not be in another. Any precise definition of what privacy is can depend on the differentiation between public and private, based on the legal determination of public and private geographical places, as well as of public and private information; on customary expectations and cultural understanding and social perception of public and private; on the accessibility of information to the unenhanced senses; and the actual state of knowledge.

9.47 In terms of the privacy impact of satellite monitoring, what seems to mark out this type of monitoring from other similar forms of surveillance is the fact that it is covert; it can be more intensive and extensive; and it can potentially monitor everyone anywhere, as it does not distinguish between public and private property (though of course not inside buildings). Government usually controls, through legislation, surveillance activities which have the capacity to be intrusive, but satellites are not currently subject to any controls and we have the somewhat uncomfortable position where often fully commercial companies are controlling a potentially invasive technology relatively unregulated.

9.48 The survey results appeared to indicate, that generally, it was the covert nature of this form of monitoring that the farmers did not like, rather than what the satellite could and could not see. Many survey respondents aired their concerns about such a ‘Big Brother’ form of surveillance. Although satellite monitoring can be uncomfortable for some because they cannot tell when and where they might be monitored, it is unlikely in general terms that the covert nature of this form of surveillance will be sufficient to be a breach of privacy. Cho raised the point whether geospatial technologies had ‘exposed privacy’, and whether this exposure has given rise to an ‘unrealistic expectation of privacy protection’. He considered that perhaps privacy had been poorly understood – resulting in reactions verging on emotional and mass fear and uncertainty, so that calm reflection had not taken place.

9.49 Privacy can be difficult to safeguard in practice because a key ingredient in terms of privacy protection is showing that there has been some unreasonable interference. It is normal for the person complaining that there has been a breach of their privacy to prove how an activity affected their rights (e.g. under Article 8(1) of the ECHR). A major factor in terms of satellite monitoring will be what the satellite can actually see (what the image shows), and why this has interfered with people’s private lives. Interestingly, the majority of those farmers surveyed had seen a satellite image of their own farm (see paragraph 8.6) and there was high awareness of what satellite technologies could and could not see (see paragraph 8.11). If the majority of

662 Based on author’s own research there appears to be no relevant case law at present.
664 Personal Communication.
665 Personal Communication.
667 Ibid.
669 Ibid.
survey respondents are aware that satellites cannot see humans, or washing drying on a line, or number plates on a car, this begs the question: what aspect of their privacy does it specifically intrude upon? It is debatable whether the current resolution levels from satellites are sufficiently intrusive to interfere with a person’s private life as protected under legislation. Using satellites to monitor vegetation change would appear to have a limited impact on a person’s private life. It seems unlikely that satellites with the resolution capabilities of Landsat and SPOT could see many things that could be considered to be intrusive (e.g. somebody sunbathing inside a walled garden). As yet, no court appears to have addressed the issue of whether the use of satellite data constitutes a breach of privacy, but as the resolution improves and the frequency of the data being used in the courts increases, it is only a matter of time before lawyers will raise these questions in court.

9.50 Questions of privacy have been raised before in the context of aerial photography in the US. One case where trespass, nuisance and privacy came together was when the celebrity Barbara Streisand sued an aerial photographer for displaying a photograph of her California home, along with other photos of the entire California coastline, on the website of the California Coastal Records Project. The court rejected her claims to privacy, finding that aerial photography of the coast was ‘not an invasion into a private place’, nor was the invasion made in a manner highly offensive to a reasonable person. The US Supreme Court has also considered a case where the police used a plane to fly over a house in order to see signs of marijuana being grown in a garden. Fences to prevent observation from casual passersby protected the house. The defence argued that the fly-over was an unreasonable search and seizure, because it violated the defendant’s reasonable expectation of privacy in his back yard under the Fourth Amendment. The Supreme Court disagreed, finding that ‘in an age where private and commercial flight in the public airways is routine, it is unreasonable for the respondent to expect that his marijuana plants were constitutionally protected from being observed with the naked eye from an altitude of 1,000 feet.’ In a further case, the US the Supreme Court ruled that the Environmental Protection Agency was permitted to photograph a chemical facility by aeroplane because they used relatively conventional aeroplane-camera equipment in a publicly navigable airspace. However, the court also commented that ‘it may well be that surveillance of private property by using highly sophisticated surveillance equipment not generally available to the public, such as satellite technology, might be constitutionally proscribed absent a warrant.

9.51 It has been nearly a quarter of a century since the two US Supreme Court judgements above. High-resolution earth observation imagery is now freely available on the internet from GoogleEarth, which has been downloaded by a third of all Internet users in the world, including in 2010 500 million people in the European Union and 300 million people in the US. It is, therefore, unclear whether a court in the US would find satellite technologies to still be ‘not generally available to the public’, or if a court would find satellites more or less intrusive than aerial photography. Again, key issues in determining whether there had been a privacy breach would probably be what the satellite could actually see and the central facts of each case.

9.52 What is important in the context of privacy under the ECHR, is that if a court found that satellite monitoring was an invasion into someone’s private life, it would have to examine next whether the measure complained of was acceptable under one of the public interest justifications under Article 8(2) of the European Convention. Even if a court found that the intrusion into privacy was justified on these grounds, any satellite monitoring would still have to be expressly prescribed by law. The Convention states that any act that may infringe Article 8 should have specific statutory authorisation, and the purpose of this is so that individuals know with sufficient clarity where they stand. It is clear that an administrative practice, however well adhered to, does not provide the guarantee required by ‘law’, and nor would provisions relating to ‘general’ investigative powers contained in a law which did not specify the use of satellites. Where satellite monitoring has already been used in compliance strategies in Europe, it has been expressly prescribed by law. European legislation gives Member States the option of using satellites to monitor fraud under farm subsidy payments in

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672 Ibid, See p38 of the judgement.
673 California v. Ciraolo (1986) 476 U.S. 207 (United States Supreme Court). See also Florida v Riley (1988) 488 U.S. 445 (United States Supreme Court) where a US court approved the use of a helicopter, hovering at 400 feet, to observe marijuana plants through a hole in the roof of a defendant’s greenhouse.
674 Ibid.
675 Dow Chemical Co. v. United States (1986) 476 U.S. 227 (United States Supreme Court).
676 Ibid.
agricultural cross compliance schemes, as well as for tracking the movement of fishing vessels to check that fishing is taking place in authorised areas. It is not known whether these provisions, which specifically mention 'satellite images' and 'satellite based monitoring systems', were originally included with Article 8 of the Convention in mind, but it would seem beneficial for legislators, at least in the EU, to expressly incorporate the use of satellite monitoring into legislation.

**Recommendation 17**

Governments wishing to use satellite monitoring in regulatory programmes should consider incorporating a provision expressly mentioning the use of these technologies in legislation. Although this might not be strictly necessary in a legal context, it could guard against challenges to admissibility, potentially under privacy legislation.

9.53 Satellite technologies are evolving faster than the law. Slonecker et al, suggested in 1998 that there was a need for ethical guidelines to protect privacy from satellite technologies, as there was an absence of a global comprehensive legal and policy framework which was of direct applicability to them. Since then there has been rapid progress in the technology. Issues of privacy are likely to prove more problematic as the technology develops. It is unclear where we are heading with resolution levels on satellites; if we have reached a plateau, or if the technology will continue to develop to as low as a few centimetres in the future. An Australian company called Nearmap are currently attempting to provide high-resolution aerial imagery of Australian cities every month, at 7 centimetre resolution levels.

9.54 Australia has, informally, already started to consider privacy issues from satellite monitoring (possibly because such monitoring is being used for vegetation clearance monitoring and enforcement). A Federal Government agency, Geoscience Australia, asked the Australian Privacy Commissioner about resolution size and whether privacy in the context of satellite monitoring is an issue. The oral response of the Privacy Commissioner was that as long as the pixel size was over 3cm, then monitoring using satellites this way was considered acceptable in Australia. It is unclear what the basis in reaching this 3cm figure was, as it appears to never have been published anywhere. However, if this figure has been, or will be, formalised, it would appear to give the green light to any form of satellite monitoring in Australia, as there are currently no commercial satellites with resolution capabilities anywhere near the 3cm figure.

9.55 The fact that over half those surveyed thought that satellite monitoring raised privacy concerns suggests that there needs to be greater consideration of and public debate over what regulated communities find to be acceptable or intrusive earth observation monitoring now, rather than legislating as a kneejerk reaction later to future step changes. This applies both to Australia and to other countries. At the very least, Governments wishing to use satellite monitoring might have to justify to their citizens why it should be used and also to undertake some form of 'privacy impact assessment', to make sure it does not have any detrimental impact on privacy either for the targeted group or from collateral viewing. Whilst the fact that satellites operate globally,
rather than over individual countries, makes the development of privacy impact assessments complex, there is still potential for similar schemes to operate elsewhere in relation to satellite monitoring.  

Recommendation 18

It would seem beneficial to ensure greater certainty as to what may constitute unacceptable or intrusive earth observation monitoring in advance, rather than after regulatory programmes are developed. Governments wishing to use satellite monitoring should be able to justify to their citizens why it is being used and put measures in place to limit intrusion. For example, there could be some form of government review on acceptable pixel size, or a regulatory impact statement might detail measures taken, to ensure that satellite monitoring is not overly intrusive.

685 A study on the use of ‘privacy impact assessments’ around the world was presented by Professor Colin Bennett of University of Victoria, Canada at the UK Information Commissioners Office (ICO), conference ‘Surveillance Society: Turning Debate into Action in December 2007. See further, <http://www.ico.gov.uk/Home/Global/surveillance_society_conference_details.aspx> last accessed 29 October 2010. The ICO also launched its Privacy Impact Assessment (PIA) handbook (Version 2) in June 2009. The handbook is designed to be a practical and comprehensive guide, aimed at organisations that are developing projects that might have implications for people’s privacy. It will help organisations assess and identify any privacy concerns and address them at an early stage, rather than leaving the solutions to bolt on as an expensive afterthought. See further: <http://www.ico.gov.uk/for_organisations/data_protection/topic_guides/privacy_impact_assessment.aspx> last accessed October 28, 2010.
Chapter Ten
Future monitoring and enforcement applications

Where else has satellite imagery been used in Australia?

What other laws are being monitored by satellites?

10.1 Where satellite monitoring has been used in a legal context in Australia in relation to other legislation, this seems to have been on an ad-hoc basis and there does not presently appear to be any other developed monitoring programmes beyond vegetation clearance. Similarly, there does not seem to be any legislation supporting its use for other forms of compliance monitoring. This ‘ad-hoc’ satellite monitoring by Government agencies appears to have taken place in four main sectors: carbon monitoring,\[686\] water monitoring,\[687\] nature monitoring\[688\] and drugs monitoring.\[689\] There are also some further examples of satellite imagery being used in courts and tribunals in Annex E to this report.

10.2 It would be interesting to note how farmers would react if they knew they were the only group regularly monitored in Australia by satellites. There already appears to be a significant town and country divide in Australia and knowledge of this might drive a wedge further between the two groups if farmers believed that they were being singled out. In practice, it appears that the intention of monitoring by this method is not to single them out per se, but rather this method is used because Australia is such a vast country, and some of the farms are such a large size that it is inevitable that farmers would be subject to this form of spatial regulatory monitoring before other groups. The technology is also not at a technical level yet to identify smaller objects and is well-suited to monitoring land-use change like vegetation clearing.

\[686\] The Commonwealth Government in Australia currently uses data from satellite monitoring for the purpose of a carbon accounting system for Australia. They measure loss of vegetation in relation to their obligations and reporting commitments under the UNFCCC and Kyoto Protocol. Satellite monitoring has also been discussed at Commonwealth Government level as potentially playing a part in a national carbon trading system [Personal Communication].

\[687\] State Governments have been using satellite imagery in some individual enforcement cases concerning water resources. Although there is not a dedicated compliance programme for this application presently, this appears to be gaining interest at State and Commonwealth level. Satellite imagery can show changes in vegetation cover from brown to green and can detect those changes that do not have a water abstraction/irrigation licence, or have taken more water than a licence allows. The South Australian Government utilised satellite imagery in a water prosecution approximately four years ago. An irrigator was taking water illegally and in contravention of his water allocation licence, which allowed the defendants to irrigate an allocated amount per hectare. Satellite images indicated they were irrigating double the area they were permitted to. The defendants were prosecuted in a criminal court and fined $18,000. The Government also took civil action, and obtained restraining orders stopping the defendants from over irrigating the farms are such a large size that it is inevitable that farmers would be subject to this form of spatial regulatory monitoring before other groups. The technology is also not at a technical level yet to identify smaller objects and is well-suited to monitoring land-use change like vegetation clearing.

\[688\] Other earth observation technologies such as monitoring using F1-11 aeroplanes and unmanned aerial vehicles (UAVs) were also being used [Personal Communication]. The Australia Federal Police and some State police forces were said to be using these earth observation technologies [Personal Communication]. States Governments sometimes passed imagery on to the police to investigate if they discovered possible drug growing sites accidentally during their vegetation clearing investigations [Personal Communication]. The satellite imagery could sometimes detect cannabis crops growing under tree canopies by showing changed colours of vegetation and through the signatures of the colour saturations of the trees.
Extending satellite monitoring programmes to other environmental laws in Australia

10.3 Farmers were asked how they would feel if the use of satellite monitoring were extended to monitor compliance with a number of other environmental laws affecting farming.

Extending satellite monitoring to laws on the disposal of waste

10.4 Farmers were first asked to consider monitoring laws on the disposal of agricultural waste (Question twenty six, statement i of the survey). Monitoring is currently carried out by inspections on the ground and could in practice be difficult to police across large areas of land. It is not known whether satellites have the capabilities to monitor all forms of waste disposal in practice, so this question could be purely theoretical, although the farmers did not know this. It is envisaged that larger disposal sites might be detected, but there would be difficulty detecting smaller sites, or those where an offence took place within a covered building.

Graph 27: Satellite monitoring of agricultural waste disposal

10.5 As Graph 27, above, illustrates, survey respondents were generally supportive of the use of satellite monitoring in laws relating to the disposal of agricultural waste. In South Australia, 48.2% of respondents were in favour of satellite monitoring of waste laws; 49% in Queensland; and 57.8% in New South Wales. Approximately a quarter of farmers were neutral when asked to express their opinions, and the least popular response was strongly against.

10.6 Age did not seem to be a factor across the three States. Differences based on farm size were, however, noticeable – with larger farms (those 2,500 hectares or over) less in favour of satellite monitoring than smaller

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farms (South Australia – 50.5% of smaller farms had a positive attitude towards this compared with 44.8% of larger farms; Queensland – 60.5% compared with 43.7%, respectively; New South Wales – 61.3% compared with 53.9%, respectively). New South Wales, in particular, produced a significant number of responses from larger farms that were negative compared to smaller farms. In this State, 38.4% of larger farms were against satellite monitoring to some extent, as compared with only 8.1% of smaller farms.

10.7 In the UK survey, farmers were also asked how they would feel if satellites were used to monitor compliance with laws on the disposal of agricultural waste. This found that 49% of farmers were against this; 26% were in favour; and 23% were neutral. This illustrates that many farmers in Australia seem to be far more accepting of satellite monitoring of waste laws than their UK counterparts.

**Extending satellite monitoring to laws on climate change**

10.8 Farmers were asked how they would feel if the use of satellite monitoring were extended to monitor compliance with climate change legislation (Question twenty six, statement ii of the survey). The results are contained in Graph 28, below.

Graph 28: Satellite monitoring of climate change

<table>
<thead>
<tr>
<th>Q26: Laws on climate change</th>
<th>South Australia (n = 160)</th>
<th>Queensland (n = 150)</th>
<th>New South Wales (n = 100)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly in favour</td>
<td>6.0%</td>
<td>4.7%</td>
<td>6.0%</td>
</tr>
<tr>
<td>In favour</td>
<td>17.3%</td>
<td>21.3%</td>
<td>27.8%</td>
</tr>
<tr>
<td>Neutral</td>
<td>29.3%</td>
<td>31.0%</td>
<td>40.0%</td>
</tr>
<tr>
<td>Against</td>
<td>22.5%</td>
<td>17.0%</td>
<td>24.7%</td>
</tr>
<tr>
<td>Strongly against</td>
<td>9.4%</td>
<td>19.0%</td>
<td>24.0%</td>
</tr>
</tbody>
</table>

10.9 Satellite data is already used by the Commonwealth Government in Australia for the purpose of a carbon accounting system for Australia, although this is in respect of commitments under international law, not domestic laws. Survey responses on the acceptability of satellite monitoring of laws on climate change were noticeably very different from those towards the other environmental laws contained in the survey. A higher number of farmers in each State had a negative attitude to satellite monitoring in this area than those who had a positive attitude. Survey respondents in Queensland were noticeably the most opposed to climate change monitoring using satellites – 48.7% of farmers in this State were opposed in some way. There are a number of explanations for the negative response in this area. Firstly, there is noticeable climate change scepticism amongst rural communities in Australia; quite a number of farmers made comments on the questionnaires that they thought there was no such thing as man-made climate change. A second point is that many Australian farmers see climate change as the main link and trigger for the introduction of land clearing laws, which in turn they believe has cost them money by impinging on the property rights of their own farms.
10.10 Farmers who had cleared vegetation in the last ten years were more likely to be opposed to climate change monitoring using satellites (South Australia – 37.2% who had undertaken some vegetation clearing were opposed, as compared with 30.1% who had not; Queensland – 52.2% compared with 37.1%, respectively; and New South Wales – 40.6% compared with 33.8%, respectively).

10.11 The size of the farm, again, also produced interesting results, with farmers from smaller farms (below 2,500 hectares) more likely to be supportive of satellite monitoring of climate change laws than larger farms. The larger farms were clearly more opposed to monitoring this type of law, and this was most evident in Queensland and New South Wales (New South Wales – 54.1% of larger farms were opposed in some way to satellite monitoring of climate change, as compared with 36.2% of smaller farms; Queensland – 54% compared with 24.2%, respectively).

**Extending satellite monitoring to laws on safe nitrate or pesticide levels**

10.12 Farmers were also asked to give their assessment on whether it was a positive or negative option to extend satellite monitoring to laws on safe nitrate or pesticide levels (Question twenty six, statement iii of the survey). It is not known whether satellites have the capabilities to monitor these in practice, so again this question could be purely theoretical, although the farmers probably did not know this.

Graph 29: Satellite monitoring of laws on nitrate or pesticide levels

10.13 There were very similar results in responses to safe nitrate and pesticide levels as there were for laws on the disposal of agricultural waste. As Graph 29, above, shows, the highest proportion of farmers were in favour to some extent of satellite monitoring in this area (South Australia 50%; Queensland 44.6%; New South Wales 54%). Only approximately one in five of respondents were opposed in some way to satellite monitoring.
being used in this area. Larger farms were again more likely to be against satellite monitoring of laws on safe nitrate or pesticide levels. This was especially so in New South Wales, where 21.1% of farms that were 2,500 hectares or over were strongly against this, as compared with 0% of smaller farms.

10.14 In the UK, survey respondents were similarly asked their opinion on satellite monitoring being extended to monitor laws on the safe nitrate or pesticide levels. A clear majority were against this (48%), 22% were positive, and 26% were neutral in their opinions. Again, this seems to illustrate that Australian farmers are generally more accepting of satellite monitoring than UK farmers.

Extending satellite monitoring to laws on irrigation and water use

10.15 Farmers were also asked for their opinions on using satellites to monitor laws covering water use and irrigation (Question twenty-six, statement iv of the survey). The results are contained in Graph 30, below. As noted (in paragraph 10.1), this form of monitoring has already taken place in some individual enforcement actions within States.

Graph 30: Satellite monitoring of laws on water and irrigation use

10.16 Like the position with respect to agricultural waste and nitrate/pesticide use, the acceptance of satellite monitoring of laws on irrigation and water use was quite high. In South Australia, 68.3% of respondents were in favour to some extent; 38.2%; in Queensland; 65.7% in New South Wales. Farmers in Queensland were the most opposed to satellite monitoring in this area, with 31% of those surveyed having a negative opinion of this as a monitoring application.

10.17 The results with respect to this environmental example were unsurprising, as water use is a politically sensitive topic in Australia because of the country’s climatic and environmental conditions. Important Australian rivers, such as the Murray-Darling Basin, start in Queensland and work their way down through New South Wales reaching South Australia last. Farmers in the lower States, such as New South Wales and South Australia, often complain that water is diverted or over-used in the northern States so not enough reaches them, putting the farms in the northern States like Queensland at a competitive advantage. So it is clear why farmers in Queensland might be more opposed to having their water usage monitored than other States. Therefore, it could be argued that farmers in Queensland are probably not opposed to satellite monitoring per se, but they are more against this specific application of water use being monitored.
10.18 Again, smaller farms (less than 2,500 hectares) were also more likely to be in favour, to some extent, of satellite monitoring in this area than the larger farms (South Australia – 76.1% of small farms supportive, as compared with 59.7% of large farms; Queensland – 45.9% compared with 35.1%, respectively; New South Wales – 68.3% compared with 60.5%, respectively).

10.19 In the UK, 45% of respondents were against extending satellite monitoring to laws on irrigation use, 27% were in favour, and 26% were neutral. Again, there was a reverse of the Australian position and the largest farms were more likely to be in favour of this (63% were in favour, opposed to 25% against). This is another clear example that satellite monitoring is considered more favourably by Australian than UK farmers.

**Extending satellite monitoring to laws on water pollution**

10.20 Respondents to the survey were also asked to give their opinions on satellite monitoring of laws on water pollution (Question twenty six, statement v of the survey). My interviews in Australia revealed that satellite monitoring had been used in one Government investigation concerning an oil pollution incident, but there did not appear to be any other instances where it had been used by regulators in this context. It is, therefore, not known whether satellites have the capabilities to monitor all forms of water pollution in practice, so this question once more could be purely theoretical, although the farmers probably did not know this. The results to this are contained in Graph 31, below.

Graph 31: Satellite monitoring of water pollution laws

<table>
<thead>
<tr>
<th></th>
<th>South Australia (n = 161)</th>
<th>Queensland (n = 152)</th>
<th>New South Wales (n = 103)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Strongly in favour</strong></td>
<td>18.2%</td>
<td>19.4%</td>
<td>21.7%</td>
</tr>
<tr>
<td><strong>In favour</strong></td>
<td></td>
<td>43.4%</td>
<td>55.0%</td>
</tr>
<tr>
<td><strong>Neutral</strong></td>
<td></td>
<td>25.0%</td>
<td>53.4%</td>
</tr>
<tr>
<td><strong>Against</strong></td>
<td>6.8%</td>
<td>7.8%</td>
<td></td>
</tr>
<tr>
<td><strong>Strongly against</strong></td>
<td>4.3%</td>
<td>7.9%</td>
<td>6.8%</td>
</tr>
</tbody>
</table>

10.21 Monitoring water pollution laws with satellites was the most supported environmental application by Australian farmers in this survey (South Australia – 77.6% of farmers were in favour, to some extent, of satellite monitoring of water pollution; 56.6% in Queensland; 72.8% in New South Wales – 72.8%). It is assumed that more farmers supported this more than any other application because it could directly affect them – water is used to irrigate crops and feed livestock, and could cause damage if polluted. Again, though, it was the bigger farms that were more strongly against satellite monitoring for this application than the smaller farms.

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144

Centre for Law and the Environment, UCL (2010)
Extending satellite monitoring to laws on nature conservation

10.22 Respondents were also asked to give their opinions on satellite monitoring of laws on nature conservation (Question twenty six, statement vi of the survey). There have already been a number of enforcement actions where satellite imagery has been used as evidence to show changes in protected sites (see paragraph 10.1). These appear to have been in individual cases, rather than any dedicated monitoring programme. The results to this are contained in Graph 32 below.

Graph 32: Satellite monitoring of nature conservation laws

10.23 The most popular response of farmers to this question was to choose the neutral option. However, more farmers were in favour to some extent of satellite monitoring in this area than were opposed. The size of the farm was also a factor again (South Australia – 57% of smaller farms were in favour, to some extent, of satellite monitoring being used in nature conservation laws, as opposed to 35.4% of larger farms in favour; Queensland – 44.6% compared with 28.8%, respectively; New South Wales – 48.4% compared with 34.2%, respectively).

10.24 There were some notable differences between the results of this question in the UK survey when compared to the Australian survey. In the UK survey, slightly more respondents were in favour (41%) of monitoring by satellite in this area than in Australia. This was the only environmental application where satellite monitoring was more popular with the UK than Australian farmers. The larger farms in Britain (those in the largest farm size category) were also most likely to be in favour of satellite monitoring than the smaller ones, which was opposite to the situation in Australia.

What farmers wanted if satellite monitoring was increased

10.25 Respondents were asked to rate a number of statements on what was important or unimportant to them if the use of satellites to monitor environmental and agricultural laws was to increase.
That it should cut bureaucracy

10.26 The first statement they were asked to consider was whether satellite data should be shared between regulators to cut bureaucracy (Question twenty seven, statement i of the survey). Graph 33, below contains the results to this question.

Graph 33: Sharing of satellite data to cut bureaucracy

<p>| Q27: ‘Any satellite data should be shared between regulators to cut bureaucracy.’ |</p>
<table>
<thead>
<tr>
<th>South Australia (n = 157)</th>
<th>Queensland (n = 152)</th>
<th>New South Wales (n = 103)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very important</td>
<td>26.1%</td>
<td>46.5%</td>
</tr>
<tr>
<td>Important</td>
<td>23.7%</td>
<td>45.4%</td>
</tr>
<tr>
<td>No opinion either way</td>
<td>21.7%</td>
<td>21.7%</td>
</tr>
<tr>
<td>Unimportant</td>
<td>6.6%</td>
<td>1.9%</td>
</tr>
<tr>
<td>Very unimportant</td>
<td>1.3%</td>
<td>2.9%</td>
</tr>
</tbody>
</table>

10.27 Over two thirds of respondents thought it important or very important that any satellite data should be shared between regulators to cut bureaucracy (South Australia – 72.6% said this was important to some extent; Queensland – 69.1%; New South Wales – 77.7%). Farmers in the over-55 category were more likely to find this important (South Australia – 82% of older farmers thought that this was important, as compared with 65.5% of younger farmers; Queensland – 74.1% compared with 62.1%, respectively; New South Wales – 80.3% compared with 75.7%, respectively). Very few farmers in each State thought that it was unimportant, or very unimportant, that the use of satellite data might cut bureaucracy. However, those that did think it unimportant, to some extent, tended to be opposed to this because they considered the sharing of data to increase the possibility of data protection or privacy abuses.

Comment Box 43.

My main concern is that personal privacy will eventually be affected if satellite imagery is used by too many departments/people.

Farmer in South Australia [Respondent ID Pa100]

A reduction in ground inspections

10.28 Respondents were asked if they thought it important that the use of satellites should be accompanied by a reduction in monitoring by ground inspections (Question twenty seven, statement ii). The largest proportion of people surveyed believed that it was important or very important to see a reduction in ground inspections if satellite monitoring was undertaken (South Australia – 49.6%; Queensland – 35.3%; New South Wales –
53.4%). As can be seen from Graph 34, below, Queensland, was the State with the highest proportion of farmers who thought this was unimportant or very unimportant, with a third of farmers answering this way.

Graph 34: Reductions in ground based monitoring

Q27: *The use of satellites must be accompanied by a reduction in monitoring by ground inspections.*

<table>
<thead>
<tr>
<th></th>
<th>South Australia (n = 157)</th>
<th>Queensland (n = 150)</th>
<th>New South Wales (n = 103)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very important</td>
<td>9.3%</td>
<td>13.6%</td>
<td>12.7%</td>
</tr>
<tr>
<td>Important</td>
<td>26.0%</td>
<td>39.0%</td>
<td>36.9%</td>
</tr>
<tr>
<td>No opinion either way</td>
<td>31.3%</td>
<td>29.1%</td>
<td>39.5%</td>
</tr>
<tr>
<td>Unimportant</td>
<td>5.1%</td>
<td>11.7%</td>
<td>20.0%</td>
</tr>
<tr>
<td>Very unimportant</td>
<td>5.8%</td>
<td>13.3%</td>
<td>13.3%</td>
</tr>
</tbody>
</table>

10.29 Interestingly, a reduction in ground inspections as a trade-off with satellite monitoring was considered more important in the UK, where 63% of farmers thought it important, 10% were neutral in their opinion, and only 21% thought it unimportant. In practice, State Governments are conducting fewer ground inspections because of satellite monitoring. Most only respond to incidents of potential vegetation clearing that they have been alerted to by satellite monitoring, or through public tip-offs. Therefore, Government could emphasise to farmers that satellite monitoring is *leaving them alone more*, and is less of a burden to them, than on-site inspections, because they are being subject to enforcement at a distance. On-site visits could mean that farmers are tied up for hours or even days, showing the inspector around the land and responding to investigative questions. Satellite monitoring will usually mean that only landholdings where suspected breaches have taken place will be followed up with on-the-ground inspections.

**Access to the satellite imagery**

10.30 Farmers were also asked whether they thought they should have free access to the satellite pictures used by Government (Question twenty seven, statement iii of the survey). The results to this question, contained in Graph 35, below, are unsurprising. It is easy to see why farmers would like free access to the imagery. One in five farms surveyed already purchased their own satellite imagery for farm management, so it would seem beneficial to them and many others to obtain free access to imagery.

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692 Personal Communication.
Graph 35: Access to satellite pictures

Q27: ‘Farmers must be able to have free access to the satellite pictures.’

<table>
<thead>
<tr>
<th>State</th>
<th>Very important</th>
<th>Important</th>
<th>No opinion either way</th>
<th>Unimportant</th>
<th>Very unimportant</th>
</tr>
</thead>
<tbody>
<tr>
<td>South Australia (n = 162)</td>
<td>62.3%</td>
<td>59.2%</td>
<td>4.9%</td>
<td>0.6%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Queensland (n = 155)</td>
<td>75.5%</td>
<td>32.1%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>New South Wales (n = 103)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

10.31 The respondents to this statement in the survey were all thinking along the same lines, regardless of age or farm size, with over 90% of respondents in each State finding it important or very important to have access to imagery (South Australia – 94.4% of respondents thought this was important or very important; Queensland – 99.4%; New South Wales – 94.2%).

10.32 The survey results to this question in Australia were nearly identical to the results from the UK survey, where 94% of farmers wanted to be able to have free access to satellite images.

10.33 Some countries, such as Spain, do allow farmers regular access to earth observation data accessible online or in Government offices. However, this is quite unique and this data is often from aerial photography, not satellite image. Whether Government-purchased imagery can be accessible to farmers in the future in Australia is not known.

Comment Box 44.

*If satellite technology is used responsibly in consultation with farmers, and not used as weapons against them, I can’t see any problem.*

Farmer in South Australia [Respondent ID Pa137]

Comment Box 45.

*Agriculture in Australia needs to be able to trust that this process is a bi-lateral partnership aimed at long term agricultural sustainability – both economically and environmentally.*

Farmer in Queensland [Respondent ID Pa174]

10.34 Farmers would support increased access to satellite imagery because they could potentially use it for their farms. However, making imagery available to farmers could also have significant resource implications for

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Government, especially if they had to pay extra for it, and it would probably require prior authorisation under the contract of sale if it was made readily available directly to farmers.

Data information security

10.35 Respondents were asked if they thought it important that assurances be given with regard to data information security (Question twenty seven, statement iv of the survey). Again, as Graph 36, below, demonstrates, this question received a lot of responses in favour of some form of information security assurances being given (South Australia – 93.2% of respondents said it was important or very important; Queensland – 89.7% thought it important or very important; New South Wales – 95.2% thought it important or very important). Larger farms (those 2,500 hectares or more) were more likely to think that information security was very important as compared with smaller farms.

Graph 36: Data information security

10.36 It is clear that some of the information contained in satellite data used for monitoring vegetation clearing will already be in the public domain (for example, from GoogleEarth). However, a large number of farmers were concerned with information security and made comments about this on the survey form. There seemed to be some mistrust concerning Governments and what they would do with the information collected.

Comment Box 46.

*The use of material gathered by satellites is too readily available to extreme green groups who misuse the material.*

Farmer in New South Wales [Respondent ID Pa333]

Comment Box 47.

*Gives the monitors too much power which they use. Like a control freak with a remote TV control.*

Farmer in South Australia [Respondent ID Pa015]
Comment Box 48.

**Satellites are just another tool that someone will misuse despite all assurances of security. We have been promised security so often in the past and it has been ineffective in almost every case.**

Farmer in South Australia [Respondent ID Pa110]

10.37 Regulated communities might be far more accepting of these technologies if they are given some assurances about how the data is used and stored. Governments wishing to undertake monitoring could develop codes of practice and conduct in this regard to satisfy some of these data protection concerns. Such codes could enable clear restrictions on who handles collected data, who has access to the data, whether it can be sold to third parties and whether the data can be made public on the internet. Codes would not cost much money to implement and update. If codes of practice were discussed between Government and farming groups, and any conclusions made publicly accessible this might give some legitimacy to trust in the process.

**Protection in court in case of abuse of satellite data**

10.38 Farmers were asked in the survey whether they thought it was important to have protection in the courts in case there was abuse of this satellite data (Question twenty seven, statement v of the survey). ‘Abuse’ was not defined, but was taken to mean Government using the data in a dishonest or illegal manner. The results to this question are contained in Graph 37 below.

Graph 37: Protection in courts in case of abuse of satellite data

- **Q27: ‘There should be protection in the courts in case there is abuse of this satellite data.’**
  - South Australia (n = 160)
  - Queensland (n = 153)
  - New South Wales (n = 105)

<table>
<thead>
<tr>
<th>Level</th>
<th>South Australia</th>
<th>Queensland</th>
<th>New South Wales</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very important</td>
<td>65.0%</td>
<td>70.6%</td>
<td>72.4%</td>
</tr>
<tr>
<td>Important</td>
<td>30.6%</td>
<td>22.9%</td>
<td>23.8%</td>
</tr>
<tr>
<td>No opinion either way</td>
<td>3.8%</td>
<td>5.2%</td>
<td>2.9%</td>
</tr>
<tr>
<td>Unimportant</td>
<td>0.0%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Very unimportant</td>
<td>0.6%</td>
<td>1.3%</td>
<td>1.0%</td>
</tr>
</tbody>
</table>

10.39 Over 90% of farmers surveyed wanted to see protection in the courts in case those using satellite data abused their position (South Australia – 95.6% of farmers thought this to be important or very important; Queensland – 93.5%; New South Wales – 96.2%).
10.40 Some farmers felt that there was no currently no redress against ‘false accusations’. Presumably, some of the ‘false accusations’ are because inspectors might question them about something the satellite has picked up that might have occurred on their land. Whilst this might be uncomfortable or annoying to some farmers, it is a natural part of an investigation, and farmers should be given a chance to give their side of the story to investigators before any formal charge is levied. If due process is not used, or if there has been an abuse of powers, then there are already certain safeguards in place in Australia, such as access to judicial review in certain circumstances (although this might not be financially possible or readily available to all farmers).

**That it should result in savings to the taxpayer**

10.41 Respondents were also asked if they thought that the use of satellites should result in savings to the taxpayer (Question twenty seven, statement vi of the survey).

10.42 An issue with this statement was its interpretation by respondents. It is possible that most farmers would interpret this as suggesting that satellites should only be used when their use resulted in financial savings. Others might, however, have interpreted the statement as asking them whether they agree that the method of monitoring itself is cheaper. The results from the question are contained in Graph 38 below.

Graph 38: Savings to taxpayers

| Q27: ‘The use of satellites should result in savings to the taxpayer.’ |
|---|---|
| Very important | South Australia (n = 159) | Queensland (n = 152) | New South Wales (n = 103) |
| Important | 39.0% | 36.8% | 38.0% |
| No opinion either way | 20.8% | 16.5% | 31.2% |
| Unimportant | 0.6% | 4.6% | 0.9% |
| Very unimportant | 0.6% | 2.6% | 1.9% |

10.43 Savings to taxpayers were considered important or very important by a high proportion of farmers (South Australia – 78% of farmers answered that this was important or very important; Queensland – 71% thought it was important to some extent; New South Wales – 76.7% thought it was important to some extent).
Recommendation 19

Regulated communities are more likely to accept or welcome satellite monitoring if there is some corresponding benefit. It is recommended that Government consider ways of making satellite data available for regulated communities to use or offer reductions in ground-based inspections in return for being monitored this way. Offering a ‘partnership’ approach in regulatory programmes where satellite technologies are used should be encouraged wherever possible.

More Information supplied by government

10.44 Chapter eight considered the responses of farmers when asked about their awareness of satellite monitoring of vegetation clearing. A key conclusion of that chapter was that there was a lack of communication between the regulators and regulatees. Connected to this was whether the respondents themselves felt that they had been given enough information on this subject by Government (Question twenty-three, statement iv of the survey). It is clear from Graph 39, below, that only a very small number of respondents in each State thought they had been given enough information on this subject by Government (South Australia 12.5%; Queensland 9.8%; New South Wales 11.4%). Over two thirds of the farmers surveyed did not think that they had received enough information.

Graph 39: Information supplied by government

Q23: ‘I have been given enough information on this subject by Government.’

- South Australia (n = 160)
- Queensland (n = 153)
- New South Wales (n = 105)

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<td>Strongly agree</td>
<td>1.9%</td>
<td>1.5%</td>
<td>1.9%</td>
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<tr>
<td>Agree</td>
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<td>42.5%</td>
<td>43.8%</td>
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<tr>
<td>Strongly disagree</td>
<td></td>
<td>21.9%</td>
<td>29.4%</td>
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Comment Box 50.

There should be more publication and information readily available about this whole issue.

Farmer in South Australia [Respondent ID Pa139]

10.45 It is clear that efforts have been made by Government to communicate information on satellite monitoring through web sites, publications, contact with farming bodies and organised speaking events.
However, this does not appear either to have been totally successful or to have communicated the information that interests the farmers. A Government official interviewed recognised that there had been not enough information supplied by his State Government to farmers: ‘If you were a farmer wanting an idea on what monitoring is taking place then you would be frustrated.’

Recommendation 20

It is recommended that regulators wishing to undertake a satellite monitoring programme should aim to create good channels of information between themselves and regulated communities. Many farmers are, in part, supportive of satellite monitoring, but a significant number do not feel that they know enough on the subject, and would like further information. Support for the technology could increase if efforts are made to communicate to the regulated community what satellite monitoring entails, how it is done and, importantly, the reasons behind it.

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694 Personal Communication.
Summary of key recommendations

**Recommendation 1**

Sourcing and getting access to satellite data is a major challenge without technical support. Satellite providers should look at providing better support and communication networks to Government. This could enable Government to see the possibilities that exist in a monitoring and evidential context and help them get the information that suits their needs. The introduction of a common database that could be used by non-technical laypeople, and which offered a simple search facility of databases where archived satellite imagery is held, is recommended.

**Recommendation 2**

Purchasing satellite data is more cost-effective if it can be used by others, or used for multiple purposes (subject to the relevant licensing authorisation). Governments should actively seek out these alternative uses. Government bodies considering purchasing data for monitoring programmes are recommended to establish a coordination body to champion and support activities where such images might be used elsewhere in their organisation.

**Recommendation 3**

There should be cataloguing of imagery holdings within Government to avoid purchasing the same, or similar, data repeatedly. It is recommended that if different Government departments purchase satellite imagery, then this should be coordinated through a single body. This would provide increased negotiation power and afford the opportunity for discounts when purchasing imagery in bulk.

**Recommendation 4**

Purchasing the satellite data is not the only significant expense in establishing a satellite monitoring programme. Work is required to design a programme methodology; source imagery and arrange contracts; buy computers and data storage facilities; and to employ analysts and train them. This can take a long time and cost significant sums of money. It is recommended that those considering using this technology in a regulatory context should endeavour to consider these costs in detail (with a view to avoiding under-budgeting) and do so in advance.

**Recommendation 5**

Governments should, as far as possible, consider keeping the vendor and satellite platform independent, in order to avoid dependence on a single satellite product. Although this might have cost implications, flexibility is needed to continue regulatory strategies. If only one satellite is used, there is always a danger that regulators could be left high and dry if something happens to that satellite. It is recommended that those wishing to use such technologies consider alternative strategies, such as using data from different satellites, in advance.
Recommendation 6

To assist in evidentiary support, a provision containing an evidential presumption could be introduced in legislation where satellite technologies are used in a monitoring programme. Placing the burden of proving incorrect functioning of equipment, and full disclosure of the grounds for any challenges to satellite evidence, on the other side would create fewer opportunities for spurious challenges by the defence. This could save the regulator and court time and resources.

Recommendation 7

Those using imagery in a regulatory context should check to see if there are limitation periods in the law they plan to monitor. Monitoring some laws could require comparison of imagery over several years, and it can be a slow process before a case is investigated on the ground and then brought to court. These issues, coupled with unfavourable limitation periods, could pose barriers to successful prosecutions. In certain circumstances, Governments may wish to consider extending time periods to better support the use of satellite evidence.

Recommendation 8

Use of satellite technologies could cause a substantial increase in the number of offences detected, requiring enhanced funding and resourcing in relevant departments. This could result in more money being required, as more staff would be needed to manage the increased caseload. The introduction of satellite monitoring into regulatory regimes does not solve all of a department's resource difficulties, and in fact in the short-term it can impose increased financial and resource pressures. It is, therefore, recommended that such an outcome be considered in development of strategies.

Recommendation 9

Satellite monitoring programmes require a far more strategic regulatory approach than conventional land-based approaches. Lawyers, scientists and investigators would be required to work together as a team. Regulatory agencies must, from the beginning of adopting a satellite monitoring programme, collectively understand their overall delivery aims, their individual roles within the programme, and how these varying Government functions will interact and work together. There should be dedicated personnel in each of the interdisciplinary groups appointed to work closely together and to provide communication and liaison between different arms of Government. Regular meetings, training events and published guidance should also be undertaken to foster interdisciplinary understanding and cooperation.

Recommendation 10

Evidence from satellite technologies does not appear to have reached a stage yet where it should be used alone as evidence. It is recommended that, wherever possible, it should always be accompanied by other forms of corroborating evidence, such as witness statements from ground inspections, so as to give a young technology more credibility in the eyes of the judiciary and the public.
**Recommendation 11**

It would seem sensible for national bodies, such as Geoscience Australia and Standards Australia, to work together in order to develop national standards or codes of practice, dealing specifically with using satellite imagery in a legal context. It is further recommended that Governments should liaise with the International Organization for Standardization, in seeking to develop an international best practice scheme in this area.

**Recommendation 12**

The impact of satellite monitoring is extremely difficult to measure. The evidence available so far from Australia suggests that it has probably improved compliance. However, satellite monitoring does not produce instantly quantifiable results and it is a little early to reach a conclusion either way. Compliance research should, therefore, be revisited in five years time, to see if there are any clearer indicators that satellite monitoring has had a major compliance impact effect in Australia.

**Recommendation 13**

A further recommendation would be for international or regional initiatives like the Global Earth Observation System (GEOSS) and Global Monitoring for Environmental Security (GMES), or even the European Environment Agency, to begin to record instances of satellites being used in a compliance context. One of these bodies should take ownership of collecting data from other jurisdictions to share and educate. The data could be used and compared by regulatory bodies within the European Union or other jurisdictions that might wish to incorporate satellite monitoring into regulatory programmes.

**Recommendation 14**

If a satellite monitoring programme is undertaken, it is clearly in the interest of Government to let those who may be monitored know that this is happening. Knowledge of monitoring on the part of regulated communities is likely to alter their behaviour, potentially towards enhanced compliance. Any monitoring programme should be accompanied by a strong information dissemination strategy.

**Recommendation 15**

Regulated communities were in general more supportive of satellite technologies being used if they considered this offered a fairer, more equitable and more consistent form of monitoring than by other available methods. Governments wishing to use satellite technologies in a regulatory/legal process should emphasise these benefits when introducing such a monitoring programme.
**Recommendation 16**

For there to be confidence in this form of monitoring, the farmers have to trust that the satellite imagery is interpreted correctly. The satellite image will nearly always be accurate; it is the human element (i.e. how the image is processed, interpreted and secured) that can cause problems. Following best practice procedures on data handling and security could increase reliability and trustworthiness. In order to establish confidence in the technology it would be advisable for information management procedures to be introduced and followed by Government, and that these are made publicly available.

**Recommendation 17**

Governments wishing to use satellite monitoring in regulatory programmes should consider incorporating a provision expressly mentioning the use of these technologies in legislation. Although this might not be strictly necessary in a legal context, it could guard against challenges to admissibility, potentially under privacy legislation.

**Recommendation 18**

It would seem beneficial to ensure greater certainty as to what may constitute unacceptable or intrusive earth observation monitoring in advance, rather than after regulatory programmes are developed. Governments wishing to use satellite monitoring should be able to justify to their citizens why it is being used and put measures in place to limit intrusion. For example, there could be some form of government review on acceptable pixel size, or a regulatory impact statement might detail measures taken, to ensure that satellite monitoring is not overly intrusive.

**Recommendation 19**

Regulated communities are more likely to accept or welcome satellite monitoring if there is some corresponding benefit. It is recommended that Government consider ways of making satellite data available for regulated communities to use or offer reductions in ground-based inspections in return for being monitored this way. Offering a ‘partnership’ approach in regulatory programmes where satellite technologies are used should be encouraged wherever possible.

**Recommendation 20**

It is recommended that regulators wishing to undertake a satellite monitoring programme should aim to create good channels of information between themselves and regulated communities. Many farmers are, in part, supportive of satellite monitoring, but a significant number do not feel that they know enough on the subject, and would like further information. Support for the technology could increase if efforts are made to communicate to the regulated community what satellite monitoring entails, how it is done and, importantly, the reasons behind it.
Annex A
Project sponsor and members of the advisory board

Project Sponsor

This study was funded between April 2009 and September 2010 by a United Kingdom funding body, the Economic and Social Research Council (ESRC). The ESRC funds research and training in social and economic issues and has an international reputation, both for providing high-quality research on issues of importance to business, the public sector and government, as well as training world-class social scientists. The ESRC grant award reference is RES-062-23-1865.

I am extremely grateful to the ESRC for awarding me this grant and funding this project and research report.

Advisory Board

An Advisory Board, to whom I extend my gratitude, provided advice and assistance during the course of the study. However, the research was carried out by myself, and any views expressed are not intended to represent the collective or individual view of any person or organisation other than the author, except where explicitly mentioned.

All members of the Advisory Board acted in a personal capacity and this report therefore does not purport to represent the views of any specific organisation with which they are associated.

• Professor Ray Harris, Emeritus Professor of Geography, University College London.
• Dr. Simon Kay, European Commission Joint Research Centre.
• Professor Richard Macrory QC, Barrister and Professor of Environmental Law, University College London.
• Tanja Masson-Zwaan, President, International Institute of Space Law and Deputy Director, International Institute of Air and Space Law, University of Leiden.
• Jonathan Robinson, Director of Legal Services, Environment Agency.
• Dr. Andy Shaw, Director of Knowledge Exchange, NERC National Centre for Earth Observation, University of Reading.
• David Stott, Chief Prosecutor, Environment Agency.
• Professor Maureen Williams, Chair, Space Law Committee of the International Law Association and Professor of International Law, University of Buenos Aires.
• Professor Frans von der Dunk, Othmer Professor of Space Law, University of Nebraska-Lincoln and Director of Black Holes.
• Joanne Wheeler, Partner, CMS Cameron McKenna LLP.
Annex B
Interviewees

The following organisations/individuals were consulted/interviewed as part of this research:

- The Australasian Environmental Law Enforcement and Regulators neTwork (AELERT), Australian Capital Territory.
- AgForce, Queensland.
- Alan Macsporran SC, Queensland Bar.
- Attorney-General's Department, Government of South Australia.
- Australian Farm Institute, New South Wales.
- Australian Institute of Criminology, Commonwealth Government, Australian Capital Territory.
- Australian National University, Australian Capital Territory.
- Blake Dawson, Sydney, New South Wales.
- Brisbane City Council, Queensland.
- Canegrowers, Queensland.
- Charles Mason, Queensland.
- Colin Nicol, Western Australia.
- Department of Environment, Climate Change and Water, Government of New South Wales.
- Department for Water, Government of South Australia.
- Department of Environment and Natural Resources, Government of South Australia.
- Environmental Defender's Office, New South Wales.
- Environmental Defender's Office, Queensland.
- Environmental Defender's Office, South Australia.
- Environmental Protection Authority, Government of South Australia.
- Geoscience Australia, Commonwealth Government, Australian Capital Territory.
- His Honour Justice Brian Preston, Chief Judge, Land and Environment Court of New South Wales.
- Her Honour Christine Trenorden, The Senior Judge, Environment, Resources and Development Court, South Australia.
- Her Honour Judge Julie Dick, District Court of Queensland.
- His Honour Judge Rackemann, District Court of Queensland, Planning and Environment Court of Queensland.
- His Honour Judge Marshall Irwin, District Court of Queensland.
- Judicial Commission of New South Wales, New South Wales.
- Meat & Livestock Australia, Brisbane, Queensland.
- National Farmers' Federation, Australian Capital Territory.
- Natural Resources Management Council, Government of South Australia.
- New South Wales Farmers Association.
- Philip Sheridan, Queensland Bar.
- PricewaterhouseCoopers Australia, New South Wales.
- Queensland Farmers’ Federation.
- Roads and Traffic Authority, New South Wales.
- South Australian Farmers Federation.
- The Sydney Morning Herald Newspaper, New South Wales.
- University of Queensland.
- University of South Australia.
- University of Southern Queensland.
- University of New England, New South Wales.
- Wentworth Group of Concerned Scientists, New South Wales.
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<td>Duffy, M.</td>
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Annex D
Key Australian legislation relevant to satellite monitoring

Queensland Legislation

Vegetation Management Act 1999 (Queensland)\textsuperscript{695}

\textbf{s66A Instruments, equipment and installations}\textsuperscript{696}

(1) An instrument, equipment or installation prescribed under a regulation that is used in accordance with any conditions prescribed under a regulation is taken, in the absence of evidence to the contrary—
(a) to be accurate and precise; and
(b) to have been used by an appropriately qualified person.
(2) A party to the proceeding intending to challenge a matter mentioned in subsection (1)(a) or (b) must give each other party notice of the party’s intention to adduce relevant evidence at least 20 business days before the evidence is adduced.
(3) The notice must state the grounds on which the party intends to rely to prove that the instrument, equipment or installation—
(a) was not accurate or precise; or
(b) was not used by an appropriately qualified person.

\textbf{s66B Certificate or report about remotely sensed image}\textsuperscript{697}

(1) A signature on a certificate or report purporting to be the signature of an appropriately qualified person who gave the certificate or report is evidence of the signature it purports to be.
(2) A statement of any of the following matters in the certificate or report is evidence of the matters stated in the absence of evidence to the contrary—
(a) the person’s qualifications;
(b) a stated document is a remotely sensed image, or a copy of a remotely sensed image, of a stated area;
(c) the date on which a stated remotely sensed image was produced;
(d) the person’s stated conclusions drawn from a stated remotely sensed image;
(e) the location of a stated area;
(f) whether vegetation in a stated area has been cleared;
(g) whether a stated area is or is likely to be an area of remnant vegetation or regulated regrowth vegetation.
(3) A party to the proceeding intending to challenge the statement must give each other party notice of the party’s intention to adduce relevant evidence at least 20 business days before the evidence is adduced.
(4) The notice must state the grounds on which the party intends to rely to prove that the statement was not correct.

\textbf{s68 Summary proceedings for offences}\textsuperscript{698}

(1) A proceeding for an offence against this Act, or for a vegetation clearing offence, must be taken in a summary way under the Justices Act 1886.
(2) Subject to subsection (4), a proceeding for an offence against this Act must start—
(a) within 1 year after the commission of the offence; or
(b) within 1 year after the offence comes to the complainant’s knowledge, but within 5 years after the offence is committed.
(3) Despite the Planning Act, and subject to subsection (4), a proceeding for a vegetation clearing offence must start—
(a) within 1 year after the commission of the offence; or
(b) within 1 year after the offence comes to the complainant’s knowledge, but within 5 years after the offence is committed.
(4) If a Magistrates’ Court considers it just and equitable in the circumstances, the court may, at any time, extend a time set under this section.
(5) Subsection (4)—
(a) applies to an offence regardless of whether it was committed before or after the commencement of the subsection; and

\textsuperscript{695} effective on 26 March 2010.
\textsuperscript{696} ins 2003 No. 10 s 70; amd 2009 No. 43 s 39.
\textsuperscript{697} ins 2003 No. 10 s 70; amd 2009 No. 43 s 40(1) (retro), (2)–(3).
\textsuperscript{698} amd 2003 No. 10 ss 73, 76 sch.
(b) does not apply to an offence if the time for starting a proceeding for the offence had expired before the commencement of the subsection.

(6) A vegetation clearing offence does not come to the complainant's knowledge merely because the complainant receives a remotely sensed image that may provide evidence of the offence.

s68C Recovery of costs of investigation

(1) If a court convicts a person of an offence against this Act or a vegetation clearing offence, the court may order the person to pay the department's reasonable costs of investigating the offence, including reasonable costs of preparing for the prosecution of the offence.

*Examples of reasonable costs*—
1 obtaining and analysing remotely sensed images
2 costs of travelling for departmental officers and experts

(2) Subsection (1) does not limit the orders for costs the court may make.

### Vegetation Management Regulation 2000 (Queensland)

#### s1A Definitions

*image base* means an image or mosaic of images, for example an aerial photograph or a satellite image.

#### s3 Matters prescribed for property vegetation management plan

(5) The location and extent of the area proposed to be cleared must be shown by—
(a) a map showing—
(i) the boundary of the area on an image base; and
(ii) 5 or more points visible in the image base that correspond to identifiable fixed features; and
(iii) the Map Grid of Australia 1994 coordinates and zone references for each point, acquired by GPS or similar system of satellites that receives and processes information; and
(iv) a description of the feature that each point represents; or
(b) a description of the boundary of the area by reference to Map Grid of Australia 1994 coordinates and zone references for the area.

### Land Act 1994 (Queensland)

#### s431D Instruments, equipment and installations

(1) An instrument, equipment or installation prescribed under a regulation that is used in accordance with any conditions prescribed under a regulation is taken, in the absence of evidence to the contrary—
(a) to be accurate and precise; and
(b) to have been used by an appropriately qualified person.

(2) A party to the proceeding intending to challenge a matter mentioned in subsection (1)(a) or (b), must give at least 28 day's notice of the party's intention to adduce relevant evidence.

#### s431E Certificate or report about remotely sensed image

(1) A signature on a certificate or report purporting to be the signature of an appropriately qualified person who gave the certificate or report is evidence of the signature it purports to be.

(2) A statement of any of the following matters in the certificate or report is evidence of the matters stated in the absence of evidence to the contrary—
(a) the person's qualifications;
(b) a stated document is a remotely sensed image, or a copy of a remotely sensed image, of a stated area;
(c) the date on which a stated remotely sensed image was produced;
(d) the person's stated conclusions drawn from a stated remotely sensed image;
(e) the location of a stated area;
(g) whether a stated area is or is likely to be an area of remnant vegetation.

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699 ins 2003 No. 10 s 74.
700 effective on 18 December 2009.
702 sub 2004 SL No. 63 s15; amd 2009 SL No. 245 s6.
703 effective on 1 July 2010.
704 ins 2003 SL No.10 s27.
705 ins 2003 No. 10 s 27; amd 2004 No.1 s44(1) sch 1.
(3) A party to the proceeding intending to challenge the statement must give at least 28 day’s notice of the party’s intention to adduce relevant evidence.

(4) In this section—
remnant vegetation means remnant vegetation within the meaning of the Vegetation Management Act.

s431H Limitation on time for starting offence proceedings
A proceeding for an offence against this Act must start within—
(a) 1 year after the offence is committed; or
(b) 1 year after the offence comes to the complainant’s knowledge, but within 5 years after the offence is committed.

s431L Recovery of costs of investigation
(1) If a court convicts a person of an offence against this Act, the court may order the person to pay the department’s reasonable costs of investigating the offence, including reasonable costs of preparing for the prosecution of the offence.
Examples of reasonable costs—
1 obtaining and analysing remotely sensed images
2 costs of travelling for departmental officers and experts
(2) This section does not limit the orders for costs the court may make.

Schedule 6
image base means an image or mosaic of images, including, for example an aerial photograph or a satellite image.

required particulars, for a map of a future conservation area or a part of lease land, means—
(a) the boundary of the area or part on an image base; and
(b) 5 or more points visible in the image base that correspond to identifiable fixed features; and
(c) the Map Grid of Australia 1994 coordinates and zone references for each point, acquired by GPS or similar system of satellites that receives and processes information; and
(d) a description of the feature that each point represents.

Survey and Mapping Infrastructure Act 2003 (Queensland)

s3 Purposes of Act
(1) The main purposes of this Act are to provide for the following—
(a) developing, maintaining and improving the State survey and mapping infrastructure;
(b) maintaining and improving cadastral boundaries throughout the State and information held by the department about the boundaries;
(c) coordinating and integrating survey and mapping information;
(d) improving public access to survey and mapping information;
(e) defining administrative areas, and describing and working out administrative area boundaries.
(2) The purposes are to be achieved mainly by providing for the following—
(a) the making of standards and guidelines for achieving an acceptable level of survey quality;
(b) the obligations and powers of persons carrying out surveys;
(c) the establishment and maintenance of recognised permanent survey marks;
(d) the recording of survey and mapping information, including the establishment of the following State datasets —
(i) the administrative area boundary dataset;
(ii) the State remotely sensed image library;
(iii) the State digital cadastral dataset;
(iv) the survey control register.

s50 State remotely sensed image library
The chief executive must keep a library (the State remotely sensed image library) containing the remotely sensed images of land and coastal waters of the State the chief executive

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706 (prev s 446) amd 2003 No. 10 s 28(1)–(3); renum and reloc 2003 No. 10 s 28(4) amd 2004 No. 1 s 44(1) sch 1.
707 ins 2003 No. 10 s 27.
708 ins 2007 No. 19 s 203(2).
709 effective on 7 May 2010.
considers are of value for—
(a) a survey and mapping infrastructure purpose; or
(b) defining an administrative area, or describing or working out an administrative area boundary.

131 Evidentiary provisions about State remotely sensed image 710

(1) This section applies to any proceeding.
(2) A certificate, purporting to be signed by the chief executive or by a person authorised by the chief executive, and stating any of the following matters about a State remotely sensed image of land or coastal waters accompanying the certificate is evidence of the matters stated—
(a) the image is a State remotely sensed image, or a copy of a State remotely sensed image of a stated area;
(b) the location of the area shown in the image;
(c) a feature or point, or the location of a feature or point, shown in the image;
(d) the date and time when the image was taken or made;
(e) the approximate scale of the image.
(3) The signature on the certificate is evidence of the signature it purports to be.
(4) A person who purports to be authorised by the chief executive to sign the certificate is, in the absence of evidence to the contrary, to be authorised to sign the certificate.
(5) A party to the proceeding intending to challenge a matter mentioned in subsection (2) must give at least 28 days notice of the party’s intention to adduce relevant evidence.
(6) In this section—
State remotely sensed image means a remotely sensed image taken or copied from the State remotely sensed image library.

New South Wales Legislation

Water Management Act 2000 (New South Wales) 711

s367 Evidentiary certificates 712

(1) A certificate that is issued by the Minister and that states:
(a) that an instrument, a copy of which is set out in or annexed to the certificate, being an instrument purporting:
(i) to be issued, made or given for the purposes of this Act, and
(ii) to have been signed by the person authorised to issue, make or give the instrument, or by another person acting as delegate or on behalf of the person, was issued, made or given on a specified day, or
(b) that a document, a copy of which is set out in or annexed to the certificate, is a copy of part of, or an extract from, a register or water allocation account kept under this Act, or
(c) that an image, a copy of which is set out in or annexed to the certificate:
(i) is a photograph or other remotely-sensed image of a specified kind, and
(ii) portrays specified land as at a specified date, or
(d) that an amount payable under this Act by a specified person has, or has not, been paid, is admissible in any legal proceedings and is evidence of the fact or facts so stated.
(2) A certificate that is issued by the Minister and that states that, on a date or during a period specified in the certificate:
(a) a specified person was, or was not, the holder of a specified access licence or approval, or
(b) a specified access licence or approval was, at a specified time, revoked or suspended for a specified period or was revoked or suspended subject to specified conditions, or
(c) a specified condition of an access licence or approval was, at a specified time, imposed or revoked, or
(d) specified land was, or was not, the subject of a specified approval, or
(e) specified land was, or was not, within a specified water management area, or
(f) a specified part of a water source was, or was not, within a specified water management area, or
(g) a specified water management work was, or was not, at a specified location within a specified parcel of land, or
(h) a specified water management work was, or was not, the subject of a specified water management work approval, or
(i) the conditions of a specified access licence or approval were, or were not, as so specified, or
(j) the terms of a specified available water determination were, or were not, as so specified, or

710 previously s62, renumbered 2010 No. 12 s 214(2).
711 effective on 1 July 2010.
(k) a specified person was, or was not, an authorised officer in relation to a specified provision of this Act, or
(l) a specified person was, or was not, an authorised analyst, or
(m) a specified person was, or was not, a member of staff of the Department, or
(n) a specified delegation under this Act was, or was not, in force, or
(o) a specified access licence or approval was, or was not, in force, or
(p) specified matters were, or were not, recorded in the Access Register or were, or were not, recorded in specified terms, or
(q) the water allocations credited to a specified access licence were, or were not, as so specified, or
(r) a specified number of water allocations were, or were not, credited to, or debited or otherwise withdrawn from, a specified access licence, or
(s) a specified quantity of water was, or was not, ordered in relation to a specified access licence, or
(t) information required to be furnished to the Minister or an authorised officer pursuant to this Act was, or was not, received, or
(u) an approved river gauge had, or had not, been maintained in accordance with the requirements (if any) prescribed by the regulations, or
(v) the readings on an approved river gauge were, or were not, as so specified, is admissible in any legal proceedings and is evidence of the fact or facts so stated.

(3) In any legal proceedings, evidence is not required:
(a) as to the accuracy or reliability of an approved river gauge, or
(b) as to the manner in which an approved river gauge was operated, unless evidence is adduced that the gauge was not accurate, was not reliable or was not properly operated.

(4) For the purposes of this section, a document purporting to be a certificate under this section is, unless the contrary is proved, to be taken to be such a certificate.

(5) In this section, "approved river gauge" means a gauge of a type or design approved by the Minister, by order published in the Gazette, for the purpose of measuring the level or flow of water in a river or lake.

(6) In this section:
(a) a reference to a water management work includes a reference to a corresponding kind of work to which Part 2, 5 or 8 of the Water Act 1912 extends, and
(b) a reference to an approval or access licence includes a reference to an entitlement (within the meaning of clause 2 of Schedule 10) that confers a corresponding authority.

s367A Evidence of analysts

(1) A certificate of an authorised analyst stating the result of an analysis or examination is admissible in evidence in any legal proceedings as evidence of the facts stated in the certificate and the correctness of the result of the analysis or examination.

(2) A certificate of an authorised analyst that, on receipt of a container containing a sample submitted to the analyst by an authorised officer or any other person, the container was sealed and the seal securing the container was unbroken is admissible in evidence in any legal proceedings as evidence:
(a) of the facts stated in the certificate, and
(b) that the sample was the same sample as the one obtained by the authorised officer or other person, and
(c) that the sample had not been tampered with before it was received by the analyst.

(3) For the purposes of this section, a document purporting to be a certificate under this section is, unless the contrary is proved, to be taken to be such a certificate.

s367B Rebuttable presumptions

(1) In any proceedings for an offence against this Act or the regulations being taken against a landholder:
(a) the fact that a water management work is or has been located:
(i) on the landholder's land, or
(ii) in a river or lake within the landholder's land,
gives rise to a rebuttable presumption that the work was constructed by the landholder, and
(b) the fact that a water management work is being or has been used:
(i) on the landholder's land, or
(ii) in a river or lake within the landholder's land,
gives rise to a rebuttable presumption that the work is being or has been used by the landholder, and
(c) the fact that water is being or has been taken from a water source by means of a water supply work situated:
(i) on the landholder's land, or

713 Ins 2008 No 73, Sch 3 [2].
714 Ibid.
(ii) in a river or lake within the landholder's land, gives rise to a rebuttable presumption that the water is being or has been taken by the landholder, and
(d) the fact that water is being or has been discharged into a water source by means of a drainage work situated on the landholder's land gives rise to a rebuttable presumption that the water is being or has been discharged by the landholder, and
(e) the fact that water is being or has been used on the landholder's land gives rise to a rebuttable presumption that the water is being or has been used by the landholder, and
(f) the fact that a controlled activity is being or has been carried out on waterfront land within the landholder's land gives rise to a rebuttable presumption that the activity is being or has been carried out by the landholder, and
(g) the fact that an aquifer interference activity is being or has been carried out on the landholder's land gives rise to a rebuttable presumption that the activity is being or has been carried out by the landholder.

(2) In any proceedings for an offence against this Act or the regulations being taken against the holder of an approval for a water supply work, the fact that water is being or has been taken from a water source:
(a) by means of the work, or
(b) through metering equipment installed in connection with the work, gives rise to a rebuttable presumption that the holder of the approval is or has been using the work to take water from that water source.

(3) In any proceedings for an offence against this Act or the regulations, the fact that a work of the kind referred to in:
(a) the definition of "drainage work" in the Dictionary, or
(b) paragraph (a), (b) or (c) of the definition of "water supply work" in the Dictionary, is capable of being used for the purpose referred to in that provision gives rise to a rebuttable presumption that the work has been constructed or used for that purpose.
Annex E
Selected court cases in Australia where satellite imagery was used

Table. 1 – New South Wales

<table>
<thead>
<tr>
<th>Case name/reference</th>
<th>Case Type</th>
<th>Use of Satellites</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Department of Environment and Climate Change v Olmwood Pty Limited (2010) NSWLEC 15 (Land and Environment Court of New South Wales, Australia).</td>
<td>Prosecution under the Native Vegetation Act 2003.</td>
<td>Yes. SPOT 5 satellite data was used in conjunction with aerial photography.</td>
<td>At paras 132-136 the judge set out the affidavits of the image supplier (SPOT) and the image process manager. None of the photographs or images was challenged on the basis of lack of provenance. The interpretation of the SPOT5 images was argued by the defence to be a flawed methodology by the prosecution expert witness to assess the age of vegetation because he was not able to identify particular vegetation or the heights of the vegetation from these images. The Judge found that the evidence was soundly based. Evidence accepted. Defendant convicted.</td>
</tr>
<tr>
<td>2) Director-General, Department of Environment and Climate Change v Mario Mura [2009] NSWLEC 233 (Land and Environment Court of New South Wales, Australia).</td>
<td>Prosecution under the Native Vegetation Act 2003.</td>
<td>Yes. SPOT 5 satellite data was used in conjunction with aerial photography.</td>
<td>Evidence accepted. Defendant convicted.</td>
</tr>
<tr>
<td>3) Director-General, Department of Environment and Climate Change v Jack &amp; Bill Issa Pty Ltd (No 5) (2009) NSWLEC 232 (Land and Environment Court of New South Wales, Australia).</td>
<td>Prosecution under the Native Vegetation Act 2003.</td>
<td>Yes. SPOT 5 satellite data was used in conjunction with aerial photography.</td>
<td>Evidence accepted. Case was decided on liability of landholder. Defendant convicted.</td>
</tr>
<tr>
<td>4) Director-General, Dept of Environment and Climate Change v Calman Australia Pty Ltd; Iroch Pty Ltd; GD &amp; JA Williams Pty Ltd t-as</td>
<td>Prosecution under the Native Vegetation Act 2003.</td>
<td>Yes. SPOT 5 satellite data was used in conjunction with</td>
<td>Evidence accepted. Guilty plea and sentencing. Defendant convicted.</td>
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<tr>
<td>Case Study</td>
<td>Details</td>
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<td><strong>7) Strutton v Bevington Shores Manufactured Home Village (Residential Parks) (2009)</strong> NSWCTTT 339 (New South Wales Consumer, Trader &amp; Tenancy Tribunal, Australia)</td>
<td>Compensation for breach. Use of Google Earth. The applicant claimed water meters had been installed on her site in park and wanted them removed and compensation. Park owner used Google Earth to show site boundaries. Judge held that ‘they seemed to support the park owners’ assertion’ that the meters were not installed on applicants’ site.</td>
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<tr>
<td><strong>6) Dunleavy v Peak (2009)</strong> NSWCA 72 (New South Wales Court of Appeal, Australia)</td>
<td>Road Traffic Accident. Use of Google Earth photographs. Google Earth used to show road and site in question. Not under challenge itself.</td>
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<tr>
<td><strong>5) Walker Corporation Pty Ltd v Director-General of the Department of Environment and Climate Change (No. 2) (2009)</strong> NSWLEC 177 (Land and Environment Court of New South Wales, Australia).</td>
<td>Power of entry under the Native Vegetation Act 2003. Yes. SPOT 5 satellite data was used. Evidence accepted. Statutory power of entry and inspection. Necessary to enter land as conclusions about species of vegetation could not be determined by SPOT5 imaging and ground truthing required. Another inspection necessary as no determination had been made in earlier inspection as to whether person contravened the Act. The summons was dismissed.</td>
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<tr>
<td><strong>Jerilderie Earthmoving (2009)</strong> NSWLEC 182 (Land and Environment Court of New South Wales, Australia).</td>
<td>aerial photography.</td>
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<tr>
<td>Wales Industrial Relations Commission, Australia</td>
<td>background evidence to show premises and backyard where drinking occurred, not evidence of the act itself.</td>
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<tr>
<td><strong>10)</strong> Director-General of the Department of Environment and Climate Change v Taylor (2007) NSWLEC 530 (Land and Environment Court of New South Wales, Australia)</td>
<td>Prosecution under the Native Vegetation Conservation Act 1997.</td>
<td>Yes. Satellite data was used in conjunction with aerial photography.</td>
<td>Evidence accepted. Guilty plea and sentencing. Images used to assess the extent of changes of cover on the subject land. Defendant convicted.</td>
</tr>
<tr>
<td><strong>11)</strong> Dalmien P/L v Director General Department of Infrastructure Planning and Natural Resources (2005) NSWLEC 204 (Land and Environment Court of New South Wales, Australia)</td>
<td>Appeal of remediation direction pursuant to the Native Vegetation Conservation Act 1997.</td>
<td>Yes. Satellite data was used in conjunction with aerial photography.</td>
<td>Evidence accepted in part. Used to prove clearing done by defendant, not previous owner, and that it was not regrowth. Court found that the expert witnesses’ frequent qualifications and refinements of their responses on complex technical matters did not assist the court. Judge’s impression was that this level of evidence can only be used as an indicator of guideline of clearing activity and not on a determinative basis. Persuaded to accept the evidence of expert witness as his approach was more site-specific based on field inspection of the site and correlation with actual vegetation and soil conditions. Disregarded human corroboration of previous owner that he had cleared previously as no supporting evidence confirming this. The consistency of satellite imagery, aerial photographs, and ground-truthing were held to provide clear indicators that some of the clearing was not done by former owner of property and could not be...</td>
</tr>
<tr>
<td>Case</td>
<td>Alleged Clearing in Contravention</td>
<td>Yes. Satellite Data from Landsat 7 was used in conjunction with aerial photography.</td>
<td>Challenge Based on Jurisdictional Error and Procedural Fairness, Wednesbury Unreasonableness, and Estoppel.</td>
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<tr>
<td>12) Slack-Smith and Another v Director General of the Department of Land and Water Conservation (2003) NSWLEC 189 (Land and Environment Court of New South Wales, Australia).</td>
<td>Alleged clearing in contravention. Native Vegetation Conservation Act 1997. Judicial review of declaration.</td>
<td>Evidence accepted.</td>
<td>Remediation areas were identified by hatching in the map, which was a reproduction of a Landsat 7 image. Whether approval given. Court did not set aside whole direction, but make certain conditions void.</td>
</tr>
<tr>
<td>13) Archibald v Byron Shire Council (2003) NSWCA 292 (New South Wales Court of Appeal, Australia).</td>
<td>Planning. Existing use and intensification of land. Environmental Planning and Assessment Act 1979</td>
<td>Yes. SPOT 5 satellite data was used in conjunction with aerial photography.</td>
<td>Evidence not accepted. Appeal against quarry’s conviction for intensification of quarry’s operations which could not be classed as “continuing use”. The findings of the first instance court (Land and Environment Court) were overturned in the Court of Appeal, because the court found that the satellite imagery was not reliable in the absence of survey ground truthing, and also contradicted the ground truthing which had taken place. Thought that the trial judge had misunderstood the evidence from the satellite data and aerial photographs, which was also found to be unreliable and inconsistent. Conviction quashed.</td>
</tr>
<tr>
<td>Wales Supreme Court, Australia)</td>
<td>used.</td>
<td>from the time when insurance company were aware of “turbid water” following the review of satellite imagery. Application successful.</td>
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<tr>
<td><strong>15)</strong> Max Hams &amp; 1 Ors v CGU Insurance Limited (2002) NSWSC 273 (New South Wales Supreme Court, Australia)</td>
<td>Insurance. Yes. Satellite data from Landsat was used.</td>
<td>Evidence accepted. Damage caused by inundation of water. Whether inundation constituted a ‘flood’ under policy conditions. The satellite data was used to support theories as to the timing, source and movement of the water. The satellite image found to be authentic, and was acquired from an appropriately authorised organization and was processed according to standard practice. Admissibility not disputed. The court discussed the limitations of expert scientific evidence submitted. Especially problems if in terms of ‘aspects of their evidence where they had either not visited the site at all or had only been in a position to view certain parts of the local topography’.</td>
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</table>

| Planning. |
| Existing use and intensification of land. |
| Environmental Planning and Assessment Act 1979. |

Satellite Imagery was used in conjunction with aerial photography.

Satellite data used to show two periods of significant expansion of a quarry.

The report of the expert witness on satellites was not in any way based on personal observation or assessment. His conclusions were based upon the result of calculations by computer of the date derived from satellite observation.

Evidence accepted.

Application granted.

17) ANZ Banking Group Ltd v P A Wright & Sons Pty Ltd (1999) NSWSC 628 (New South Wales Supreme Court, Australia).

| Banker and customer, Fiduciary relationship. |

Satellite Imagery was used.

Forced sale by bank and arguments of loss.

Both expert witnesses used satellite imaging of the group’s properties to express views as to their state at the time of inspection of analysis. Court found little difference between expert opinions.

Evidence accepted.

Judgement for plaintiff.

18) Land & Water Conservation, Director-General, Department of Orlando Farms Pty Ltd (1998) 100 A Crim R 543 (New South Wales Supreme Court, Australia).

| Prosecution under the State Environmental Planning Policy 46 – Protection and Management of Native Vegetation. |

SPOT HRV 2 satellite data was used in conjunction with aerial photography.

Evidence accepted.

Guilty plea and sentencing.

Extent of clearing accepted by both sides because of satellite imagery, but conflict as to other expert ecology witnesses conclusions on environmental harm.

Defendant convicted.

<table>
<thead>
<tr>
<th>Case name/reference</th>
<th>Case Type</th>
<th>Use of Satellites</th>
<th>Decision</th>
</tr>
</thead>
</table>

Table. 2 – Queensland
<table>
<thead>
<tr>
<th>Case</th>
<th>Details</th>
<th>Satellite Data Use</th>
<th>Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>20)</strong> Munya Lake Pty Ltd &amp; Ors v The Chief executive, The Department of Natural Resources and Water (2010) QSC 58 (Supreme Court of Queensland, Australia).</td>
<td>Judicial review. Water entitlements, allocations and licences.</td>
<td>Yes. Satellite data was used in conjunction with aerial photography.</td>
<td>Driver disputed the speeding distance alleged by the police officer by producing some measurements from Google Earth to suggest a shorter distance. Judge found no merits for appeal. Conviction stands. Satellite images and more predominately, aerial photography, was used to show water entitlements. Dispute over whether works on a section of the property allowed taking overland flow water, and had been used to create a storage area. Evidence accepted. Judge found that although the applicants disagreed the Department of Water had not identified a failure to take into account any relevant material or information which might have caused them to come to a different decision.</td>
</tr>
<tr>
<td><strong>21)</strong> Wiltheyman v Simpson (2009) QCA 388 (Queensland Court of Appeal, Australia).</td>
<td>Prosecution for native vegetation clearing under the Integrated Planning Act 1997.</td>
<td>Yes. Satellite data was used in conjunction with aerial photography.</td>
<td>Appeal in the Court of Appeal by Government based on District Court findings which erred in interpretation. Evidence accepted. Value and accuracy of regional ecosystem map and relationship with satellite imagery. No field inspections for botanical assessment had been undertaken. Suggests that remote sensing evidence might be sufficient without ground truthing depending on the ‘reliability methodology and techniques employed’ to interpret the image. S66B certificates under the VMA and their evidentiary</td>
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<tr>
<td>Case</td>
<td>Details</td>
<td>Prosecution for</td>
<td>Evidence accepted</td>
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<td>24)</td>
<td>Fernandez &amp; Oths v The Body Corporate for the Island of the Pines (2009) QCCTBCCM 028 (Queensland Commercial and Consumer Tribunal, Australia).</td>
<td>Commercial and consumer.</td>
<td>Google Earth was used.</td>
</tr>
<tr>
<td>25)</td>
<td>Grummitt Planning Pty Ltd v Gold Coast City Council and Chief Executive Department of Main Roads (2009) QPEC 47 (Queensland Planning &amp; Environment Court).</td>
<td>Non compliance with signage requirements under the Integrated Planning Act 1997.</td>
<td>Google Earth was used.</td>
</tr>
<tr>
<td>27)</td>
<td>Department of Natural Resources &amp; Water v Parkinson Pastoral Co. (2008) No. 02102008 D.1 T1-2/LF &amp; T2/LF (MAR) ROM1, Transcript of Proceedings (Magistrates’ Court of Roma,</td>
<td>native vegetation clearing under the Integrated Planning Act 1997.</td>
<td>Yes. Satellite Imagery was used.</td>
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<tr>
<td>Case</td>
<td>Allegation</td>
<td>Evidence</td>
<td>Reason</td>
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<tr>
<td>28) Witheyman v Van Riet &amp; Ors (2008) QCA 168 (Queensland Court of Appeal, Australia).</td>
<td>Prosecution for native vegetation clearing under the Integrated Planning Act 1997.</td>
<td>Yes. Satellite Imagery was used.</td>
<td>Limitation of time for prosecution. When the complainant knows the offence has been committed.</td>
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<td>Proceedings bought more than a year after the offence came to the complainants’ knowledge.</td>
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<td>Complainant inspected satellite imagery which suggested vegetation had been cleared. Whether this counted as start of complainants’ knowledge.</td>
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<td>Appeal was dismissed.</td>
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<td>Signage. Street appeared from Google Earth photograph to be a residential street.</td>
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<td>Appeal was dismissed.</td>
</tr>
<tr>
<td>30) Witheyman v Van Riet &amp; Ors (2007) QDC 342 (District Court of Queensland, Australia).</td>
<td>Prosecution for native vegetation clearing under the Integrated Planning Act 1997.</td>
<td>Yes. Satellite Imagery was used.</td>
<td>Limitation of time for prosecution. When the complainant knows the offence has been committed.</td>
</tr>
<tr>
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<td></td>
<td>Proceedings bought more than a year after the offence came to the complainants’ knowledge.</td>
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<td>Complainant inspected satellite imagery which suggested vegetation had been cleared. Whether this counted as start of complainants’ knowledge.</td>
</tr>
<tr>
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<td>Appeal was dismissed.</td>
</tr>
<tr>
<td>31) Affinis Pty Ltd v Harth &amp; Ors (2007) QLRT 90 (Land and Resources Tribunal Queensland, Australia).</td>
<td>Compensation. Mining lease.</td>
<td>Yes. Satellite data was used in conjunction with aerial photography.</td>
<td>Compensation for underground mining activities under homes.</td>
</tr>
</tbody>
</table>
### Table. 3 – South Australia

<table>
<thead>
<tr>
<th>Case name/reference</th>
<th>Case Type</th>
<th>Use of Satellites</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overland Corner Station Pty Ltd &amp; Anor v Gould (2010) SASC 61(Supreme Court of South Australia, Australia).</td>
<td>Prosecution for native vegetation clearing under the Native Vegetation Act 1991.</td>
<td>Yes. Satellite data was used in conjunction with aerial photography.</td>
<td>Identified the period in which the clearance occurred by a comparison of two satellite images taken on different dates. Evidence accepted and not disputed.</td>
</tr>
</tbody>
</table>
Defendant convicted.

<table>
<thead>
<tr>
<th>Case name/reference</th>
<th>Case Type</th>
<th>Use of Satellites</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>37) Gould v Overland Corner Station Pty Ltd and Mitolo (2009) AMC-08-11847 (Magistrates’ Court of South Australia, Australia).</strong></td>
<td>Prosecution for native vegetation clearing under the Native Vegetation Act 1991. Remarks on penalty.</td>
<td>Yes. Satellite data was used in conjunction with aerial photography.</td>
<td>Reliability of evidence was not an issue. The judge did however say: “I accept that Mr. Storry’s evidence concerning the approximate areas cleared was reasonably accurate and reliable”.</td>
</tr>
<tr>
<td><strong>38) Brinkworth &amp; Anor v Dendy (2007) SASC 120(Supreme Court of South Australia, Australia).</strong></td>
<td>Prosecution for native vegetation clearing under the Native Vegetation Act 1991.</td>
<td>Yes. Satellite data was used in conjunction with aerial photography.</td>
<td>Satellite imagery used to show the court the areas cleared, and identifying the species of native vegetation removed. Case was considered against argument on the rule of duplicity. Appeal allowed.</td>
</tr>
<tr>
<td><strong>39) Dendy v Brinkworth &amp; Brinkworth (2006) SASC 179 (Supreme Court of South Australia, Australia)</strong>*</td>
<td>Prosecution for native vegetation clearing under the Native Vegetation Act 1991.</td>
<td>Yes. Satellite data was used in conjunction with aerial photography.</td>
<td>Satellite imagery used to show the court the areas cleared, and identifying the species of native vegetation removed. Case was considered against argument on the rule of duplicity. Appeal dismissed.</td>
</tr>
</tbody>
</table>

**Table. 4 – Other Jurisdictions in Australia**

<table>
<thead>
<tr>
<th>Case name/reference</th>
<th>Case Type</th>
<th>Use of Satellites</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Federal Court of Australia</strong></td>
<td><strong>40) Mei Ying Su v Australian Fisheries Management Authority No 2 (2008) FCA 1485(Federal Court of Australia).</strong></td>
<td>Fisheries. Forfeiture of foreign fishing vessel. Onus of proof and standard of proof – whether vessel being used for offence.</td>
<td>Satellite data was used (GPS navigation). Vessel monitoring system (‘VMS’) data. Experts dispute over GPS movements and speed. Argument that could not have been fishing at one point as going too fast and at other stage the engine was being repaired. Court found that the Australian Fisheries Management had Authority failed to prove, on the balance of probabilities,</td>
</tr>
</tbody>
</table>

| Convention on Wetlands of International Importance (‘Ramsar Convention’). |Prosecution for clearing land on declared wetland under s16(1) of the Environmental Protection and Biodiversity Conservation Act 1999. | Based upon clear and cogent evidence that the Mitra was not within the AFZ at the time as a result of a mistaken but reasonable belief of fact, on the part of the Master. | Was clearing and dredging in Ramsar site. | Overlaid some of the satellite images with data defining the boundaries of the Ramsar site and neighbouring properties. Aerial photography used to show clearing. | Satellites imagery between 1973 and 1985, before the effects of the diversion of water for irrigation had become apparent, identified 220,000 hectares of wetlands and floodplain woodlands in the floodplain. Evidence accepted. | Defendants (Greentree and Auen) convicted. |

### Administrative Appeals Tribunal of Australia


| Civil aviation. | Pilot flew plane lower than 500 feet. | Cancellation of licence sought. | Satellite image showing meteorological conditions. |

### Victoria


| Planning. | Proposal to build an indoor recreation centre. Claim of overshadowing. | Expert gave computer generated shadow analysis that was done using satellite imaging. Court found this was not easy to decipher even after expert explanations in the principal evidence and in cross-examination. | Decision upheld and permit given. |

#### 44) McConnell Dowell Middle East LLC v Royal & Sun

<p>| Insurance. | Plaintiff got satellite images taken of various locations in |</p>
<table>
<thead>
<tr>
<th>Alliance Insurance Plc [2008] VSC 501 (Supreme Court of Victoria, Australia).</th>
<th>Theft of mining property from diamond mine in Central African Republic (CAR).</th>
<th>Satellite data was used.</th>
<th>Theft of mining property from diamond mine in Central African Republic (CAR). Satellite data was used in 2002 to determine if significant objects, including the plaintiff’s plant and equipment, were present at those locations. It was not possible to locate the equipment yard without being provided with precise coordinates or landmarks. As to the camp-site image, it revealed a building approximately four square metres in size, and another object approximately two square metres in size (possibly a small building or motor vehicle), but did not reveal any other vehicles, buildings, or large man-made objects. Claimed for cost of satellite images</th>
</tr>
</thead>
<tbody>
<tr>
<td>45) Karen Ann and Peter Thomas Le Comte v John Fenn (2007) VCAT Ref no P1264/2007 (Victorian Civil and Administrative Tribunal, Australia).</td>
<td>Planning.</td>
<td>Yes. Google Earth was used.</td>
<td>Proposed child-care centre. Enclave of entirely residential development. Importance of resident’s expectation of non-residential intrusion; tone of area; detriment of children’s noise, issues of traffic safety and amenity. An image from Google Earth was used to show that about 80% of lots on the estate were developed. Not under challenge itself.</td>
</tr>
<tr>
<td>46) F.E. &amp; S.M Kealy v A.M. Carter and Department of Sustainability and Environment (2003) VCAT 1978 (Victorian Civil and Administrative Tribunal, Australia).</td>
<td>Planning. Review of decision. Wetlands.</td>
<td>Yes. Satellite data was used in conjunction with aerial photography.</td>
<td>Construction of drain. Impact on native vegetation. Archived satellite image from 1993 indicated the presence of water in the freshwater meadow. Court found this to be strong evidence suggesting the meadow was still a healthy functioning wetland prior to the Council’s works. Evidence accepted. Council ordered to cease</td>
</tr>
<tr>
<td>Location</td>
<td>Duty of Care Owed</td>
<td>Satellite Data Used</td>
<td>Reason</td>
</tr>
<tr>
<td>-------------------</td>
<td>------------------</td>
<td>---------------------</td>
<td>----------------------------------------------------------------------</td>
</tr>
<tr>
<td>Northern Territory</td>
<td>Yes.</td>
<td>Yes.</td>
<td>Fire. Caused destruction of property. Plaintiff argued it started on crown land and he was owed a duty of care as no firebreaks on the crown land side of the boundaries. Information obtained from satellite imagery cast doubt on the likelihood that there had been any fire on the eastern side of the river at about the relevant time. Fire started elsewhere. Evidence accepted. Plaintiffs claim was dismissed.</td>
</tr>
<tr>
<td>Gardner v Northern Territory of Australia (2003) NTSC 113 (Supreme Court of the Northern Territory, Australia).</td>
<td>Duty of Care owed.</td>
<td>Satellite data was used.</td>
<td></td>
</tr>
<tr>
<td>Western Australia</td>
<td>Yes.</td>
<td>Yes.</td>
<td>Accuracy of scientific evidence. Whether or not a satellite navigator is a ‘notorious’ scientific instrument. Judge agreed that it wasn’t, but that the vessels position did not entirely depend on the use of that system (e.g. the totality of the evidence did not entirely depend upon the use of the satellite navigator system. Whether hearsay evidence admitted. A number of uncontradicted matters, including expert evidence and the s16(4) certificates of proof, which negatived any hearsay allegation, built up a case beyond reasonable doubt. GPS evidence not totally accepted, but case proved. Appeal dismissed.</td>
</tr>
<tr>
<td>Southern Properties (WA) Pty Ltd v Executive Director of the Department of Conservation and Land Management [No. 2] (2010)</td>
<td>Negligence. Duty of Care.</td>
<td>Satellite data was used.</td>
<td>Claim that defendants were negligent in 2004 in conducting a prescribed burn on Crown land, which abutted vineyards. Alleged this caused smoke taint to grapes. Plaintiffs argued</td>
</tr>
</tbody>
</table>
Satellite Monitoring of Environmental Laws – Lessons to be Learnt from Australia

<table>
<thead>
<tr>
<th>Case Study</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>WASC 45 (Supreme Court of Western Australia, Australia)</td>
<td>they suffered economic loss. Defendants' expert reported on satellite imagery of smoke plume location in relation to the burn. Although this report was tendered by consent, and without cross-examination, the judge preferred the plaintiffs’ evidence from an expert witness who had photographed it, on the location and extent of the smoke. Court found satellite evidence report to contain too much technical discussion which, without elaboration, and was difficult to follow. This makes it difficult properly to assess the cogency of his conclusions. Court also inferred from his report that at times of cloud-cover, the satellite could not detect whether there was smoke over the vineyard. Conflicting statutory powers and duties - Prescribed burning. Plaintiff lost on this point.</td>
</tr>
<tr>
<td><strong>50) Armstrong &amp; Anor v Rokich &amp; Anor (2008) WADC 182 (District Court of Western Australia, Australia).</strong></td>
<td>Misleading and deceptive conduct under Fair Trading Act 1987. Sale of farm - misrepresentation of cleared area. Causation of loss.</td>
</tr>
<tr>
<td><strong>51) The Medical Board of Western Australia and Valibhoy (2008) WASAT 17 (State Administrative Tribunal, Western Australia).</strong></td>
<td>Medical negligence.</td>
</tr>
<tr>
<td>Case Study</td>
<td>Authority</td>
</tr>
<tr>
<td>---------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>52) Burnett and Town of Cambridge (2006) WASAT 29 (State Administrative Tribunal, Western Australia)</td>
<td>Town planning. Impact on amenity from noise from new roofed alfresco area.</td>
</tr>
<tr>
<td>52) Mount Lawley Pty Ltd v Western Australian Planning Commission (2006) WASC 82 (Supreme Court of Western Australia in Civil, Australia)</td>
<td>Wetlands. Environmental significance.</td>
</tr>
</tbody>
</table>
| 53) John Nominees Pty Ltd v Dixon (2003) WASC 151 (Supreme Court of Western Australia, Australia) | Land clearing. Prosecution under the Soil and Land Conservation Regulations | Satellite data from Landsat was used in conjunction with aerial photography.               | Defence appealed on basis that the Magistrate erred in law by allowing into evidence aerial and satellite photographs. Also contended that they should
1972.
Admissibility of aerial photos and satellite images of the land as public documents.

not have been admitted because the witness who tendered them was not an expert.

In terms of verification and authentication the judge found: “A photograph needs to be authenticated to be received in evidence for the purpose for which these satellite photographs were tendered. One method of authentication is evidence from the photographer, where there is one; to verify what it is that is depicted on the photograph. But such authentication may well be provided by a witness, other than the photographer, who can verify what is depicted”.

“With regard to the distinct question of the accuracy or reliability of what is depicted, the satellite photographs were produced by technology far more complex than an everyday camera. That technology and the accuracy and reliability of its product are matters beyond ordinary knowledge and experience. Although the issue was not directly ventilated in argument before me, it appears that it was open to the learned Magistrate to accept from the evidence of Mr. Wallace that the satellite photographs or images could be accepted as accurate photographic depictions of that part of the earth’s surface which they portrayed.”

Judge raised issued that there was no verification of the images in CD form. No attempt to have these CD’s certified as true copies of original data. This issue was not the subject of direct submissions by counsel. However, he assumed that the satellite photographs were not properly admitted
Satellite Monitoring of Environmental Laws – Lessons to be Learnt from Australia

| in evidence. Case won because aerial photographs were correctly received in evidence. Satellite data inferred to not be admissible as evidence. “The Court does not decide the issue of what is required in order to render satellite images admissible and admissibility in this case as it finds the Magistrate would have come to the same decision without the satellite photographs or imagery and the evidence founded on it”.

|
Annex F
Information about the survey

1. Key information about the survey

1.1. Structure of the survey

Questionnaires were structured and written in line with existing principles used in standard design. The advice and support of colleagues with experience of questionnaire structure and design in UCL was relied upon, and a research assistant with experience of survey design and implementation was employed during the project. The final survey was very professional and accessible.

The first part of the questionnaire (Section 1) asked the respondent to give details about themselves and their farm. This included details of farm location; industries on the farm; size of farm; type of farm (in terms of tenure and management); and age-group. Respondents were also asked to indicate whether they had been involved in any form of vegetation clearing during the past one year, or if they were planning any form of vegetation clearing in the future.

Other sections of the questionnaire then covered the respondent’s general awareness of satellites (Section 2); their awareness of satellite monitoring of vegetation clearing (Section 3); their attitudes and opinions towards satellite monitoring of vegetation clearing (Section 4); and finally their thoughts on extending the use of satellites for other purposes (Section 5).

A copy of the questionnaire used can be seen in Annex G to this report.

1.2 Target of the survey

As satellite monitoring of vegetation clearing is performed at State level in Australia, surveys were targeted at landholders in three States: South Australia, Queensland and New South Wales.

The questionnaires were developed with the cooperation of our Australian contacts within State Governments, although all control of the surveys was exclusively held by University College London (UCL). The academic credentials of the project and the independence of the survey itself from any Government agency was considered extremely important in encouraging farmers to provide candid feedback.

The surveys were also not framed at a particular section of agricultural respondents in each State; instead they had general applicability to those in this regulated community who were monitored by satellite.

2. Procedure for the survey

2.1 Data collection – posted surveys

A postage survey was primarily used to collect the data. One thousand UCL questionnaire booklets were sent to selected recipients in each of the three States, with three thousand survey recipients in total. The names and addresses of survey recipients were supplied from a list held by a private Australian company, Baron Strategic Services, who provide consulting market information services about Australian farms. The farming database held by them contains approximately one hundred and ten thousand farmer names and addresses from across Australia and our survey recipients were randomly selected from each State, by them, from this purchased list.

On 21st October 2009, three thousand colour questionnaire booklets were posted to farmers in South Australia, New South Wales and Queensland. The booklets were accompanied with a signed covering letter explaining the objectives of the research project and the survey itself. It was felt that it was important in this letter to emphasise the survey’s independent academic credentials and to also be upfront about it being undertaken by a United Kingdom (UK) university. The letter sought to explain why landholders should participate in this survey and its relevance to Australian policy, as well as its possible wider international importance and impact.
Each questionnaire pack posted out contained a self-addressed stamped envelope, to be returned to the UCL School of Energy and Resources campus in Adelaide, Australia. The closing data for the survey was 1st February 2010, so those who received surveys had approximately three months to reply. A prize draw was offered in each of the three States, giving entrants the chance to win an iPod or a subscription to a farming newspaper, to encourage higher returns of questionnaires.

2.2 Data collection – web-based

The questionnaire booklet was also accessible on the internet. The online version of the survey was hosted on the UCL site and constructed using Opinio survey software. It went live on 22nd October 2009 on this link: <https://opinio.ucl.ac.uk/s?s=7200>.

The existence of this survey was advertised extensively throughout Australia, using key State/national farming unions, internet sites, State/national radio broadcasting, and the press.

3. Response rates for the survey

3.1 Questionnaires

As indicated above, three thousand questionnaires were sent out in total (one thousand each in South Australia, Queensland and New South Wales). The numbers of questionnaires providing usable data that were returned (either as mailed paper copies or as emailed scans) was: South Australia – 163; Queensland – 153; New South Wales – 106.

This gives response rates of: South Australia – 16.3%; Queensland – 15.3%; New South Wales – 10.6%. There was an overall response rate of 14.1% of questionnaires posted.

3.2 Opinio internet survey

An additional six questionnaires were filled in online by respondents from these three States via the Opinio web system at UCL. These responses have been included in the overall analysis. Including these responses gave a total for each State of: South Australia – 164; Queensland – 157; New South Wales – 107.

A further six Opinio questionnaires were submitted by landholders from other Australian States (Western Australia and the Northern Territory). These questionnaires were not included in the main survey analysis contained in this report. Comments from farmers in these States will be given where appropriate.

3.3 Acceptability of response rate

Unsolicited questionnaires sent out to members of the general public would normally expect to attain response rates of 1–20%. The overall response rate to the posted questionnaires of 14.1% represents a reasonable response to this type of survey.

Response rates were unlikely to be extremely high because the survey was sent by an independent academic based in another country, who was personally unknown to survey recipients. Additionally, during the interview phase of the project, a significant number of interviewees in each of the States commented that Australian farmers were notably over-surveyed and this could significantly impact on the return rate of this questionnaire. Many predicted that the degree of apathy caused by ‘survey overload’ had gone up enormously, and the confidence in the usefulness of surveys had also gone down. One State farming association predicted return rates of 1% or 2% to this survey, and considered a figure over 10% to be excellent.

This UCL survey also had two hundred and seventy nine returns marked as ‘no longer at this address’, which was about 9.3% of the total number of surveys posted. A number of interviewees commented that this should be expected. This was primarily because there was a problem with maintaining up-to-date, accurate contact databases in a large rural country. A high turnover of farmers was not uncommon in Australia, with significant numbers of farmers leaving the land in recent years. This was because of retirement, takeovers, and poor environmental conditions such as drought causing declining incomes. The large number of unsuccessfully delivered surveys undoubtedly impacted on the final response rate.
Whilst the survey should be considered a success, if it were to be done again, survey recipients would also be sent follow-up postcards, reminding them of the survey, several weeks after receiving the first survey booklet. It is believed that if there had been a budget to do this it would have encouraged an even higher response rate.

4. United Kingdom survey 2008

4.1 Background

A small pilot survey in the UK had already been undertaken in 2008, by UCL, under a project funded by the Arts and Humanities Research Council. This survey was carried out to assess attitudes in the UK farming community towards monitoring by satellite. At the time of the survey, satellite monitoring had been used in the UK for over a decade to check subsidy fraud under European agricultural support schemes. This survey was not identical to the one used in Australia, but contains a number of the same or similar questions. It will be referred to a number of times in this report to highlight comparative differences in awareness and attitudes, between the UK and Australia.

In the UK pilot survey, four hundred and eighty paper questionnaires were sent out to UK respondents, in the farming industry, unsolicited. Just over half of these questionnaires were sent out to farms that were the biggest farming subsidy claimants in the UK. Most of these would obviously be larger farms and were chosen because they would probably have a better knowledge of satellite monitoring than smaller farms. Just under half of the paper questionnaires were sent to random farms, whose contact details were kindly provided by the National Farm Research Unit in the UK. These were deliberately selected at random to get a sample reflecting different farm sizes and locations. A small number of paper questionnaires were also sent to farmers who heard about the survey and requested a questionnaire.

4.2 Response rate to UK survey

Out of the four hundred and eight questionnaires that were sent out to farmers unsolicited, one hundred and sixty one replies were received. This is a response rate of approximately a third (or 33.541%), which is significantly higher than the normal response rate for unsolicited surveys. An internet survey was also undertaken in this UK pilot study and forty one online questionnaires were completed. There were, therefore, a total of two hundred and two completed questionnaires from UK farmers, in this pilot study.

5. 2010 survey results: demographics

5.1 Farm location

At the beginning of the survey farmers were asked to give the location of their farm (Question one of the survey). The main purpose of asking this question was to be able to breakdown which State each of the respondents was in. They were also asked to give details of their Local Government area (LGA) or shire. Survey responses were received from twenty LGA’s in South Australia; eighteen LGA’s in Queensland; and sixteen LGA’s in New South Wales which confirmed that it had reached a broad geographic spread of recipients.

5.2 Farm type

Farmers were asked to give information about their farm type (Question two of the survey), to check whether the farm industry that the respondent worked in had an impact on their responses to any later questions, and/or their attitudes towards satellite monitoring.

Respondents’ farm industries varied from State to State (Table 4), as was expected in a random survey. Survey respondents in South Australia were mainly from the sheep/wool industry (86.6%) and grain industry (85.4%). In Queensland the cattle industry was the more dominant industry (89.7%). In New South Wales the most numbers of respondents were in the cattle industry (69.8%) and sheep and wool industries (68.9%).

Many farms had multiple types of industry, which is why the figures in the columns of Table 4 below add up to more than the numbers of respondents supplying data.

<table>
<thead>
<tr>
<th>Table 4: Number of survey respondents working in each farm industry</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td><strong>South Australia</strong></td>
</tr>
<tr>
<td>Cattle industry</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Sheep and wool industries</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Grain industry</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Horticulture industry</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Dairy/Viticulture/ Other industries</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Respondents supplying data</td>
</tr>
<tr>
<td>Respondents not supplying data</td>
</tr>
</tbody>
</table>

5.3 Farm size

Farmers were asked to give the approximate area of their farms in hectares (Question three of the survey). In general, the survey provided a good sample of small, medium and large farms in the three Australian States surveyed. Table five shows that the smallest farm surveyed was 2 hectares (ha) and the largest farm was 150,000 ha.

<table>
<thead>
<tr>
<th>Table 5: The mean and median size of farms surveyed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td><strong>South Australia</strong></td>
</tr>
<tr>
<td>Minimum farm area (hectares)</td>
</tr>
<tr>
<td>Maximum farm area (hectares)</td>
</tr>
<tr>
<td>Mean farm area (hectares– rounded to nearest 100)</td>
</tr>
<tr>
<td>Median farm area (hectares– rounded to nearest 100)</td>
</tr>
<tr>
<td>Respondents supplying data</td>
</tr>
<tr>
<td>Respondents not supplying data</td>
</tr>
</tbody>
</table>
5.4 Ownership and management of property

Survey participants were asked to give details of the tenure of their property and details of its management (Question four of the survey). Most of the farmers surveyed owned the freehold to their properties (South Australia – 93.2%; Queensland – 73.1%; New South Wales – 72.1%). Nearly every farm surveyed was also family-run (South Australia – 98.6%; Queensland – 100%; New South Wales – 98.9%).

Because most of the farms surveyed were freehold-owned and family-run properties, this might suggest that Australian farmers could have a greater personal attachment to their land. There has been a long-running problem with some Australian farmers refusing to accept (or harbouring resentment of) Government imposed rules concerning what can and cannot take place on their farms. Some farmers strongly believe that freehold ownership should mean that they alone should decide how to manage their properties. In relation to vegetation clearing this has resulted in a lot of controversy and legal challenges in some States.

5.5 Involvement in vegetation clearing

In the survey, farmers were asked whether they had been involved in any form of vegetation clearing in the last decade, or whether they were planning any form of vegetation clearing in the future (Questions five and six of the survey).

As can be seen from Graph 36, the majority of respondents surveyed in South Australia and New South Wales had not been involved with any form of vegetation clearing in the previous ten years (78.4% in South Australia and 67.3% in New South Wales). The exception was Queensland, where just over 70% of farmers had cleared land on their own farm alone. A further 5.8% of farmers in this State had carried out vegetation clearing on their own farm and additionally as a contractor clearing someone else’s farm. One conclusion that might be arrived at, from these figures, is that Queensland respondents might be expected to have significantly different views on vegetation clearing than respondents from the other two States.

Graph 42: Past involvement in vegetation clearing

Q5: Have you been involved in any form of vegetation clearing during the last 10 years?

- South Australia (n = 162)  Queensland (n = 155)  New South Wales (n = 107)

<table>
<thead>
<tr>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes, but only on my own farm</td>
</tr>
<tr>
<td>Yes, but only as a contractor carrying out vegetation clearing on someone else’s farm</td>
</tr>
<tr>
<td>Yes, both on my own farm and as a contractor carrying out vegetation clearing on someone else’s farm</td>
</tr>
<tr>
<td>No</td>
</tr>
</tbody>
</table>

Centre for Law and the Environment, UCL (2010)
The fact that the farmers above disclosed that they were clearing vegetation from their land does not mean that these actions were illegal, as there are many exemptions operating under legislation in all three jurisdictions which allows for lawful clearing in certain situations.

Perhaps unsurprisingly, the numbers of farmers planning to clear vegetation in the future dropped in two jurisdictions. Decreases in vegetation clearing in South Australia and Queensland can be seen when comparing Graph 36 and Graph 37. This could be because the farmers surveyed had already cleared as much land as they needed to clear (in anticipation of future restrictions); legislative amendments in these States may have become more restrictive in allowing vegetation clearing; there was greater environmental awareness amongst the farmers surveyed; or, finally, there was a greater perceived threat of being detected if the clearing was illegal. What was surprising was that the numbers of farmers planning to clear vegetation from their land actually increased by 4.1% in New South Wales. This four per cent swing cannot be explained.

5.6 Age of farmers

Farmers were asked to indicate the age range they belonged to (Question seven of the survey). The pattern of age distribution was similar amongst respondents in each State surveyed. There were only a small percentage of farmers under the age of 35 in the three States (5.5% of South Australian farmers; 3.2% of Queensland farmers; 0% of New South Wales farmers). The highest numbers of farmers were in the over 55 years old category (47.2% in South Australia; 57.1% in Queensland; 59.4% in New South Wales).

In order to assess whether age had an influence on responses to other questions in the survey, the respondents were divided into two categories: ‘Over 55 years old’ and ‘55 years old and younger’. The responses of farmers in these two categories were then compared.
Annex G
Copy of survey
Survey on Satellite Monitoring of Vegetation Clearing

The aim of this academic survey, which is independent of any government agency, is to assess attitudes in the Australian farming community towards the use of satellites when monitoring vegetation clearing. A key part of the research will be your input and the survey should take no more than 15 minutes to complete. You will be asked 27 questions, the majority being simple multiple choice. All responses are anonymous. The survey will close on 1st February 2010.

A prize draw for survey participants will be held on 2nd February 2010 at noon. The three winners will be notified immediately and will have the choice of receiving either a new Apple iPod nano 8GB player or a year’s subscription to one of the following: (i) The Land; (ii) Queensland Country Life; or (iii) Stock Journal. The result will be announced on the UCL website (http://www.ucl.ac.uk/laws/environment). If you wish to enter the draw, please provide the requested details at the end of the survey.

If you would like more information about the survey and research, please contact Ray Purdy at UCL by email (raymond.purdy@ucl.ac.uk).

Thank you for your participation! Your help is greatly appreciated.

Section 1 Farm Details

1. Whereabouts in Australia is your farm located?
   LGA or Shire: State:

2. Which farm industries do you work in? (select all options that apply)
   - Cattle industry
   - Sheep and wool industries
   - Horticulture industry (except viticulture)
   - Viticulture industry
   - Grain industry
   - Dairy industry
   - Other (please specify)

3. Approximately how many hectares is your farm?
4. What type of farm is it? *(select one option for part (i) and one option for part (ii))*
   (i) Tenure:
       - [ ] Leasehold or shared
       - [ ] Freehold
   (ii) Management:
       - [ ] Family run
       - [ ] Corporate or other

5. Have you been involved in any form of vegetation clearing during the last 10 years? *(select all options that apply)*
   - [ ] Yes, on my own farm
   - [ ] Yes, as a contractor carrying out vegetation clearing on someone else’s farm
   - [ ] No

6. Are you planning on any form of vegetation clearing in the future? *(select all options that apply)*
   - [ ] Yes, on my own farm
   - [ ] Yes, as a contractor carrying out vegetation clearing on someone else’s farm
   - [ ] No

7. What is your age group? *(select one option)*
   - [ ] Under 35 years old
   - [ ] 35-55 years old
   - [ ] Over 55 years old

**Section 2 General Awareness of Satellites**

8. Have you ever seen a satellite image of your farm? *(select one option)*
   - [ ] Yes
   - [ ] No

   [If you answered “No” to question 8, ignore question 9 and move directly to question 10.]

9. Where did the satellite image come from? *(select all options that apply)*
   - [ ] The farm purchased it
   - [ ] Google Earth
   - [ ] State Government department
   - [ ] State library archive
   - [ ] Other *(please specify)*
10. As far as you know, which of the following things can be identified by a satellite? (select all options that apply)

- [ ] A cow
- [ ] A patch of wild vegetation
- [ ] A tractor
- [ ] Clothes on a washing line
- [ ] Paddock fence lines
- [ ] A person’s identity
- [ ] The amount of water used for irrigation
- [ ] A number plate on a car
- [ ] A single tree
- [ ] A house
- [ ] Illegally dumped waste

Section 3 Awareness of Satellite Monitoring of Vegetation Clearing

11. Have you heard of either of the following being used to monitor vegetation clearing in Australia? (select all options that apply)

- [ ] Satellites
- [ ] Aerial photography
- [ ] Neither of the above

[If you did not tick “Satellites” in question 11, ignore questions 12-18 and go straight to Section 4.]

12. By what means did you hear about this satellite monitoring? (select all options that apply)

- [ ] Other farmers
- [ ] Financial assistance schemes to improve or protect wild vegetation on properties
- [ ] Government or regulator
- [ ] Farmers’ union or association
- [ ] Farming press
- [ ] General media
- [ ] Other (please specify)

13. Below, select one option in response to part (i) and one option in response to part (ii):

<table>
<thead>
<tr>
<th>(i) Is satellite monitoring being used to monitor vegetation clearing in your state?</th>
<th>Yes, definitely</th>
<th>Yes, probably</th>
<th>No opinion either way</th>
<th>No, probably not</th>
<th>No, definitely not</th>
</tr>
</thead>
<tbody>
<tr>
<td>(ii) Has your own farm been subject to satellite monitoring of vegetation clearing?</td>
<td>Yes, definitely</td>
<td>Yes, probably</td>
<td>No opinion either way</td>
<td>No, probably not</td>
<td>No, definitely not</td>
</tr>
</tbody>
</table>
14. Estimate the length of time that satellite monitoring of vegetation clearing has been taking place in your state. If you are uncertain, please make a guess. *(select one option)*

- [ ] Less than 5 years
- [ ] 5-9 years
- [ ] 10-14 years
- [ ] 15 years or more

15. Estimate the percentage of farms in your state that are monitored by satellites annually under vegetation clearance laws. If you are uncertain, please make a guess. *(select one option)*

- [ ] Less than 20%
- [ ] 20-49%
- [ ] 50-79%
- [ ] 80% or more

16. Estimate how often each farm in your state is monitored using satellites under vegetation clearance laws. If you are uncertain, please make a guess. *(select one option)*

- [ ] More often than once a year
- [ ] Once a year
- [ ] Once every 2-3 years
- [ ] Once every 4-5 years
- [ ] Less often than once every 5 years

17. In your opinion, how does the level of satellite monitoring of vegetation clearing in your state compare to other Australian states? If you are uncertain, please make a guess. *(select one option)*

- [ ] We have more monitoring checks by satellite
- [ ] We have about the same number of monitoring checks by satellite
- [ ] We have fewer monitoring checks by satellite

18. Have you heard of any farmers who have been prosecuted for vegetation clearing after being detected by satellite monitoring? *(select all options that apply)*

- [ ] I have not heard of any prosecutions
- [ ] Yes, in my own state
- [ ] Yes, in another state *(please specify which state)*
### Section 4 Attitudes & Opinions towards Satellite Monitoring of Vegetation Clearing

[For some of the remaining questions, space is provided for you to elaborate further on your answers, should you wish to do so. If the space provided is insufficient, note that there is additional room for comments at the end of the survey.]

19. Below, select one option in response to part (i) and one option in response to part (ii):

<table>
<thead>
<tr>
<th>(i)</th>
<th>What is your attitude to the use of satellites for monitoring vegetation clearing?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Strongly in favour</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>(ii)</th>
<th>What is your opinion of the vegetation clearance legislation itself in your state?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Strongly in favour</td>
</tr>
</tbody>
</table>

If you would like to elaborate on your answers to questions 19(i) and (ii), use the space below:

---

20. If you had to choose, which of the following would you prefer for Government monitoring of vegetation clearing? *(select one option)*

- [ ] Site visits by inspectors only
- [ ] Satellite monitoring only
- [ ] Both satellite monitoring and site visits by inspectors

If you would like to elaborate on your answer to question 20, use the space below:

---

21. Should you be informed each time your farm is monitored by satellite for possible vegetation clearing? *(select one option)*

- [ ] Yes
- [ ] No
- [ ] No opinion either way

If you would like to elaborate on your answer to question 21, use the space below:
[If you answered “No” to question 21, ignore question 22 and move on to question 23.]

22. When should you be informed that your farm is being monitored by satellite? (select one option)

☐ Before the monitoring takes place
☐ After the monitoring takes place
☐ Before and after the monitoring
☐ No opinion either way

If you would like to elaborate on your answer to question 22, use the space below:

---

23. For each of the following statements on satellite monitoring of vegetation clearing, select the option that indicates your level of agreement:

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly agree</th>
<th>Agree</th>
<th>Neutral</th>
<th>Disagree</th>
<th>Strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;It is an invasion of a farmer’s privacy.&quot;</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☒</td>
<td>☐</td>
</tr>
<tr>
<td>&quot;It can stop dishonest people in the farming industry giving the law-abiding majority a bad name.&quot;</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☒</td>
<td>☐</td>
</tr>
<tr>
<td>&quot;The data will only be handled and interpreted correctly by adequately qualified personnel.&quot;</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☒</td>
<td>☐</td>
</tr>
<tr>
<td>&quot;I have been given enough information on this subject by Government.&quot;</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☒</td>
<td>☐</td>
</tr>
<tr>
<td>&quot;It is acting as a deterrent against illegal vegetation clearing.&quot;</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☒</td>
<td>☐</td>
</tr>
<tr>
<td>&quot;It allows farmers to operate on a fairer and more equal basis, assuming every farm is monitored.&quot;</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☒</td>
<td>☐</td>
</tr>
<tr>
<td>&quot;It is a more consistent and accurate method than other means of checking vegetation clearing.&quot;</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☒</td>
<td>☐</td>
</tr>
<tr>
<td>&quot;It is a more cost effective method of monitoring than ground inspections.&quot;</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☒</td>
<td>☐</td>
</tr>
</tbody>
</table>
Section 5 Using Satellites for Other Purposes

24. Do you think that satellites are currently being used to monitor other laws in Australia? *(select one option)*
   - [ ] Yes, definitely
   - [ ] Yes, probably
   - [ ] No, probably not
   - [ ] No, definitely not
   - [ ] No opinion either way

If you would like to elaborate on your answer to question 24, use the space below:

25. Which bodies do you think currently use satellites as a monitoring tool in Australia? *(select all options that apply)*
   - [ ] Federal Government
   - [ ] State Government (including state environmental protection authority)
   - [ ] Police
   - [ ] Australian Secret Intelligence Service
   - [ ] Local authorities
   - [ ] United Nations
   - [ ] Other *(please specify)*

26. How would you feel generally if the use of satellite monitoring was extended to monitor compliance with the following laws effecting farming? *(select one option for each type of law)*

<table>
<thead>
<tr>
<th>Laws</th>
<th>Strongly in favour</th>
<th>In favour</th>
<th>Neutral</th>
<th>Against</th>
<th>Strongly against</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laws on the disposal of agricultural waste</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td>Laws on climate change</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td>Laws on safe nitrate or pesticide levels</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td>Laws on irrigation and water use</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td>Laws on water pollution</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td>Other nature conservation laws</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
</tbody>
</table>
27. If the use of satellites to monitor environmental and agricultural laws was to increase, how important would you rate each of the following statements? *(select one option for each statement)*

<table>
<thead>
<tr>
<th>Statement</th>
<th>Very important</th>
<th>Important</th>
<th>No opinion either way</th>
<th>Unimportant</th>
<th>Very unimportant</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;Any satellite data should be shared between regulators to cut bureaucracy.&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;The use of satellites must be accompanied by a reduction in monitoring by ground inspections.&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;Farmers must be able to have free access to the satellite pictures.&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;Assurances must be given with regard to data information security.&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;There should be protection in the courts in case there is abuse of this satellite data.&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;The use of satellites should result in savings to the taxpayer.&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Thank you for completing the survey

Can we contact you to discuss your answers? If yes, please leave a contact number or email below:

Would you like to be entered into a draw to win either a new Apple iPod Nano 8GB silver player or a year’s subscription to one of (i) The Land, (ii) Queensland Country Life, or (iii) Stock Journal? If so, could you please leave some method of contacting you below:

If you have indicated that you do not wish to discuss your answers further, we will not contact you to do so, even if you have left your details in order to enter the draw. Also, your responses in this survey will still remain anonymous if you enter the draw.

Any further comments?