The Value of Spatial Information for Tasmania

An assessment of the value of increased investment in spatial information for the Tasmanian economy

Adapted from a report prepared for the Department of Premier and Cabinet in April 2011

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Executive summary

The Tasmanian Department of Premier and Cabinet commissioned this report at the instigation of the Tasmanian Spatial Information Council (TASSIC) to estimate the value of increased investment in spatial information for the Tasmanian economy.

The scenario on which this report is based assumes an investment of $8.3 million in value terms at the time of the original report. It is further assumed that such investment would be directed towards a number of discrete projects to deliver two distinct outcomes:

- improved access to spatial data held by government
- greater coordination and improved use of spatial data across government.

Economic impacts

In 2011, the use and re-use of spatial information is estimated to have added $104 million in productivity-related benefits to the Tasmanian economy. This value is the result of increasing adoption of modern spatial information technologies over the period 1995-2011, and is equivalent to slightly more than 0.45 per cent of Gross State Product in 2010.

With the level of investment assumed in the proposed scenario, economic growth is projected to be higher. It is projected that with the scenario investment of $8.3 million, Gross State Product would be $105 million higher by 2020 than it would be without such investment. Real incomes in Tasmania are also projected to be $97 million higher with that investment than without.

Not all of this increase can be attributed solely to the scenario investment. Other government organisations would also need to maintain and develop their use of spatial information over the next ten years. However, scenario investment in improved access to authoritative foundation data is a prerequisite to realising these gains.

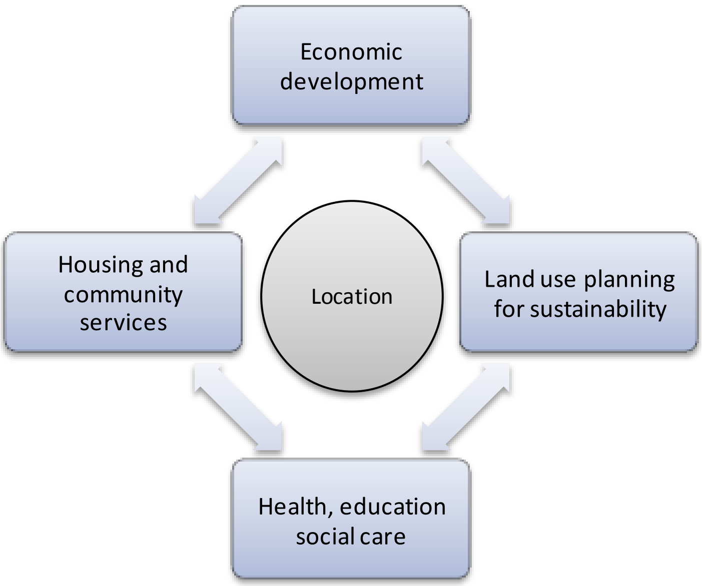
Evidence in Australia and overseas suggests that some of the benefits would be cashable in the short term, particularly in operational arms of government. However, full realisation of the gains would require resources that are freed up as a result of productivity gains to be redeployed to other productive activities in the economy. The growing demands on Government services in Tasmania suggest that the former would be applicable in portfolios such as health and human services.

Implications for government agencies

Improved use of spatial information has implications for more effective policy formulation and reduced cost of service delivery for Government agencies. The most significant impact would be in improved linkages between economic development, planning and community services. These activities are mutually reinforcing (see Figure 1).

Improved coordination of planning with economic development would enable earlier delivery of the productivity gains across the economy. Better coordination of land use planning and community services would result in more effective engagement with the community and ultimately greater flow through of higher levels of economic activity to local communities.

Figure 1 **Location links economic and community development**



Source: ACIL Tasman

Other (non-productivity) benefits linked to the increasing use of spatial information are probably worth multiples of the economic benefits. Uncertainties around the likelihood of future natural disaster events and valuation methodologies limit the ability to express such benefits in dollar terms. Nevertheless, non-productivity benefits are important to policy and decision making.

Improvement in the efficiency of water management and natural resource management through better planning and management supported by spatial information could feasibly deliver value in the order of $1 million per year from a 1 per cent improvement in the efficiency of water resources management. This is considered a possible outcome as a result better use of spatial information in the water sector. Wider improvements in natural resources management are likely to be worth multiples of this value.

Improved management of natural disasters through a more coordinated use of spatial information could reduce the average annual damage costs in the order of several millions of dollars. This does not take into account the value of lives saved.

The value of spatial information in protecting Tasmania's biosecurity is also likely to be in the millions of dollars annually. One national study estimated that the cost of control and value of production protected by biosecurity was $8 billion nationally in 2005. The value to Tasmania of protecting its agricultural production and participating in nationally coordinated action is likely to be in the millions of dollars in average damage costs avoided.

Improved delivery of community services, including family and child centres, schools, acute health care as well as primary health care is very difficult to value. This report estimates the accumulated improvement in the efficiency of delivery health and human services could be up to 1.5 per cent by 2020. This represents around $20 million as a percentage of the Department of Health and Human Services Budget.

Spatial information as a source of productivity

Spatial information defines location or place through a georeference in the form of coordinates, addresses or by defining areas such as postcodes or census output areas. This information refers to, amongst other features, streets, protected zones, properties, assets (e.g. lamp posts, signs, bollards), incident locations and administrative boundaries.

The underpinning technology is used to capture, store, manage, analyse and visualise the data, often in form of digital maps. Most importantly, modern spatial information enables the linking and association of people and services through a common location which helps to identify where things happen, where there is a particular need or where to find the nearest service.

The effect of introducing geospatial information technology and services on the economy can be summarised as the ability to deliver more with the same resources by using spatial technologies.

Spatial information can improve decision making in three critical respects:

- Visualisation – allowing patterns and trends to be illustrated in a form that can be easily understood by politicians and citizens.

- Integration – everything happens somewhere and the location 'signature' of an event provides a mechanism for linking sources of data that cannot be easily associated using conventional approaches
- Analysis – the consequences of decisions degrade with distance, looking at different scenarios and the interaction of related decisions is always enhanced by considering their location criteria. For instance, selecting the site for a community facility or optimising bus routes requires spatial analysis.

Spatial information is critical to better decisions based on evidence. Spatial information can provide the fusing of different classes of data to analyse and understand linkages between location, demographics, economic development and social services. It provides the foundation on which policy makers, planners, businesses and the community can make better strategic decisions.

The future

The value of spatial information is likely to increase in Tasmania, as in the rest of the world, as adoption in government and industry increases. However the effectiveness of its application as a source of productivity depends on access to quality foundation data and greater awareness of its use and potential.

Spatial information delivers productivity improvements in waves of innovation. It is the accumulation of these improvements that delivers the value to government services and the economy.

Experience in the UK has also demonstrated that, by providing spatially based information to the community, the costs of service delivery by local governments and local public services can be reduced. This trend is likely to continue over the next ten years.

To realise these benefits, it is important that Government agencies have access to foundation data at an appropriate level of accuracy, and can draw on and add value to this data to meet specific needs. This requires good coordination of systems across government and clear priorities for custodianship and maintenance of data. This also applies to industry and ultimately the community.

While there appears to be pent-up demand for spatial data in many sectors of industry, awareness of the potential to use spatial data to analyse and formulate policy and deliver programs is variable across Government agencies. Increasing awareness of its potential in Government agencies is important to realising future value for government services, the economy and the community.

1 Introduction

In 2011, ACIL Tasman was appointed by the Department of Premier and Cabinet to undertake an assessment of the value of increased investment in spatial information for the Tasmanian economy.

This work was initiated by the Tasmanian Spatial Information Council (TASSIC) and subsequently conducted in association with development of a business case for further Government investment in spatial information.

ACIL Tasman teamed with Lester Franks and ConsultingWhere to undertake this work.

The terms of reference for the original report were:

> "Assessing the value of increased investment in spatial information for the Tasmanian economy. Including analysis of models used to assess the value of spatial information in a similar context nationally, and/or internationally.
>
> A qualitative and, where achievable within the timeframes of the project, quantitative analysis of the impact on the needs of Government agencies and State-owned enterprises including:
>
> - the benefits of increased investment in spatial information including an analysis of the impact on public sector productivity, and
> - the costs to Government agencies and State owned enterprises arising from increased investment in spatial information.
>
> Assessment of the proposed options, based on national and international literature and expert experience, concord with:
>
> - directions in the use of spatial information to support the cost effective delivery of government services, policy, decision making, economy-wide innovation and growth
> - the appropriate role of government in supporting the dissemination and use of spatial information."

2 Spatial information

Spatial information defines a location or place through a geo-reference in the form of coordinates, addresses or by defining areas such as postcodes or census output areas. This information refers to, amongst other features, streets, protected zones, properties, assets (e.g. lamp posts, signs, bollards), incident locations and administrative boundaries. The underpinning technology is used to capture, store, manage, analyse and visualise the data, often in form of maps. Most importantly, spatial information enables the linking and association of people and services through a common location which helps to identify where things happen, where there is a particular need or where to find my nearest service.

At the broadest level, spatial information is a critical enabling technology for:

- evidence-based decision-making
- designing and managing services and infrastructure
- achieving and enforcing regulatory compliance
- dialogue with citizens about their area and its future
- performance management
- describing and monitoring environmental conditions and change
- understanding and locating customer needs.

Spatial information is an integrating technology, supporting the drive for more effective public services to be better focused on customers, shared across local strategic partnerships, managed more efficiently and used more intelligently. It is already fundamental to governments in providing a location context for:

- defence and national security
- emergency management
- biosecurity
- land use planning
- urban and regional development
- property titles
- road, rail and maritime infrastructure
- mapping vegetation, endangered species and areas of environmental and cultural value
- monitoring emissions
- search and rescue
- air and maritime navigation.

It is increasingly becoming an essential component in delivering many services including:

- Planning, economic development and regeneration, transport and traffic management, environmental protection and conservation, waste management, housing, schools admissions, care provision and customer services.
  - These services use geospatial information to develop plans for areas and services, assess planning applications, determine transport accessibility, route bin collections, locate people's social and educational needs, manage assets and properties, target well-being and health improvements, identify sustainable business opportunities and target energy inefficiencies.
- Managing natural resources, monitoring compliance with environmental criteria through baseline mapping of vegetation, soils and water quality
  - spatial information underpins the National Carbon Accounting System, supports programs such as TASVEG and will provide valuable support to policy formulation such as under the Climate Futures project.
- Planning and managing natural disasters and managing national security
  - spatial information is used by the State Emergency Service, fire and ambulance services as well as in support of national security and critical infrastructure activities that involve the Commonwealth as well as the State Government.
- Customer insight initiatives, where the geospatial context is used to gain a better understanding of customers' needs and enhance service delivery by relating it to the location of people, communities and businesses using socio-economic, demographic and environmental profiling techniques.
- Enabling citizens to help themselves in making the most appropriate choices and accessing what they need when they need it.
  - this is an emerging area of the use of spatial information that is yet to realise its full potential. It has, however, been recognised overseas in the context of social inclusion, participatory democracy and mutual obligation.

Spatial information has also been identified by the United Kingdom (UK) government as a means of reducing government expenditure by providing the capability for a more self-reliant community.

Also in the UK, the Society of Information Technology Managers in local government (SocITM) in its latest annual survey of the use of information technology in the United Kingdom, IT Trends (SocITM Insight, 2010), found that of fourteen defined technologies necessary for delivering better services, the top tools are all related to customer service, with geographic information systems the most often mentioned (in over 80% of cases). So, it is clear that the value of spatial information is already widely recognised, both to improve the delivery of local services and underpin policy decisions.

In short, spatial information is fundamental to linking people, services, business and assets to a place – everything happens somewhere.

2.1 What is spatial information

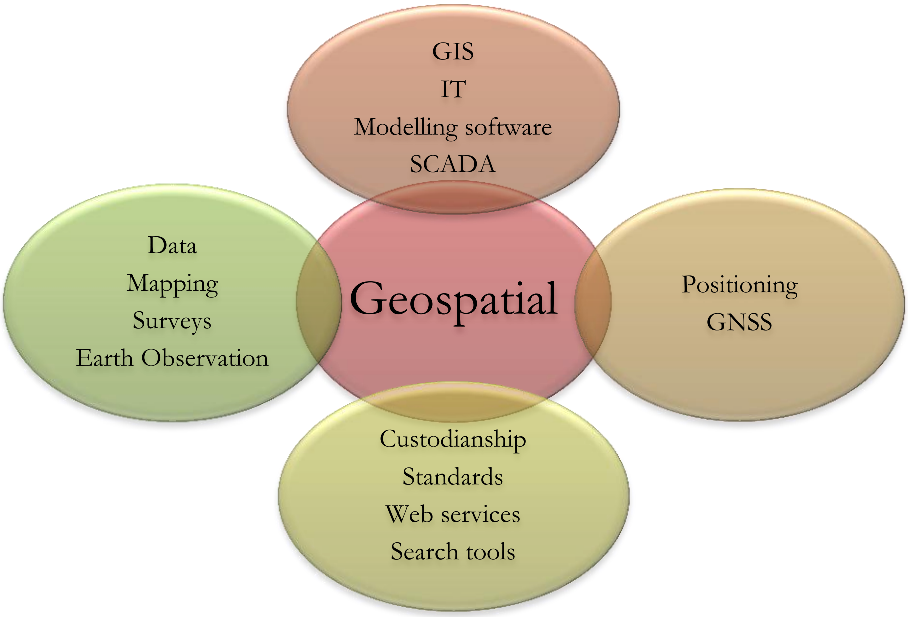
Spatial information (SI) describes the physical location of objects and the metric relationships between objects. Spatial information was originally recorded on paper maps and was the area of interest of surveyors, navigators, engineers and astronomers. This situation remained essentially unchanged until the advent of modern computers, which has permitted maps to be produced, and therefore spatial information to be disseminated, in digitised form. The marginal cost of disseminating digitised spatial information is often close to zero.

Digital mapping, digital photography and remote sensing technologies fit easily into digital communications systems. When combined within geographic information systems and accurate satellite positioning systems, they provide an opportunity for layering data in ways that were not possible prior to say 1990.

The increase in processing power has also allowed capture and analysis of spatial data to move beyond 'surface description' to subsurface or three-dimensional data, and from static points to real time analysis of moving objects. Seismic mapping, photogrammetry, and many other areas of application have consequently emerged as specialties in their own right.

Modern technologies used to acquire and process spatial information include satellite based global positioning systems and imagery, geographical information systems, information and computing technology systems and a range of simulation and modelling software that enables a wide range of geospatial data to be layered onto digital maps (see Figure 2).

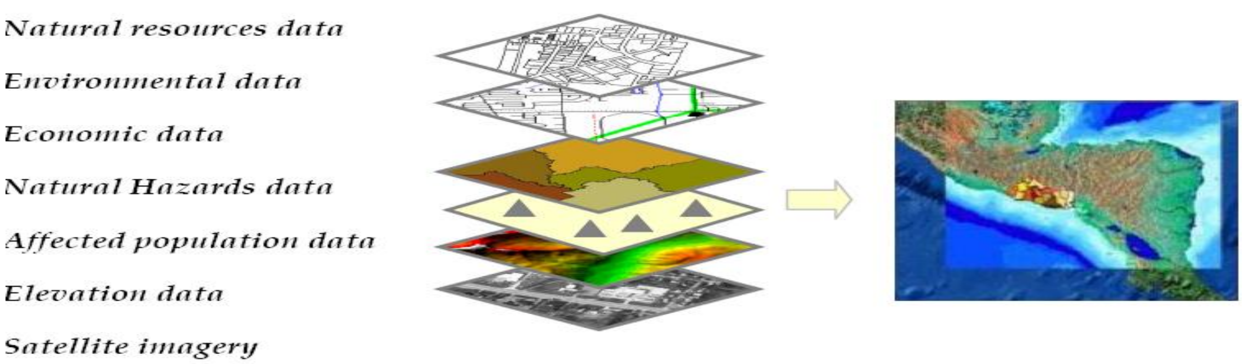
Figure 2 **Modern spatial information supporting technologies and standards**



Note: GNSS stands for Global Navigational Satellite Systems
Source: ACIL Tasman

An important characteristic of spatial data is the capacity to layer different types of data onto a digitised map as illustrated in Figure 3. Data from different sources can be combined to provide new insights into physical, demographic, economic and land use relationships. This can be for planning road alignments to planning the location of community centres facilities. This capability, combined with accurate satellite based positioning has created opportunities for analysis, planning and even control of operations that were not previously possible.

Figure 3 **Layered data**



Data source: ACIL Tasman

This report is primarily concerned with what may be termed 'modern' spatial information technologies – those technologies that combine the capabilities of digital mapping, accurate positioning, spatial modelling and optimisation and web-based applications.

2.1.1 Relative and absolute spatial information

There is a basic distinction between relative and absolute spatial information. Absolute spatial information requires geographical coordinates and delivery of these has in recent years been made possible at increasing levels of accuracy due to the advent of global positioning systems (GPS). Absolute spatial information, delivered in digitised form, is certainly included in this report.

Relative spatial information captures relationships of objects in space. A number of modern production techniques rely on very accurate relative spatial information. For example, underground mining machines are increasingly automated and use an array of high-tech sensors and tools to capture and process relative spatial information.

There is no 'hard-and-fast' or objective rule to decide whether new processes or products that rely on relative spatial information should be included in this economic assessment – for example, modern computer assisted design (CAD) programs deal with relative spatial information. Basic CAD was however excluded from the scope of the present analysis as it was judged to fall within general ICT.

Interoperability and layering was used several times as a criterion to help decide whether a process or application qualified as 'modern' spatial information technology.

For example, where absolute spatial information was integrated into CAD through layering of absolute spatial data over existing relative data this was accepted as being 'modern' spatial information technology.

2.1.2 Users of 'modern' spatial information

There are currently few, if any, sectors of the economy that have not begun to use modern spatial information technologies. Sectors such as property and business services (including surveying), mining, energy and agriculture are already reaping significant benefits from their use.

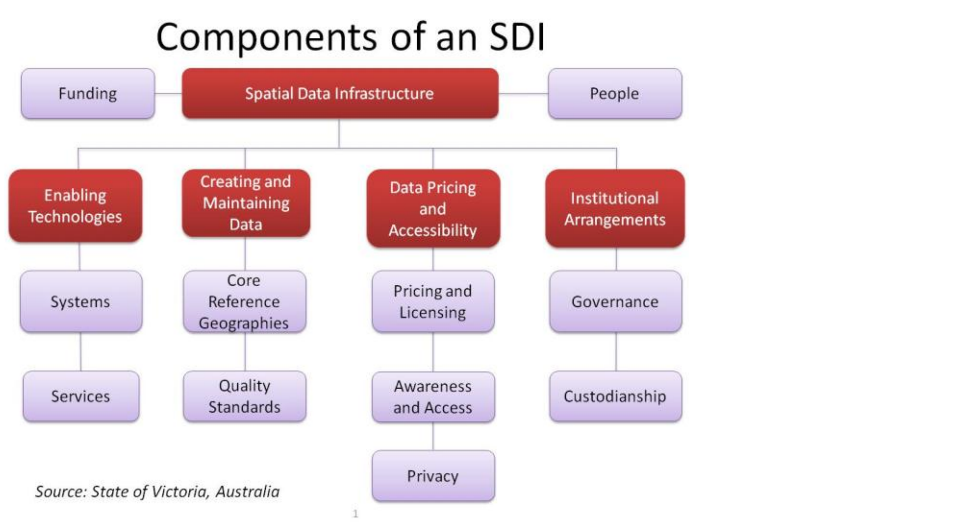
Governments are also one of the biggest users. Spatial technologies support a wide range of activities including geoscience, bathymetry, biosecurity, emergency management, defence, environmental and natural resources management, development approvals and public administration.

2.1.3 Spatial data infrastructure

With increasing penetration of spatial information into almost all aspects of government and industry organisations, the concept of spatial data infrastructure emerged to encapsulate the systems, policies, custodianship and access arrangements that are required to support the data and make it available to a widening range of users.

Possibly the most definitive recent reference work on Spatial Data Infrastructure (SDI) is that written by Ian Masser, titled GIS Worlds –Creating Spatial Data Infrastructures. Figure 4, below, is based on that work and illustrates the fundamental components. The main pillars are enabling technologies, data creation and maintenance, pricing and accessibility, and institutional arrangements. We have enhanced this view by explicitly recognising that the infrastructure also requires adequate funding and human resources in order to be realised.

Figure 4 **Components of an SDI**



Data source: (Parliament of Victoria, 2009)

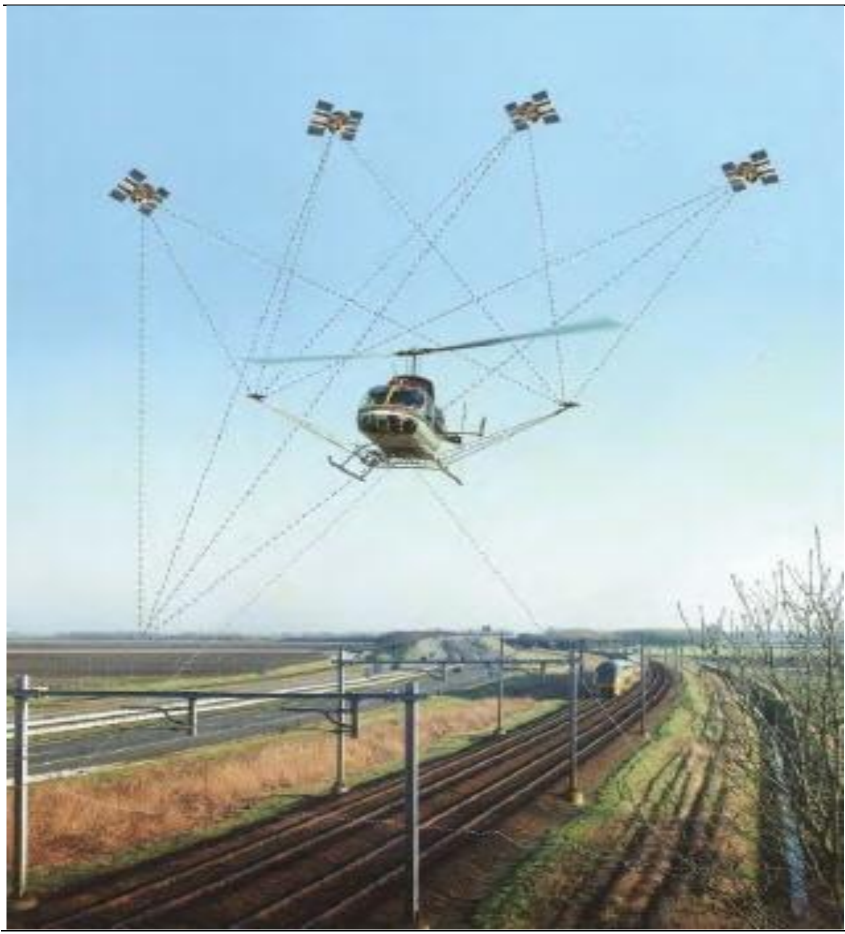
An SDI is therefore not simply a database. The concept includes a broad range of systems and activities that are necessary for access to data.

2.2 Applications of spatial information

2.2.1 Current applications

The largest users of spatial information in Australia have been in the planning construction, resources, mining and transport and infrastructure areas. It has long been used in air and sea navigation, defence and national security. There has been an unprecedented growth in the ways of gathering data through airborne capture, using an array of emerging technologies including accurate positioning with Global Navigational Satellites (GNSS) augmented by ground stations, laser-based Light Detection and Ranging (LiDAR) using airborne measurement, and optical and radar satellites. An illustration of one airborne technique is shown in Figure 5.

Figure 5 **Capturing data with airborne LiDAR**

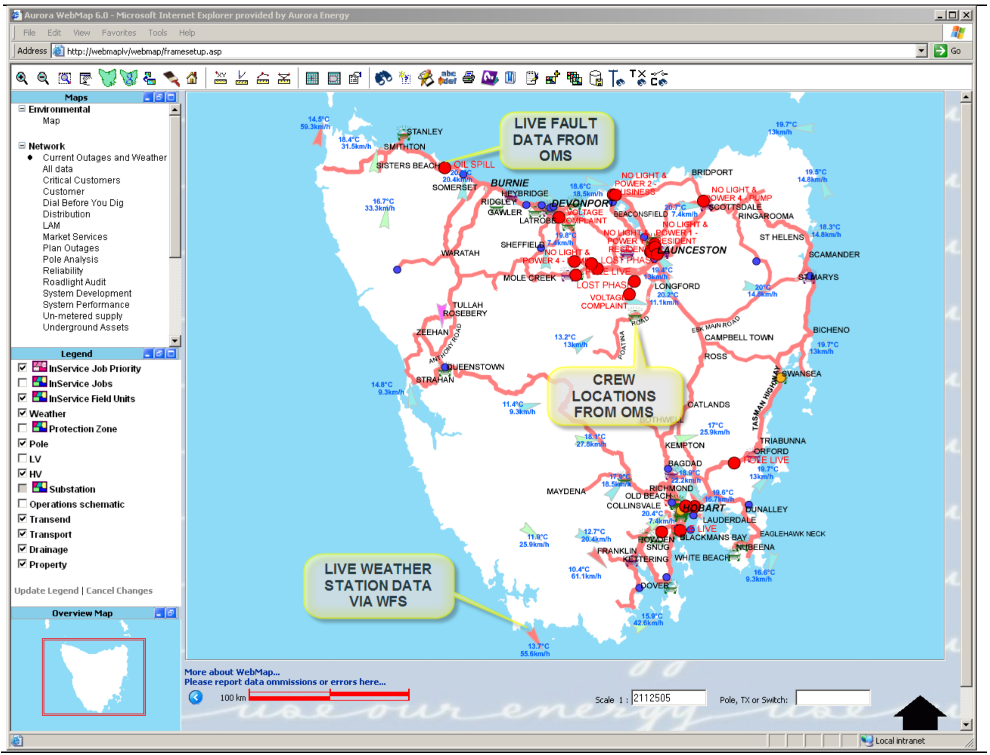


Data source: Fugro Airborne

Spatial information systems were used in the planning and layout of the Tasmanian natural gas transmission and pipeline distribution systems, for the identification of endangered species as well as for planning the pipeline route during design. It is now being used a management tool by TasGas. This has uses not only in operations, but also by maintenance crews in locating and registering faults.

Aurora Energy also uses a GIS system to manage and monitor its electricity distribution network. This enables the recording of faults and system condition, and enables mapping and monitoring of customer complaints to further assist in planning maintenance programs. An illustration of the Aurora system showing the customer complaint recording is shown in Figure 6.

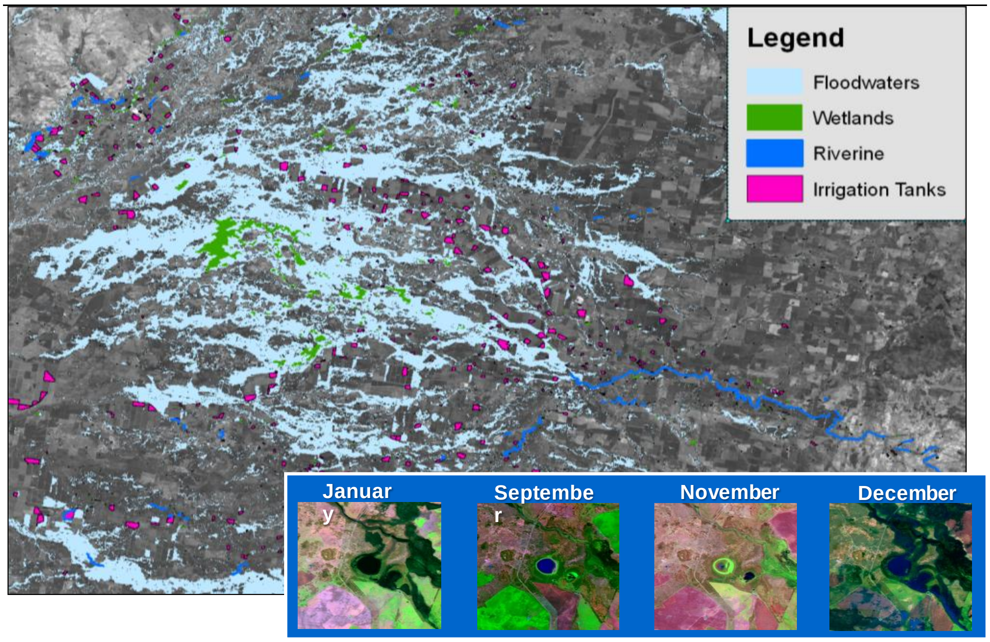
Figure 6 **Aurora Energy GIS mapping of the distribution system**



Data source: Aurora Energy

Another traditional application has been in environmental monitoring. An early application was in vegetation mapping (see Figure 7). This has been important for compliance with environmental requirements. It also has applications in monitoring carbon sequestration and by mining companies to maintain baseline monitoring for licence requirements.

Figure 7 **An example of vegetation mapping using Landsat**



Data source: Geoscience Australia

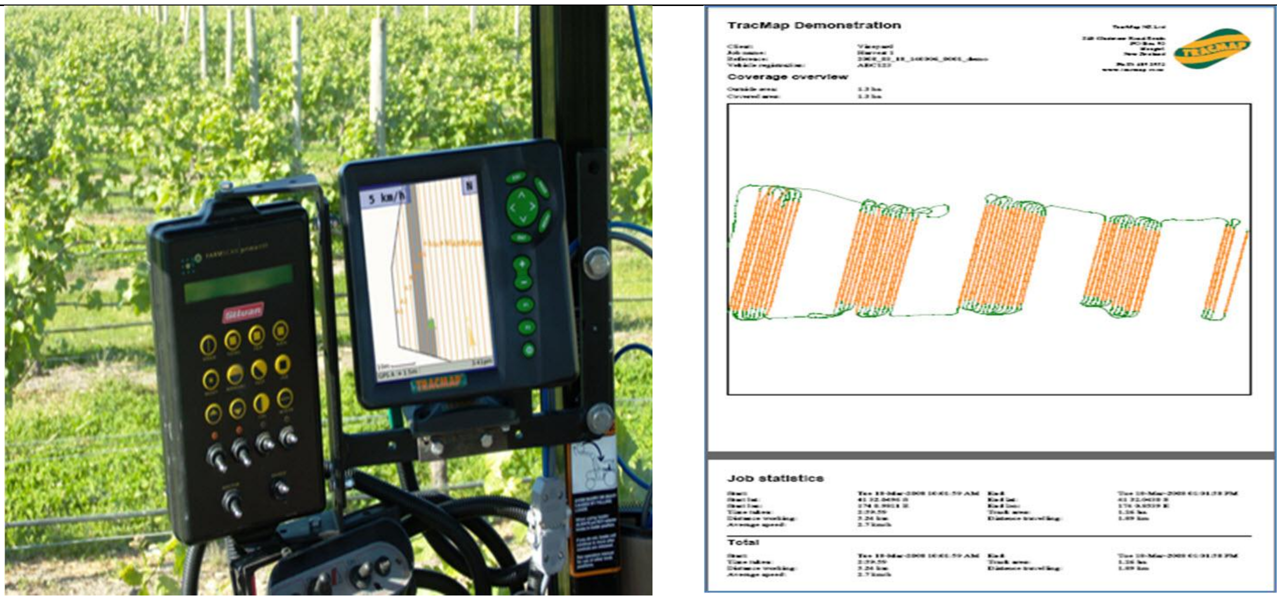
The ability to layer data and the growing ways in which this data can be accessed has increased the potential uses significantly. For example the use of spatial information by the surveying industry in road planning and construction has been very significant. It has been a major source of improvement in efficiency in road construction in Australia and New Zealand (ACIL Tasman, 2009).

Figure 8 **Use of spatial information in road construction in New Zealand**

Data source: (ACIL Tasman, 2009)

Spatial information systems also are finding applications in agriculture for precision farming, yield monitoring, fertiliser control and controlled traffic farming (self-steering tractors). Productivity benefits have been estimated to be of the order of 20 per cent for broad acre cropping. It also has applications in horticulture and viticulture.

Figure 9 **Controlled traffic farming – GPS in a vineyard in New Zealand**



GPS Unit *Route map*

Data source: http://www.tracmap.co.nz/viticulture--horticulture/, Tracmap demonstration map : http://office.tracmap.co.nz

Spatial information systems are also being used for route optimisation in the provision of local services, including municipal services, local transport and ambulance services. It is not yet used in Tasmania to a significant degree, but interviews indicate that there is some interest from local service providers.

Spatial systems are achieving savings in fuel and travel time in Wales. Cardiff City Council, Education Services, is responsible for 140 schools in its area. The Schools' Transport Team manages the transportation of 3,500 mainstream pupils and 840 with a statement of special education needs or special transport needs. Faced with increasing costs, a high burden of contract management and meeting sustainability commitments, they realised that route optimisation offered a solution to all three imperatives.

Using a commercial Route Optimisation application[1] and the Ordnance Survey Integrated Transport Network (ITN), they were able to link the relevant data on routes, vehicles, stops and pupils. The data is displayed on two adjacent Ordnance Survey maps – one showing the needs and the other the existing routes allocated. Planners can then group the pupils together based on their

1

needs and/or location. The system then adjusts the routes to determine the new journey time and cost, and enables of number of different options to be considered.

The benefits were significant:

- £1,300,000 to £1,800,000 saved in the first two years of operation (the majority due to re-tendering on a route by route basis)
- significantly reduced travel distances and hence carbon emissions – routes reduced by 1,200 miles a day
- children spend less time in transit, with the average journey down from 14 to 12 miles
- less congestion on school sites as 40 less vehicles are required
- shorter contract planning time and more efficient tendering: it is estimated that time spent on this will be halved from four to two months.

Such application delivers immediate benefits to transport authorities, schools and students.

2.2.2 Emerging applications

As spatial applications are developed across industries, other industries have been picking up the basic data and adding value for commercial applications. This can range from civilian use of hazard warning systems, development approvals systems and even the use of road mapping in the tourism industry.

An example is the "100% Pure New Zealand" overlay for the Google Earth visualisation tool provided by Tourism New Zealand. The layer allows users to pan and zoom to destinations and click details of what they will find (see example below). Tourism New Zealand has a website[2] that provides historic and predicted tourist flows. Service providers in the tourist industry can use a browser to construct custom maps, which show tourist flows by country of origin, transport mode, and season. Users of the Tourism New Zealand site can also download the underlying data and use a free downloadable tool for more sophisticated analysis, such as scenario planning.

Private and government organisations are developing sophisticated visualisations of tourist flows for analysis. These visualizations help them to:

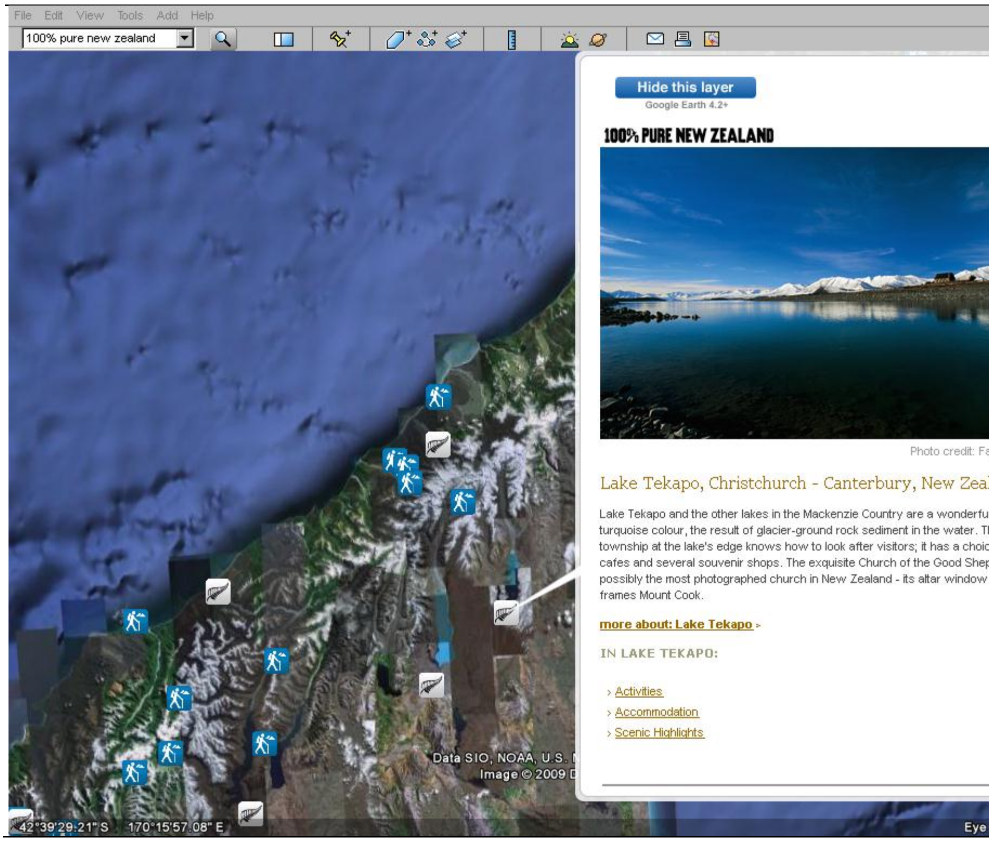
- plan tracks and other facilities in specific locations, like national parks
- understand stopping behaviour – developing intelligence into how people travel, and where and why they stop. Using stopping models, maps can be developed that reflect the average tourist's probability of stopping at

[2] http://tourism.maphost.co.nz/

particular places – which has obvious commercial value. GIS assists in this process by allowing multiple flow representations on a single map

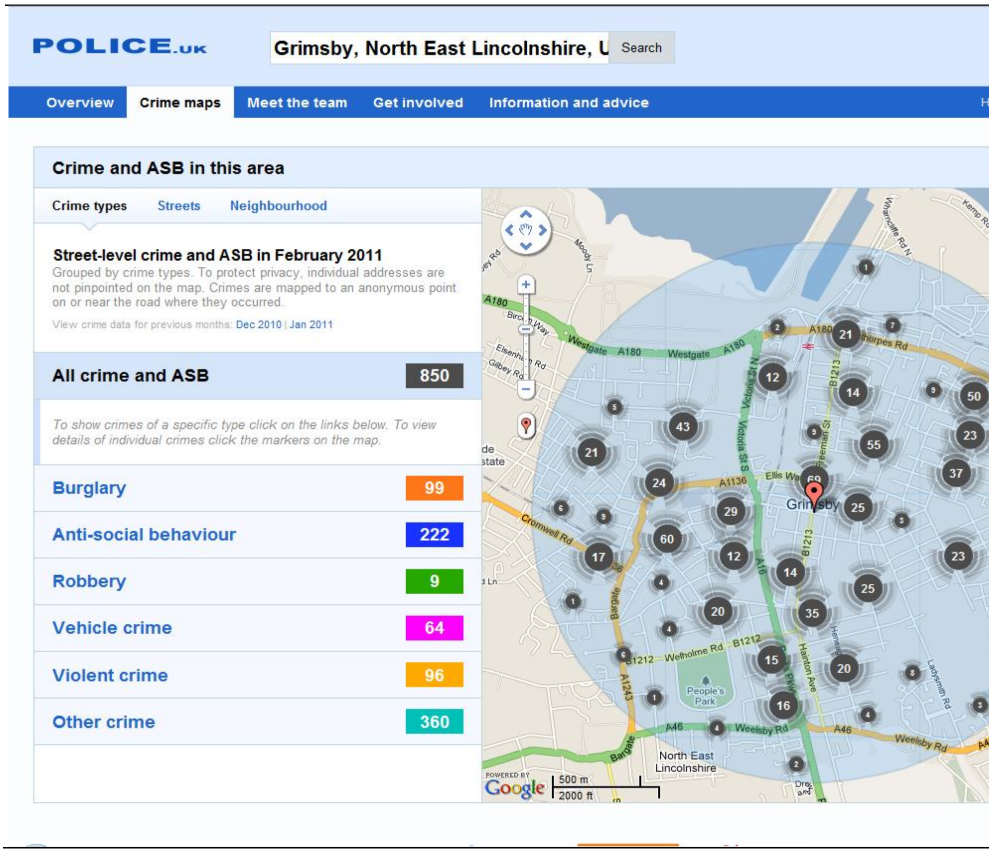
- model the biosecurity impacts of tourism flows – tourism presents a significant biosecurity risk (Forer, 2008)
- make detailed analyses of flows to plan facilities and investment.

Figure 10 **100% New Zealand Google Earth Overlay**



Spatial information is being used by police forces to map and understand crime. The London Metropolitan Police and the Camden Council in east London are using GIS mapping to better analyse the causes of crime and plan prevention measures to reduce the load on policing. The North Yorkshire police are now provided with handheld GIS devices to provided situational awareness information during investigations of crime scenes and locations. An illustration of a crime mapping application in Grimsby in the UK is shown in Figure 11.

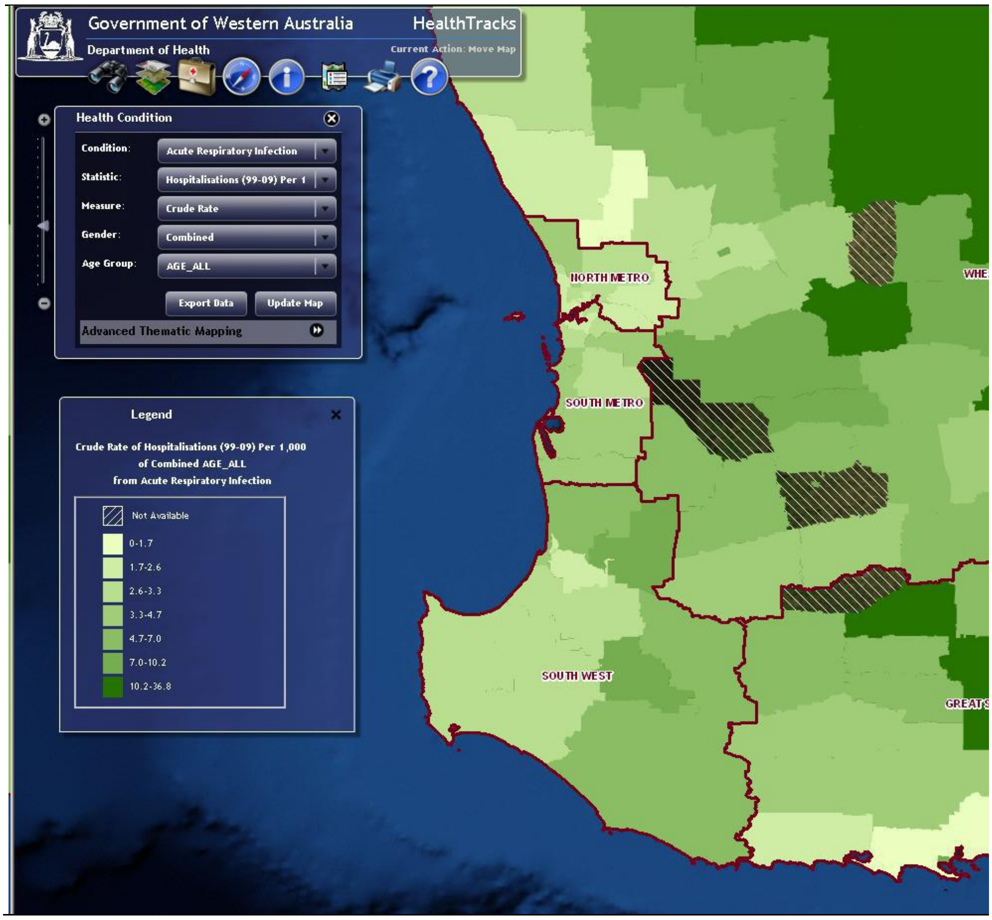
Figure 11 **Crime mapping in the UK**



Data source: ConsultingWhere

Spatial data is also being used in the UK and Australia to improve the analysis of health patterns in relation to suburbs and environments, and to better plan the investment in and the location of health facilities and hospitals. Figure 12 shows a GIS-based health analysis tool developed by the Western Australian Department of Health. The user-friendly web-based application uses spatial information in the presentation of baseline evidence for decision-making, with fast access to information that is easily understood by users. By spatially enabling a range of relevant statistics, public health managers, policy developers and planners can gain a broader understanding of the geographic relationships between health services and areas of health need, enabling them to link environment to particular diseases or conditions and make more appropriate, targeted decisions for the delivery of services to the community.

Figure 12 **Health tracking analysis in Western Australia**



Data source: (Department of Premier and Cabinet, March 2011)

An emerging development in the use and application of spatial information is involvement of the community in the spatial systems of government and even industry organisation. The emergence of smart phones has created the opportunity for the public to also provide data into spatial information systems. Figure 13 shows an application for a smart phone that allows citizens to report problems to the local council. Users can use their phone to record a problem such as a pothole, graffiti or dumped rubbish, and log it into the system. The location is automatically geocoded, providing the authorities with instant location data.

Box 1 **Greater community engagement**

The trend towards involvement of the community in provision of community services will be made more feasible with future developments in spatial information. This has been adopted in the United Kingdom as a means of reducing the costs of local public services by engaging the community in addressing issues of disadvantage. This is the philosophy behind the "Big Society" approach which is described in the following terms:

> "The Big Society is about helping people to come together to improve their own lives. It's about putting more power in people's hands – a massive transfer of power from Government to local communities."

There are three elements to the Big Society agenda:

- Community empowerment:
  - giving local councils and neighbourhoods more power to take decisions and shape their area. Planning reform will replace the old top-down planning system with real power for neighbourhoods to decide the future of their area.
- Opening up public services:
  - public service reforms will enable charities, social enterprises, private companies and employee-owned co-operatives to compete to offer people high quality services.
- Social action:
  - encouraging and enabling people to play a more active part in society. Funding will be provided to promote citizen service, training community organisers and encourage people to get involved in their communities.

In the context of this the use of spatial information it might see the transfer of responsibility for maintaining a database of, for example, "potholes" to local communities. The local people have an interest in making sure such information is current and reflects the priorities of the community. The payback for this "crowd sourced" approach to the local authority is to reduce the effort required for data creation and management.

Source: ConsultingWhere

The Tendring Local Council in the UK has opened its GIS system to the public. Development approvals are now made available with mapping data via the internet. This has significantly reduced the demands on Council staff in dealing both with objections to development applications as well as providing advice to ratepayers.

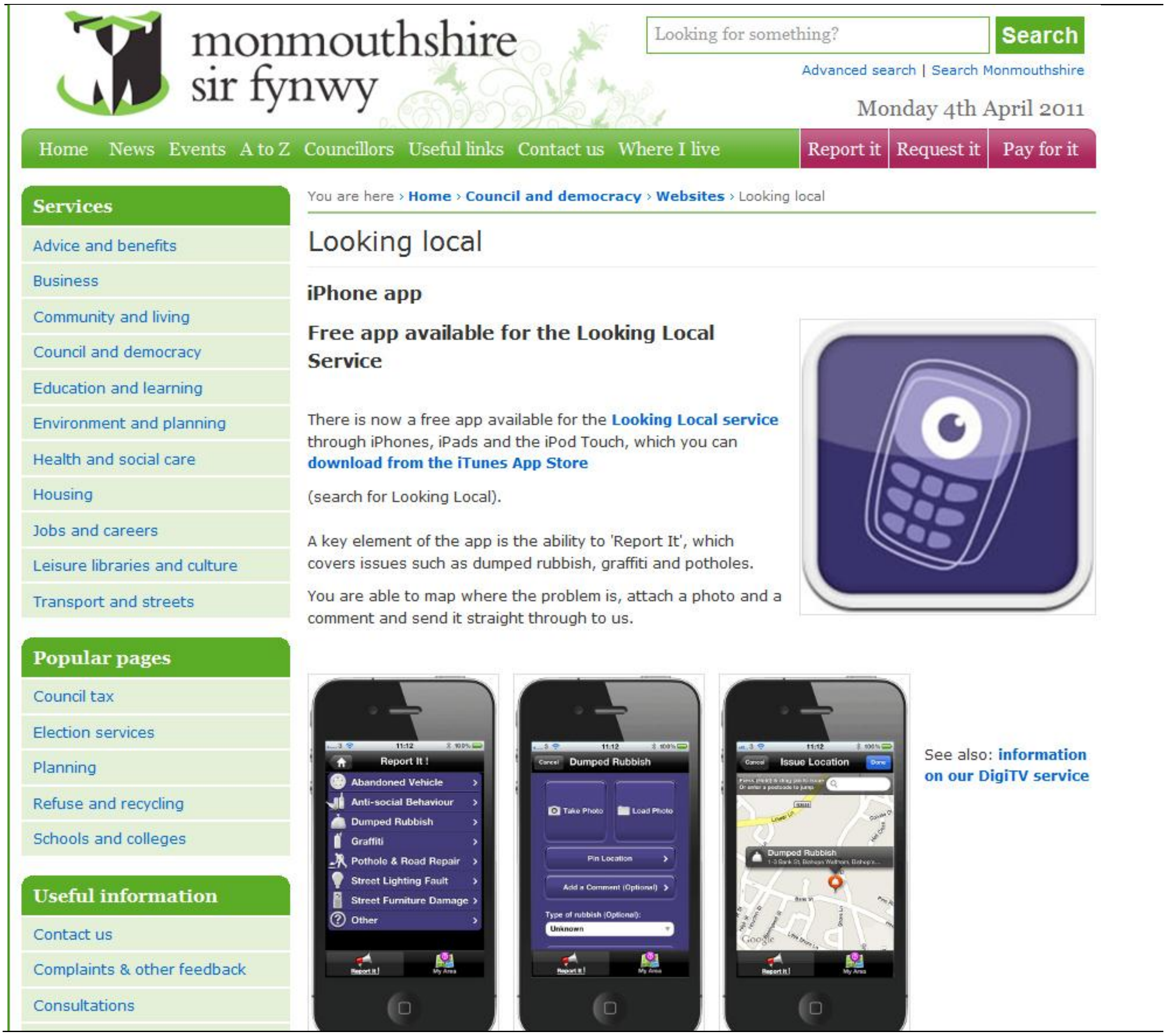
This shifting of communications between the public and the local council reduced the demands on staff and delivers cashable benefits in terms of reduced operating and staff costs to deal with complaints as well as development approvals. In the UK this is referred to as 'channel shift' and has potential applications across public services more generally.

2.2.3 Greater engagement with the community

The ability to provide information to the community is an important new development in the use of spatial information. Most users of a computer are now familiar with the use of mapping programs to locate services, plan trips or view mapping data in many formats. The development of mapping capability in smart phones is also being used provide the community with hazard warning.

An example of a smart phone application for locating local community services in the UK is shown in Figure 13.

Figure 13 **Providing access to the community**



Data source: ConsultingWhere

New South Wales Rural Fire Service has developed 'Fires Near Me', an application providing mapped information about current fire incidents across Australia on a smart phone (see Figure 14). The application provides users with the ability to source information on incidents near them, using either an entered locality or the GPS function of the smart phone.

Figure 14 **Fires Near Me smart phone application**

Data source: (DPAC, 2011)

The future of spatial information systems presents the prospect of improving the ability for public sector organisations to plan and manage their operations, improve strategy and decisions based on evidence-based planning and ultimately to provide for better engagement with the community in a two-way flow of information where place is important.

For most government services, place is important.

3 The scenario

3.1 Current situation

Tasmanian Government agencies achieved considerable progress in the coordination and delivery of spatially-based information during the mid-1990s.

The Land Information System Tasmania (LIST) was considered leading edge, award-winning technology when it was developed. However, its core hardware and software is now around fifteen years old and has become outmoded and inefficient. It does not allow the enhancement of services to meet acknowledged and growing demand. In addition, many current services do not conform to internationally accepted standards. As a result, LIST is incapable of supporting the increasing demand for interoperability.

The system is also not well set up to be extended into other disciplines such as demography and social sciences. As a result, Government agencies have limited capability to benefit from sharing and analysing spatial information.

3.2 Goals

The scenario proposes new investment by the Tasmanian Government in spatial information. The intended immediate beneficiaries of such investment would be Government organisations. There would also be flow-on benefits and more efficient, effective and sustainable outcomes for the broader Tasmanian community and the Tasmanian economy.

The goals of investment in spatial information are to:

- improve the supply of quality spatial information to meet current and projected needs and
- build Government capability to realise the value of spatial information through the implementation of standards, policies, shared spatial analysis capability resources and business support.

The overall aim is to significantly increase the value of spatial information to Government through appropriately targeted investment.

3.3 Action areas

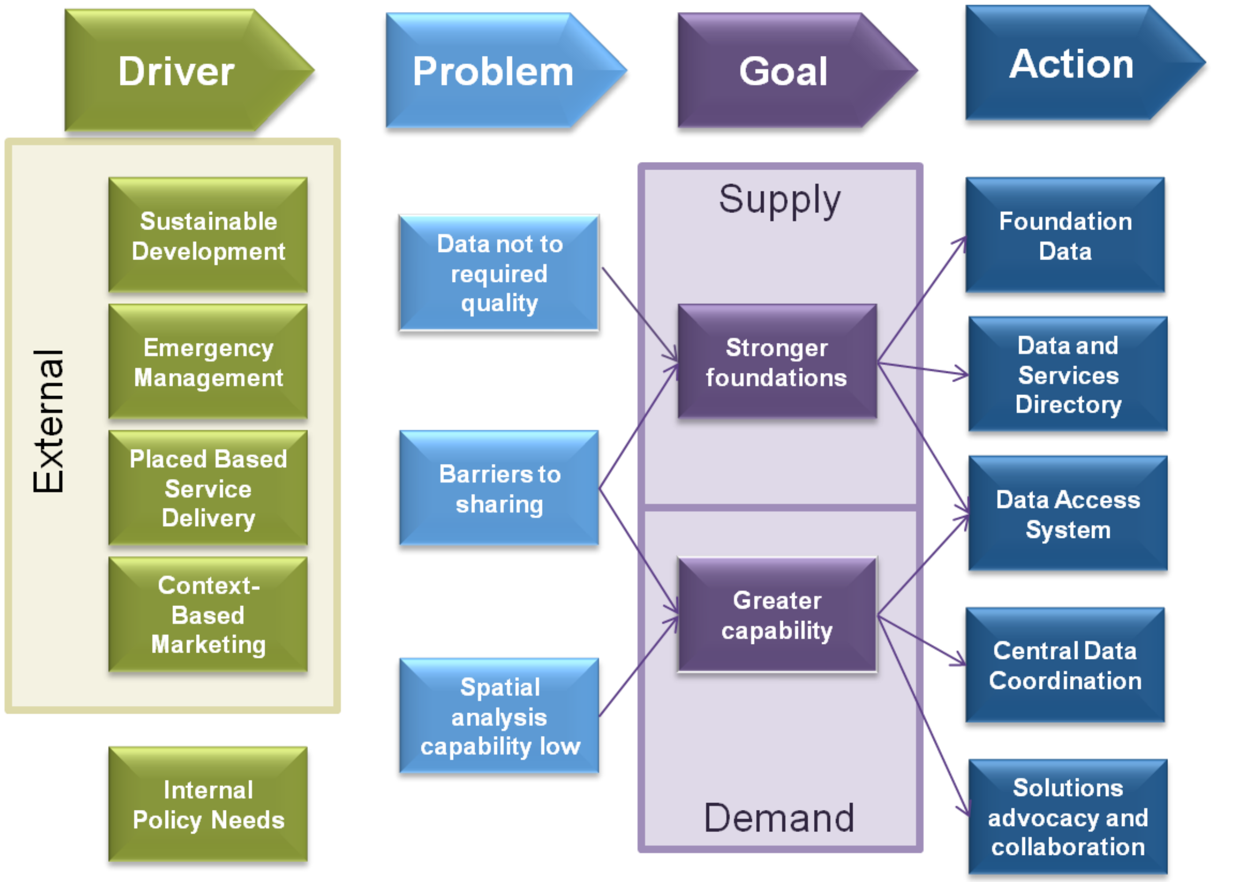
Five action areas have been identified by the Tasmanian Government:

- foundation data: enhance and acquire key spatial data sets that have application across many government functions.
- discovery of data and services: establish and maintain a whole-of-government data and services directory.

- access and delivery of data and services: enhance and maintain systems that provide access to data and services.
- central data coordination: establish a centrally coordinated framework of policies and standards, including mechanisms to align and rationalise data capture and maintenance.
- spatial solutions advocacy and collaboration: develop whole-of-government spatial analytical and business development capability to support integration of the use of spatial information into core business systems.

These actions are illustrated in Figure 15.

Figure 15 **Action areas**



Data source: (DPAC, 2011)

The drivers for these actions are sustainable development, emergency management, placed-based service delivery and context-based marketing. As will become evident from the discussion that follows, these four drivers underpin the achievement of a number of high priority economic and social policy goals of the Tasmanian Government.

The proposed actions would aim to address both supply and demand aspects of the collection, use and application of spatial data in Tasmania. One of the challenges of extracting the full value of spatial information, including access through associated supporting systems, is the creation of capability across government to use and deploy spatial applications.

The scenario allows investment in key areas as shown in Table 1.

Table 1 **Investment profile**

Key area for investment	Action
1. Foundation data	Enhance and acquire key spatial datasets – cadastre (property boundaries), transport network, remotely sensed imagery, property addresses, emergency management data
2. Discovery of data and services	Develop and maintain a whole-of-government data and services directory
3. Access and delivery of data and services	Enhance and maintain technological systems and services for access and delivery of data and services
4. Spatial data collection and maintenance	Establish a centrally coordinated framework of policies and standards for the collection and maintenance of spatial data that continues to meet the needs of data custodians and end-users, including mechanisms to align and rationalise data capture and maintenance
5. Spatial solutions, advocacy and collaboration	Develop whole-of-government analytical and business development capability to support the integration of the use of spatial information into core Government business systems

Data source: (Department of Premier and Cabinet, March 2011)

3.4 Assessment of proposed actions

Investment in the key areas proposed is a significant step forward in the profile and recognition of spatial information in Tasmania. These areas have been studied for alignment with existing strategy, with comment generated about some specific elements.

The stated primary purpose of investment is to build solid foundations upon which the Tasmanian Government can "realise the value of spatial information to deliver benefits for the entire Tasmanian community". This statement properly recognises the value of spatial information to Government, and indirectly to the community.

The scenario is founded on and well-aligned with the 'Strategic plan for spatial information in Tasmania 2009-2012' developed by TASSIC, as confirmed through direct discussions with the TASSIC Chair.

It is important to recognise and emphasise that spatial information should be *considered as infrastructure*, not just as a series of tools to support traditional hard infrastructure.

Recognition as such starts to give credibility to the arguments for recurrent spending, and aligns the terminology of 'maintenance' with that of traditional infrastructure.

One of the problems highlighted in existing Government documents is the lack of feedback loops and methods to inform future policy and practice. One method to improve that situation is the careful selection of Key Performance Indicators (KPIs). The user community in particular (including the private sector) would gain comfort from the establishment of KPIs as a way of assessing the success or otherwise of Government spending.

It is important that any future investment in spatial information is not seen as a quasi-redistribution of existing capability. It is important that investment is in addition to, not at the expense of, current (functioning) spatial programs and services.

In the proposed scenario, it would be expected that some investment would result in 'cashable' savings for some areas of government in the near term.

The importance of coordination and uniformity of approach across Government cannot be overstated. A whole of government approach is critical to develop and support analytical and business capability. The implementation of discrete projects would require close consultation with the expected user community, e.g. a program for remotely sensed imagery capture.

The inclusion of non-government stakeholders in the governance of such activities should also be considered. This would assist with private sector 'ownership' of future public policy and practice.

It would be useful to utilise the influence of the TASSIC Chair as much as possible to assist in keeping stakeholders informed and enthusiastically involved.

3.4.1 Level of investment

The level of investment suggested in the scenario is modest compared with similar expenditures in New Zealand and Canada. This comment is made with full cognisance of the current, extremely challenging economic environment.

It is important that any future investment is not at the expense of existing functioning and useful programs. Building on existing capacity – not eroding it – is critical.

The type of investment outlined in the scenario creates a foundation for future discretionary investment as opportunity arises, either through policy, political or financial circumstances.

3.4.2 Summing up

The scenario presented is aligned with current thinking and strategy documents. Overall, financial implications of this level of investment appear relatively modest compared with the levels of investment in New Zealand and Canada. The potential return on investment (ROI) in spatial information is significant.

While a 'big picture' investment in all key areas presented in the scenario may not be able to be implemented immediately, having well planned and 'ready for implementation' plans to hand will mean an easier investment decision can be made in the future.

4 Spatial data and creation of value

In this section, we introduce the concept of applying economic assessment to the field of spatial information. Some of the key arguments for the approach adopted here are developed, including issues of productivity in the public sector as well in the private sector and the role and impact of knowledge within the economy.

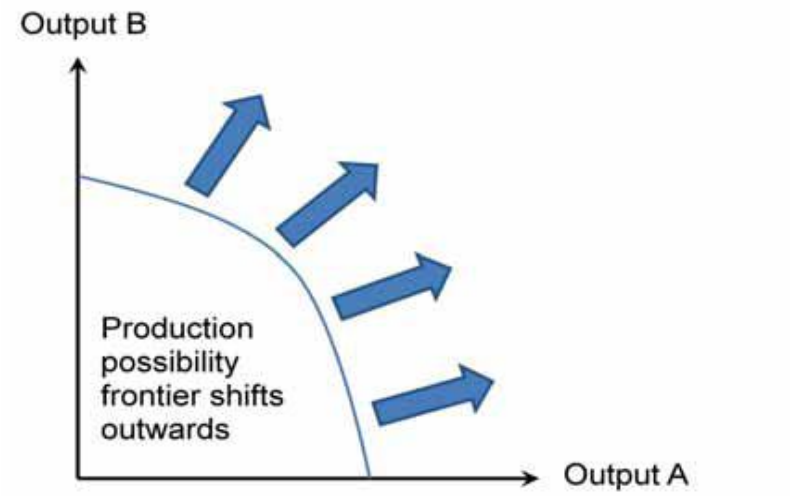
We discuss the need to consider firstly, the 'counterfactual' – that is, the improvements in efficiency that technology would have generated in the absence of geospatial information; and secondly, the elasticity of demand for services. The section concludes by examining what economic research leads us to believe it is reasonable to expect in terms of technology adoption. It also models the application of this research to the geospatial information in the local public service market.

4.1 Spatial information, the economy and society

4.1.1 Increasing productivity in public service delivery

The effect of introducing spatial information technology and services on the economy can be summarised as the ability to deliver more with the same resources by using geospatial technologies; this idea is summarised in Figure 16 which shows an economy's so-called 'production possibility frontier' shifting outward as a result. One of our aims is to provide a better understanding of the likely extent and the factors affecting the rapidity of this shift in the local public sector.

Figure 16 **Spatial information and the economy's productive capacity**



Source: ACIL Tasman

There will always be winners and losers from shifts in technology and services – some tasks or jobs may, for example, become redundant – but the argument is that, overall, society can produce more and better outputs with the same inputs. This means that losers can be compensated while still leaving extra value for the economy as a whole. This 'extra value' may come in several forms:

- extra time available to existing staff, who can thus be redeployed in other production or service areas, or to improve product or service delivery
  - some of the implicit savings may result in an actual lowering of costs to public service providers which in turn enables more services to be provided for the same amount of money or the same level of services for lower budget appropriations. In the current budgetary climate, such developments are crucial to maintaining service levels.
- more widely, if there is strong competition among commercial adopters of the new technology and if many or all firms adopt the technology, better products and services *as well as* price reductions may flow to final consumers who thus benefit from what economists call 'consumer surplus' (an amount that they would have been willing to pay but are not asked to pay)
  - where there is some degree of 'imperfect' competition so that firms can 'hold on' to the extra value in terms of reduced input costs or a premium charged on new products to final users, this may free up financial resources that can be reallocated to a number of areas.

A proportion of the 'extra' value to the economy is thus captured by final end users, and some of it is captured by the 'intermediaries' that deliver products and services (and this can include government, non-profit and commercial users). Economic growth, in turn, means the 'size of the pie' as a whole increases, which feeds back to these organisations as increased demand for their products. This 'size of market' effect is in addition to the effects discussed above.

Improved outcomes in areas such as health, education, social care and the environment are important non-market benefits from the use of geospatial information; these will also have longer term impacts on the economy which are harder to estimate and beyond the scope of the modelling for the original report. These long term effects may, however, be critical to sustainable economic growth and should not be underestimated.

The range of possibilities means that the impacts of introducing geospatial information can differ widely by application and across sectors, and accounting for these impacts can be difficult, which indicates a practical issue with attributing benefits from new technology when it consists of a range of complementary innovations including geospatial ones.

The terms data, information and knowledge are often used interchangeably. Information refers to data that has been organised so that it can be communicated, reproduced or interpreted. Whilst this is knowledge, it is only of a 'rudimentary' type. As long as it remains unused, its value resides mainly in the *options* it creates for future analysis and 'value addition'.

Spatial information can aid deeper knowledge creation and enable inventive or innovative activity, thus ultimately contributing to the production of 'useful' knowledge. The 'core' spatial industry specialises in generating, as well as utilising, geospatial information to create value added products and services.

Value addition does not always occur along a 'linear' path to market. Invention and innovation involve complex knowledge networks that are currently still very much the realm of economic research; however, the role and value of information in determining broad macroeconomic outcomes has been increasingly recognised as advanced industrialised economies are shifting to what has become known as the 'knowledge economy'. The role of research and development and human capital has been emphasised as influencing levels of long run economic growth (key papers by Grossman and Helpman, 1990, Romer, 1990). More recently, the Power of Information report (Mayo E, 2007).

Knowledge is sometimes seen as a kind of 'multipurpose' capital that can be transferred across sectors and applications; however, there is some controversy about this interpretation as there is a distinction between specific knowledge (which cannot be transferred) and other types of knowledge (which are hard to define and measure). The economic literature on knowledge capital, and it links with information, is extensive and increasingly concerned with empirical verification (e.g., Eckwert, An economic assessment of the Spatial Information Foundations business case d Zilcha, 2001, Loof and Heshmati, 2002, Haag et al., 2004, Gibbs and Middleton, 2008)

In a related development, the Nobel Prize winning economist Joseph Stiglitz has referred to the rise of informational economics as a "change in paradigm" (see Stiglitz, 2000b, Stiglitz, 2002). This report echoes the sentiment in the context of geospatial information, arguing that full appreciation of the value of geospatial information involves a change in paradigm at various levels.

A number of reports in applied economics have scoped economic issues that are specific to geospatial information, and given some indications of the value of geospatial information (Oxera, 1999) and spatial data infrastructures or 'SDIs' (European Commission, 2006). The Cambridge study (Newbery et al

2008) on models of public sector information provision via trading funds, specify and test some model specifications that yield estimates of key demand elasticities for public information (including geospatial information). The paper provides a rigorous, 'theory driven' approach to arrive at long term price elasticity estimates, and along with the literature cited above, points to potentially high returns from geospatial information (and investment in SDIs).

However, there are potential weaknesses in these studies. In the response to the consultation on Ordnance Survey (CLG, 2010) it is suggested that the broader welfare benefits are not likely to be as significant as assumed in the Cambridge study. Also, there is still uncertainty about how much money and other resources have already gone into, and are continuing to flow into the maintenance and upgrading of SDIs.

One approach to addressing the problem of evaluating the direct and indirect economic impacts of geospatial technologies and services is to view their impacts through the prism of productivity. That is, the impact such applications have on the efficiency with which resources are employed in producing outputs and the overall impact of these accumulated productivity improvements (productivity shocks) on the wider economy and by inference economic welfare generally.

4.1.2 Productivity accounting

Productivity accounting is a branch of economics that attempts to attribute measured productivity gains to its sources. It is briefly discussed here so that the reader will have a better understanding of how the accumulated impacts of productivity improvements can be translated into wider economic impacts. That is, how productivity shocks that are employed to model the impact of geospatial information in this report.

Traditionally, productivity accounting decomposes productivity gains into gains from two major inputs, namely capital and labour, and a residual called multifactor productivity (MFP).

MFP is often seen as a proxy measure of productivity growth due to technology shifts; however, in the case of geospatial information the utilisation or absorption of this information can improve the quality of capital or labour itself. This type of impact is called *embodied* technological change and is particularly hard to measure. For example, if key employees are able to make consistently better decisions then the quality of labour has essentially improved – dealing with spatial information consequently has knowledge effects which become embodied in the labour stock.

Detailed investigation of these complexities with regard to geospatial technology is beyond the scope of this report, and as already indicated these issues have been touched upon here to assist the reader in understanding some of the discussion that follows. The first point, in relation to which the above terminology becomes important, is the history of productivity change, which really sets the geospatial information technology shift into its proper context.

4.2 With and without spatial

The economic impact assessment is based on modelling 'with-and-without' scenarios using a computable general equilibrium (CGE) model (further details on the modelling approach are presented in Attachment C). The model provides the capability to analyse the flow-on impacts of changes in different sectors of the economy following the introduction of a new technology or related changes to work practices (or productivity 'shock') and to compare the impacts of these changes on economic aggregates such as GDP, consumption, employment and investment.

4.2.1 Market failure

Much of the large and ever-expanding body of theoretical literature in informational economics is concerned with the consequences of 'market failure' in the market for information, but the literature is wide and varied (some examples are Lawrence, 1999, Eckwert and Zilcha, 2001, Chernew et al., 2008).

Box 2 explains key economic concepts which are often used when making the case for government intervention.

Box 2 **Market failure and natural monopoly arguments**

Public goods exist where provision for one person means the product is available to all people at no additional cost. Public goods are said to be non-rivalrous (that is, consumption by one person will not diminish consumption by others) and non-excludable (that is, it is difficult to exclude anyone from benefiting from the good). Common examples include flood-control dams, national defence and street lights.

Given that exclusion would be physically impossible or economically infeasible, the private market is unlikely to provide these goods to a sufficient extent. The nature of public goods makes it difficult to assess the extent of demand for them. It is ultimately a matter of judgement whether demand is sufficient to warrant government provision.

Externalities occur where an activity or transaction has positive (benefits) or negative (costs) economic welfare effects on others who are not direct parties to the transaction. Public goods and some externalities are similar analytically – externalities have public good characteristics in that they are non-rivalrous and non-excludable.

Information failures occur where there is insufficient or inadequate information about such matters as price, quality and availability for firms, investors and consumers to make informed decisions. Government may perceive a role to complement or verify market supplied information – for example, government licensing, registration and labelling regulations for chemicals and pharmaceuticals.

Natural monopoly occurs where it is more efficient for one firm to supply all of a market's needs than it would be for two or more firms to do so. It arises where there are significant economies of scale resulting from fixed costs which are large relative to the variable costs of supply. Monopolies may charge excessive prices, so regulation or government ownership is often adopted.

Source: Productivity Commission (Australia)

In addition to these, governments take into account equity-based arguments. With regard to spatial information, 'supply side' arguments for a role for government can be identified in the following areas:

1. Making data available: infrastructure investment, collection and publishing of data are activities that have 'public good' as well as 'natural monopoly' justifications:
   - i once data are released into the public domain, anyone can use them
   - ii there are significant economies of scale in data collection and in the use of data and the infrastructure that supports it.
2. Providing middleware, basic standards, and regulatory frameworks: the government can play a role to help overcome information failure, through for example (i) awareness and best practice guideline information, (ii) criteria for selecting suppliers, (iii) international initiatives such as INSPIRE and (iv) setting applicable standards. It can play a role in providing 'middleware' (e.g. a Registry) where the market fails to provide such

middleware. It also has a responsibility to develop regulatory frameworks where:

- i there are few incentives for 'core' private spatial industry companies to direct potential users to sources of basic data or to other providers
- ii similarly, successful private providers have little incentive to self-regulate and/or standardise; it is in their interest to minimise the potential for the loss of repeat customers.

3. Training and education: governments are traditionally involved in training and education as private companies often under-invest in this area because they risk losing that investment when their staff members move to competitors ('free riders').
4. Assisting small business: this has an equity component but also an innovation system rationale; most of the spatial industry companies are small or 'micro' businesses with 5 to 20 employees (Park et al., 2008).

At the same time, there are 'demand side' arguments for governments' involvement with spatial information:

1. To assist with efficient provision of services: governments provide many services that benefit from use of spatial information.
2. Policy making: governments recognise that having access to spatial data and modelling of geospatial events over time can play a significant role in shaping policy (e.g., coastal erosion and land development); this also relates to governments' wider responsibilities to their constituents (for example social welfare, health and sustainability). The role that spatial information plays in driving the "information economy" is also increasingly widely recognised.

Key observations

It is important to note that:

- spatial information is not a public good until it is placed in the public domain (it is to some degree 'excludable' and is not a public good by virtue of its mere existence);
- market failure does not automatically imply that government *should* interfere; costs and benefits from intervening must still be assessed
  - this also means that government has to carefully balance private sector interests with the wider public interest when deciding to intervene, and ideally seek solutions that deliver the wider results whilst not impeding private initiatives
- similarly, a natural monopoly situation does not mean that government *must* perform this function; there are several private companies that have the

ability to provide some of the key geospatial information services, and are even able to afford some of the infrastructure spending, that would traditionally have been seen as the remit of government

- finally, dynamics can be important and if government enters or supports a sector that is moving rapidly it should also consider its 'exit' strategy – along with the preceding comment this means that the *appropriate role of government is fluid and shifts over time.*

The key tests for involvement of the public sector are:

- a public interest need is to be met, and
- a public agency is sole provider, or
- the private sector is unable to provide a particular product or service, or
- based on national competition policy measures, use of a public sector provider is the most cost efficient use of resources.

4.2.2 Government failure

While the term 'market' failure is employed almost routinely in debates about what governments should or should not do, concepts of 'government failure' are not discussed as frequently. Stiglitz (2000a) outlines four major reasons for the systemic failures of government to achieve its stated objectives in his textbook *Economics of the Public Sector*: limited information; limited control over private market responses; limited control over bureaucracy and limitations imposed by political processes.

In the context of the use of spatial information in England and Wales, it was commented several times during the preparation of this report that national and local government holds a large amount of geospatial data but that this is either not being shared effectively across departments (i.e. held in 'silos') and sometimes not released at all, and that there is a lack of knowledge as to what data are available where, and how one can access them. This situation could indicate aspects of 'government failure' in the economist's sense of the term. It has led to suboptimal data sharing within government as well as lower data use and re-use by non-government entities.

Stiglitz (2000a, p. 205) provides a number of explanations for this type of public sector inefficiency, including an absence of competition (a corollary to being the natural monopoly), the absence of incentive pay and various principal-agent problems such as the pursuit of bureaucratic objectives and high levels of risk aversion exhibited by government departments.

4.2.3 Elasticity of demand for information

The elasticity of demand measures the change in the quantity demanded which occurs following a change in the price of the product or service being traded. This is an important consideration for spatial information policy, as many government data custodians continue to charge for spatial data.

There is evidence that charging a price, however low, can have a strong deterrent effect, in particular when potential buyers are unsure of what they are buying or how it will assist them (uncertainty of product is a peculiar feature inherent in the market for traded information; see Stiglitz, 2000b).

Secondly, where a price is charged for information, there is evidence that demand is elastic, i.e. responds relatively strongly to changes in the price charged (and 'cuts out' as price exceeds a threshold level). A recent example comes from New Zealand's National Institute for Water and Atmospheric Research (NIWA):

> "This year, we opened up web-based access to our archived data free of charge. The response was excellent with the number of registered users of the National Climate Database rising from 130 to over 4000." (NIWA Annual Report 2008)

In other words, a drop in price to zero saw 'demand' multiply by more than 30-fold. However, this may not reflect the 'true' price elasticity because of the large backlog of demand that may have been met in the first year. The Cambridge study similarly cites other sharp increases in demand following the introduction of free access policies and concludes that in most instances the price elasticity is likely to be between 1.0 and 2.0 (Newbery et al., 2008). Although, as observed, doubt has been expressed about the validity of their conclusions, price elasticity greater than 1, at the bottom end of their range, means that for each percentage change in the price, there is a greater percentage change in demand.

If the price elasticity of demand for spatial information is significantly greater than one, it means that reducing the price of spatial information will significantly spur use and uptake of that information.

4.3 Technology adoption and diffusion

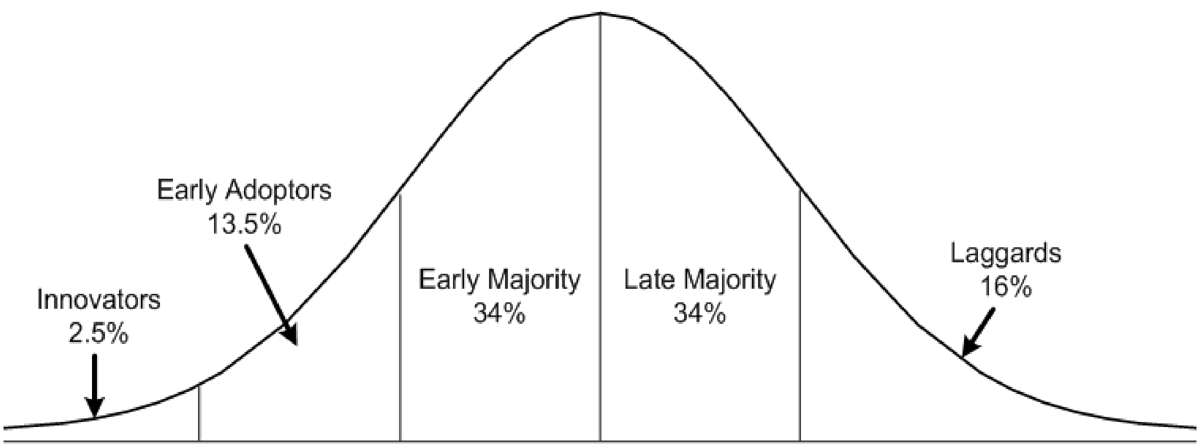
As indicated in the last section, the economic impact of spatial information will ultimately reflect the level of adoption as well as the degree to which benefits are reaped by individual adopters. Making data available and reducing price are clear levers by which adoption and diffusion can be accelerated.

More broadly speaking, the classic textbook reference by Rogers (1964) identified a five-step decision process involved in technology adoption and diffusion:

1. Knowledge – potential adopter becomes aware of an innovation but has no particular opinion of it (this could be via advertising or through word-of-mouth)
2. Persuasion – the potential adopter seeks further information to help form an attitude toward the innovation
3. Decision – the potential adopter engages in activities that lead to a choice to adopt or reject the innovation (the process is internal to the person and can be difficult to measure empirically; however considerations of price and perceived usefulness/necessity will play into this decision)
4. Implementation – the innovation is adopted and put into use (e.g., user installs geospatial data software or uses car navigation aids)
5. Confirmation – person evaluates the results of an innovation-decision already made which may affect decisions such as whether to continue using the innovation or return to previous status quo (e.g. remove software or return car navigation aid).

Rogers also estimated the categories of adopters as being innovators (2.5 per cent), early adopters (13.5 per cent), early majority (34 per cent), late majority (34 per cent) and laggards (16 per cent), see Figure 17. These reference figures are adopted for the current report, as they were based on and have been broadly corroborated by many case studies including those in the original contribution by Rogers.

Figure 17 **Roger's model of adoption**



Data source: Rogers (1964)

Rogers does not indicate a typical 'speed' of adoption or rate of diffusion over time, although the received wisdom now states that adoption typically follows an S-curve path with a 'tipping point' occurring at some stage where rapid uptake in the broader population occurs.

The Bass model, named after Frank Bass whose 1969 paper concerned take up of consumer durables (Bass, 1969), still forms the main mathematical approach to predicting the rate of adoption over time. It follows Rogers' model by differentiating between innovators and imitators, but importantly for the purposes of this report, it differentiates between two coefficients:

- the coefficient of innovation, external influence or advertising effect, and
- the coefficient of imitation, internal influence or word-of-mouth effect.

The critical finding which has been widely validated is that the latter coefficient is much more important in determining the rate of uptake over time (by a factor of twenty or more).

This has important policy implications for the spatial information sector. It means that people are far less likely to adopt if they read or hear about a product; rather, they need hands-on experience or 'demonstration' of the benefits. The private sector is traditionally very efficient at doing this, and in the case of car navigation aids we are witnessing the 'take-off' phenomenon now – where rapid adoption occurs as a result of the demonstration effects.

The issue with assuming a simplistic S-shape uptake curve is, however, that the spatial information market as a whole is dynamic over time and that there are in fact many different types of spatially enabled products and services. While we may already be past the turning point for car navigation aids, enterprise GIS is much lower in the curve. We return to this point in considering the specifics of spatial information in local public services.

4.3.1 Adoption waves

It is useful to the predictions of future use to review the patterns of diffusion of spatial information within the community from an historical perspective.

In a recent study by ConsultingWhere and ACIL Tasman into local government in England and Wales, it was found that adoption of spatial information occurred in waves of innovation.

Spatial information has been in operational use in local government in England and Wales for well over twenty-five years. Although, some pioneering systems were operational by the early 1980's (Gilfoyle I, 2004), substantive 'take-up' was really stimulated by the report into the Handling of Geographical Information in 1987 (Chorley, 1987). In 1990, it began to move beyond the innovators phase on the Rogers adoption model.

We identified four interlinked and overlapping waves of adoption:

Basic Implementation

This first wave of implementation was characterised by the introduction of basic desktop geographic information systems (GIS) for specific projects or within a single department. This was, in part, facilitated by availability of Ordnance Survey digital mapping through the first Service Level Agreement with local government. By 1998, the market survey of GIS in Local Authorities (Allbrook, 1998) reported that virtually every local authority stated that they had a digital mapping system or GIS, compared to only 82% in 1995.

Central Storage

The second wave, facilitated by the development of national standards, such as BS7666 for land and property gazetteers, is characterised by the gradual linking of discrete data bases and storage in centralised corporate database management systems. This wave brought with it increased productivity, as users could combine an increasing array of datasets across a number of services, including highways, planning and estate management, as well as managing local issues including providing faster and improved information to the public. In 1998, Allbrook's survey identified less than 10% linked to corporate systems, however by 2002, a comprehensive survey into the use and management of geographic information in local e-government in the UK (Higgs & Turner 2003) showed this figure had risen to around 80%. This wave had largely run its course by 2005.

Geospatial Web

The third wave is characterised by widespread access to spatial information by both staff and the public through the web. Although static maps have been available for almost as long as the internet has been in existence, the ability to make 'non-trivial' queries and, more importantly, to complete transactions over the web, is considered the benchmark level for this adoption wave.

The importance of this wave is that it hugely increased the number and range of stakeholders able to interactively access geospatial information. Although a few pioneering authorities were active in this area as early as 2000, there was little evidence of more than a handful of authorities with fully operational transactional capabilities in 2002 (Higgs & Turner, 2003). The e-Government initiative stimulated an acceleration of implementation up to 2005, and the LGA GI survey published in 2009 (Local Government Association, 2009) puts the figure for "view only" web mapping at 89%. However, the recent SocITM Better Connected survey (SocITM, 2010) finds only 50% of authorities have transactional capabilities.

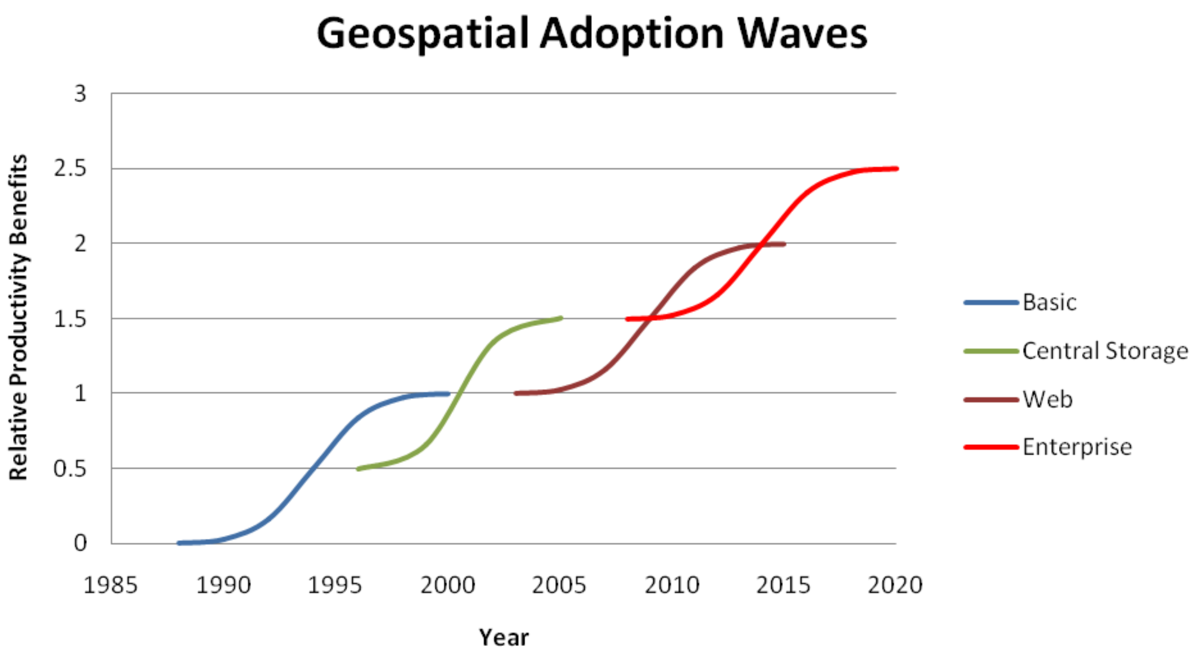
We can expect acceleration in this rate, especially with the arrival of enterprise Google maps and other similar offerings. However, whilst adoption could be completed in 2-3 years, this will not occur without action to address some of the important barriers to adoption outlined later, so we believe that a 'steady state' adoption curve would not complete until 2015.

Enterprise Spatial Integration:

The fourth wave is the integration of all of these technologies into mainstream enterprise systems where spatial information becomes as much a part of doing business as email and the internet has become. There are only a small number of organisations that have reached this position, with perhaps Dudley MBC, London Borough of Kingston upon Thames and Liverpool City Council being amongst the notable exceptions. The enterprise wave is characterised not only by spatial information being embedded in the corporate information and systems architecture but also a high level of awareness within user departments of its full potential.

The enterprise wave is being facilitated currently by the move within organisations to look at IT as a driver for efficiency by rationalising processes and greater information sharing. We believe that core spatial information, such as addresses, transport networks and georeferenced demographics, will be key enablers of the rollout of Service Oriented Architectures, and will therefore reflect their adoption trends. Figure 18 shows how each wave builds on the value added by those that have gone before. The Y axis should be conceptualised as a measure of relative productivity improvement, with each wave building on the benefits accumulated from the previous one.

Figure 18 **Four waves of innovation in geospatial systems in local government in the UK**



Source: (ConsultingWhere and ACIL Tasman, 2010)

4.4 The approach to comparing the benefits

4.4.1 Approach

The terms of reference of the original report required an assessment of the economic impacts of spatial information on the Tasmanian economy and a qualitative and where possible quantitative assessment of the implications for further Government investment.

The assessment was done for the following timeframes and scenarios:

- the accumulated impact of modern spatial information on the Tasmanian economy in 2011
- the accumulated impact of modern spatial information on the Tasmanian economy:
  - with the proposed scenario investment – referred to as **Scenario 1**
  - without the proposed investment – referred to as **Scenario 2**.

The economic implications were calculated on the basis of information available from ACIL Tasman's previous reports on the value of spatial information in Australia, New Zealand and the United Kingdom, and nine case studies.

The cases studies and other data were employed to develop the assessment of the implications for government, the community and natural resources.

The approaches are discussed in the following sections.

4.4.2 Economic implications for the Tasmanian economy

There are several approaches in economics that can be employed to assess economic impacts. These include estimating willingness to pay, use of input output tables to estimate multipliers and general equilibrium modelling. Willingness to pay approaches require extensive surveying of potential users and an assumption of elasticities of demand that can be difficult for new products. Multiplier analysis is useful but do not take into account resource transfers between different sectors of the economy. For these reasons, ACIL Tasman used general equilibrium modelling to assess the economic impacts. A full discussion of different approaches to assessing economic value is provided at Attachment B.

The economic impact assessment presented in this report is based on modelling 'with-and-without' scenarios using a computable general equilibrium (CGE) model. Details of the model are provided in Attachment C.

The model provides the capability to analyse the flow-on impacts of changes in different sectors of the economy following the introduction of a new technology (or productivity 'shock') and to compare the impacts of these changes on economic aggregates such as GDP, consumption, employment and investment.

To collect this data, nine case studies were undertaken to assess the impact of modern spatial information on government and industry. We used a standard survey form to guide the questions. Given the timeframe for this project, the respondents were asked questions at face-to-face interviews rather than filling out the questionnaire. The questionnaire addressed the following issues:

- the nature of the existing or potential application
- the productivity benefits of the application
- the expected level and rates of adoption sector-wide
- likely further benefits with the investment proposed
- future benefits and costs.

Using the results of the case studies, the consultants developed estimates of net productivity impacts of identified applications and estimates of levels of adoption across sectors to develop estimates of productivity shocks for Tasmania in 2011 and 2020 for each of the two scenarios.

These were used as inputs to provide shocks to ACIL Tasman's Computable General Equilibrium (CGE) model of the Tasmanian economy. The shocks were for:

- the accumulated benefits as at 2011
- the potential benefits in 2020 for scenarios 1 and 2.

The comparison with the results in element 2 will provide an estimate of the net benefits to date and the future net benefits that can be attributed to the proposed scenarios.

The present value of the future gains to 2020 will provide an indication of the net benefits to the Tasmanian economy from the additional investment.

4.4.3 Qualitative approaches to valuation

Consultations indicated that users see major value not only in the productivity gains that are modelled in this report, but also as in various social, environmental and other long term benefits from using modern spatial technology. Any valuation of these types of benefits is likely to yield *a multiple* of the 'pure' productivity benefits reported here; however, issues relating to the choice of valuation technique as well as significant uncertainties around the nature of benefit capture prevent 'accurate' measurement of these additional benefits.

Most of the long term planning, health, biosecurity, ecological and other benefits that can be reaped from better use of spatial information are extremely hard to value in dollar terms. Methodologies such as sophisticated willingness-to-pay (WTP) approaches are gaining recognition, but good contingent valuation studies are application specific and resource intensive, going well beyond the scope of work that could be covered here.

In the health area, it might be possible to develop relatively simplistic approaches based on the so-called value of a statistical life year (VOSLY). Saving 100 lives using a moderate VOSLY assumption would translate to a benefit of $1 billion. If it could be shown that a number of lives have been saved each year because of better/quicker ambulances, search and rescue, fire services, and so on, and if this could then be attributed to spatial information, then one could easily obtain large dollar valuations.

Furthermore, additional lives will have been saved (and will probably be saved in future) by putting hospitals in the right place, and by building streets and cities in the right place (avoiding earthquake fault lines, coastal erosion, and so on). These health benefits could in turn be worth a further sum of millions of dollars.

Planning and building 'smarter' cities and transport systems that will not only cut down fuel costs, but could also avoid accidents (e.g. in-built sensors – urban vehicles), reduce emissions, make for a better living space and so on, will add much more in terms of value that could conceivably be attributed to spatial information.

Similarly, where spatial information makes a contribution to maintaining national security and biosecurity or social cohesion, this should in theory also be recognised.

One of the problems with 'adding up' all of these values is, however, that it takes more than spatial information or GIS to *realise* these benefits. Councils have to act on the spatially layered information; individuals have to alter travel behaviour, and so on. Hence the problem with such forward-looking valuations is that there is too much uncertainty around likely events and probabilities, as well as the fact that the underlying valuation approaches are still somewhat controversial.

For this report we have derived values based on costs avoided where data is available or have dealt with the benefits in qualitative way. These are discussed in sections 5 and 8 below.

5 Tasmanian government

5.1 Economic and social overview

5.1.1 Structure of the Tasmanian economy

The Tasmanian economy remains strong after performing relatively well during the global recession. As of Mid 2010, State Final Demand has now returned to pre-global recession levels.

Table 2 **Tasmanian economic data**

		2005-06	2006-07	2007-08	2008-09	2009-10
Tasmanian Gross State Product	$m	20,108	20,615	21,519	22,247	22,341
Yearly Percentage Change In Gross State Product	%	2.7	2.5	4.4	3.4	0.4
Gross State Product Per Capita	$	41,164	41,920	43,428	44,414	44,208
Australian Gross Domestic Product	$m	967,454.0	999,687.0	1,181,750	1,195,707	1,222,802
Yearly Percentage Change In Gross Domestic Product	%	3.0	3.3	3.7	1.2	2.3
Gross Domestic Product Per Capita	$	56,015	57,095	58,197	57,770	57,925

Data source: ABS Data

In the 2009-10 financial year, the largest industry in the Tasmanian economy was manufacturing, which made up 11.7 percent of GSP. This was followed by healthcare and social assistance, financial and insurance services and Agriculture, Forestry and Fishing, all making up 9.2, 9.0 and 6.9 percent of GSP respectively.

In 2005-06 Tasmania's international export trade was dominated by Japan, totalling $555.2 million or 19.4 percent of total exports, followed by Hong Kong, $439 million, and South Korea, $324.2 million, making up 15.3 and 11.3 percent of total exports respectively. The major exports for the same year were zinc, aluminium, wood in chips or particles and wood waste, copper ores and concentrates, and seafood.

Tasmania trades with the other States of Australia by sea or air. The majority of the freight is moved by sea. Much of Tasmania's high value products, such as pharmaceuticals, salmon, trout, rock lobsters, cheese and other specialist foodstuff, are sent by air. With the increased use of just-in-time stock control, more basic manufactured goods that have a high value for their weight, such as textiles, yarns, clothing and footwear, are also being sent by air to the Australian mainland.

Tasmania's international competitiveness requires the capacity to manage freight logistics to overcome the distance to markets. It also implies the need for Tasmanian industry to develop industries selling into high value markets that can take advantage of Tasmania's area of natural advantage such as mining, agriculture, manufacturing pharmaceuticals and tourism.

The ageing population and the high proportion of the population on the some form of social welfare (34 per cent) present significant challenges for the State budget.

These facts create an imperative for well-coordinated economic policy, land use planning and social policy.

5.1.2 Economic policy

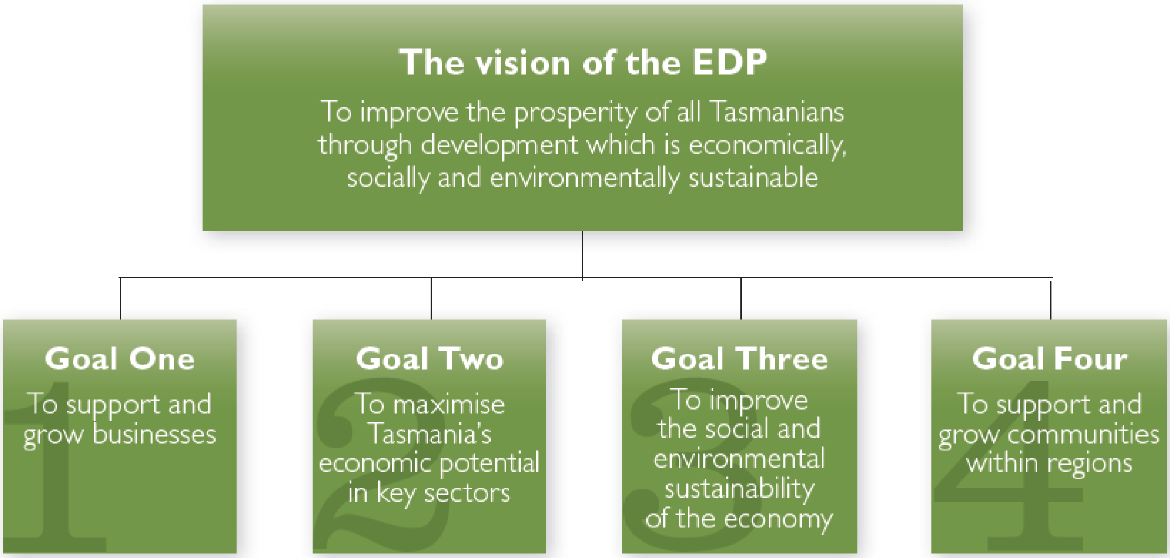
The Government set a new economic direction for Tasmania developing and implementing innovation, skills and infrastructure strategies. The Economic Development Plan (EDP) should provide a framework for a whole-of-government approach to economic development. Implementation will require the coordination of government, business and community action in coming years.

The four goals of the EDP are summarised in Figure 19. The overarching vision links four goals of developing business opportunities, maximising business potential in sectors where Tasmania has competitive and comparative advantages, improving social and environmental sustainability of the economy and most importantly supporting and growing regional communities.

EDP integrates innovation, skills and infrastructure

The EDP points out that the difference between this plan and past plans is the integration of innovation, skills and infrastructure strategies. The consultation and analysis undertaken for this report provided supporting evidence that access to spatial information will be important to realising this vision.

Figure 19 **Vision and goals for the EDP**



Data source: (Department of Economic Development Tourism and the Arts, December 2010)

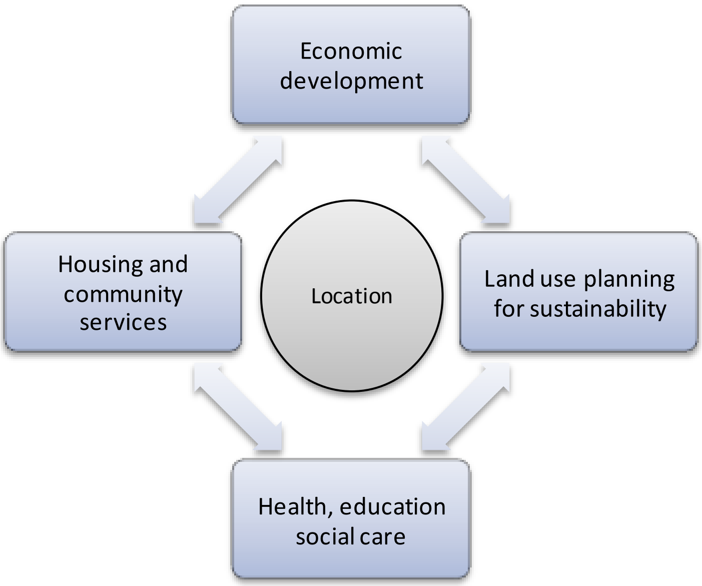
There is a link between economic development, land use planning and health and social services that became very clear during consultations undertaken. Land use planning, whether at the regional or local government level, is critical to maximising the potential of industries that are identified in the plan. Box 7 included later in this report illustrates this point.

The future businesses that will underpin Tasmania's economy will require access to infrastructure and land to expand. The communities that will provide the human resources to work in emerging industries will need well planned housing, schools, health services and in some cases social support services.

Location matters

Governments are now recognising that location is an important factor in successful economic and social policy. The linkages illustrated in Figure 20 have been summarised in UK government policy in terms of the concept that "place matters". The research undertaken for this report confirms this observation.

Figure 20 **Location links economic and community development**



Source: ACIL Tasman

Spatial information can improve decision-making in three critical respects:

- Visualisation – allowing patterns and trends to be illustrated in a form that can be easily understood by politicians and citizens.
- Integration – everything happens somewhere and the location 'signature' of an event provides a mechanism for linking sources of data that cannot be easily associated using conventional approaches – in database terms the perfect 'foreign key'
- Analysis – the consequences of decisions degrade with distance, looking at different scenarios and the interaction of related decisions is always enhanced by considering their location criteria. For instance, selecting the site for a community facility or optimising bus routes requires spatial analysis.

Spatial information supports better decisions for society

Spatial information is critical to better decisions based on evidence. Spatial information can provide the fusing of different classes of data to analyse and understand linkages between location, demographics, economic development and social services. It provides the foundation on which policy makers, planners, businesses and the community can make better strategic decisions for the future.

In the next few sections we consider the major divisions of Government and how they could best exploit the potential of spatial information based on this analytical approach.

5.2 Economic development portfolio

The Department of Economic Development, Tourism and the Arts (DEDTA) does not currently develop spatial databases for its own purposes. However, it does draw on the work of other departments and planning consultants who use spatial analysis for planning and economic development purposes.

DEDTA officers noted the challenges in economic development associated with balancing the land use requirements of agriculture, urban development and mining and industrial projects in strategic planning for economic planning and policy development.

One example is in the assessment of foreign direct investment in Tasmania. This can require decisions on available infrastructure, availability of industrial land or commercial property, skills in local labour market, an understanding of the potential for residential subdivision or even the location of retail outlets.

If industry had access to the data available in the various government databases, it would significantly lower the costs of planning and review for both government and industry. The nature of these savings means that they can also deliver savings in departmental administration through 'channel shifting' as mentioned in section 4.2.

To maintain competitive advantage, the EDP concludes that Tasmania must provide the economic framework for industries that can utilise Tasmania's ability to supply differentiated products and services, its forestry and minerals resources, and its renewable energy resources. DEDTA officials identified a number of industries that are considered important to the future of the Tasmanian economy. They include:

- tourism
- forestry
- retail
- building and construction
- minerals processing
- agriculture
- renewable energy
- transport.

All of these industries depend on location for investment success and sustainable competitive advantage. Improved access to reliable and up-to-date spatial data is fundamental to ensuring that investors in these industries are given the best chance of benefiting from the opportunities that are available and will become available in Tasmania in the future.

Underpinning sound economic development are sustainable communities and natural resources. DEDTA officials noted that spatial information was necessary to effectively plan for these attributes.

Discussion indicated that there could be a productivity improvement of around 0.25 per cent for planning approvals processes if duplication in planning for development approvals for investment proposals could be eliminated. This would not apply to the full expenditure of the Department as planning approvals are only a small proportion of DEDTA activities.

DEDTA itself could realise some savings if it had better access to more coordinated and reliable spatial information. However, the main benefits would accrue to departments and agencies with more direct involvement in planning process and resource allocation, such as the Department of Infrastructure, Energy and Resources (DIER) and the Department of Primary Industries, Parks, Water and Environment (DPIPWE). Any productivity benefit that might accrue to DEDTA has been included in the wider estimates for Government.

5.2.1 Relevance of proposed actions

Demand side components important to DPAC

To achieve these outcomes, it would be necessary for these agencies to share and develop databases that address emerging policy challenges. This would require not only authenticated data, but flexible access systems, sound data coordination and greater collaboration than occurred in the past. Greater awareness of the potential capabilities of spatial analysis by policy analysts and staff of the departments would also be necessary. Addressing demand side components is critical to realising the full potential of systems.

5.3 Planning portfolio

The Tasmanian Planning Commission (TPC) is responsible for state and regional planning. The Resource Management and Planning System (RMPS) sets out the objectives for state and regional planning in Tasmanian. The objectives of the RMPS are to:

- promote the sustainable development of natural and physical resources and the maintenance of ecological processes and genetic diversity
- provide for the fair, orderly and sustainable use and development of air, land and water
- encourage public involvement in resource management and planning
- facilitate economic development
- promote the sharing of responsibility for resource management and planning between the different spheres of government, the community and industry in the State.

The integration of sustainable natural resource management, economic development and greater public and community involvement in resource management and planning is a theme that echoes the objectives of the EDP. Better coordination between State Government agencies and the three tiers of government is also a characteristic of the approach to planning.

A report commissioned by the Tasmanian Chamber of Commerce and Industry (TCCI) observed:

> *"A well managed and implemented planning system has the ability to encourage and facilitate economic development, commercial expansion as well as maintenance of agricultural, heritage and cultural values. However, due to inherent uncertainty and information difficulties surrounding issues such as market demand, dynamic consumer preferences and environmental values, the method with which land use planning systems are implemented can have a large impact on the development outcomes that are achieved. Through the provision of incentives or disincentives for investments, land use planning schemes can have a significant impact on economic growth, investment, development and the general cost of living. The ability of land use planning systems to attract, discourage or alter developments means that there is a strong incentive to ensure that the system achieves efficient outcomes."* (Concept Economics, December 2008)

TPC is working with regional organisations and councils in the development of three Regional Planning Strategies and liaising with local government on local and local area planning.

Underneath the umbrella of the Regional Planning Strategies, local government planning and local area plans are developed. This hierarchy of planning schemes provides the framework within which development approvals are considered and approvals processed.

The planning process interacts with other planning activities undertaken by the State Government and local government, including:

- preparation of the State of the Environment Report
- protection of Agricultural Land Policy
- State Infrastructure Planning Strategy and Policy
- specific environmental projects such as the Derwent Estuary Program.
- the Coastal Vulnerability Project.

As part of its charter, TPC undertakes specific planning investigations. The Tasmanian Coastal Vulnerability Project will, for example, map coastal areas in Tasmania that have the potential to be significantly affected by climate change based on elevation, coastal landforms, modelled sea level rise and storm surge events.

It is not surprising, therefore, that the use of spatial information in integrating the elements of state and regional planning and integrating the plans and activities of government departments and agencies is increasing. Spatial information provides the foundations for natural resource management decisions, for integration of land use, economic development and community and human services.

TPC is highly dependent on reliable spatial data to implement evidence-based decisions. It draws heavily on the data in the State Infrastructure Planning System (SIPS) and LIST, and encouraged the development of a pilot Tasmanian Spatial Data Exchange (TSDX) to provide a link between government-held spatial data and spatial data held by semi-government and non-government organisations, including the water and sewerage corporations and energy companies such as Transend, TasGas and Aurora Energy.

The structure of Tasmania's economy and the imperatives of the EDP mean that planning and development approvals can involve the review of environmentally sensitive issues, land use conflicts between industry and property plans, urban and community needs and agricultural land use.

Current social problems can often be the result of past planning decisions

According to our consultations, it is critical that these decisions draw on evidence-based policies and planning. A recent assessment of the value of Local Information Systems was undertaken in the UK, in regions of comparable size to Tasmania. The study identified savings in the region of A$1million per annum in reducing the time spent by Government officials compiling evidence to underpin decisions (Foley, 2010).

The cost of not drawing on common and credible spatial data will be high in the future. One official interviewed noted that many of Tasmania's social problems are often a result of past planning decisions.

5.3.1 Relevance of data integration

Integration of the planning system into economic, social and environmental policy will require investment in all the action areas identified by the Tasmanian Government (section 3.3). Accurate, spatially-enabled data would provide the platform for integrating land use with place-based analysis, providing the potential to overlay demographic and economic data with the location of services, current and future land use, proximity to infrastructure and community services, and areas of environmental and cultural value.

This will, however, not be sufficient on its own. Demand side actions, particularly greater coordination within and between State Government, local government and community organisations, will be necessary to achieve the vision of the EDP.

5.3.2 Economic implications for state and regional planning

The 2008 report on the efficiency of the planning system in Tasmania commissioned by the TCCI estimated that improved productivity and investment from a review of the Tasmanian Planning System could result in an increase in real Tasmanian GSP of around 2.4 per cent (Concept Economics, December 2008). The TCCI report identified the following industries that would benefit from a more efficient planning system:

- construction
- retail and wholesale trade
- road and rail freight
- road, rail and air passenger transport
- telecommunications
- banking and non-banking finance and insurance
- owner dwellings.

The development approval process is expensive. Feasibility studies for the pulp mill extended into millions of dollars. The Lauderdale exercise is understood to have cost around $5 million for the developers and the former Resource Planning and Development Commission (RPDC).

Local councils are currently expending $2.3 million in developing land use strategies. These will integrate land use planning with economic development proposals. Access to spatial data will be critical for the effectiveness and efficiency of this investment.

Our consultations suggest, however, that it is likely that the benefits that have been delivered by spatial data for State and regional planning are being reduced due to the degradation in quality of the data and the lack of interconnection between the databases.

The proposed actions would address this degradation and provide foundations for better integration of spatial data for future planning decisions. It was suggested that this would deliver substantially better outcomes for economic development as well as better outcomes for Tasmanian communities in the future.

For the purpose of the modelling, we have assumed that by 2020 this would result in a 1 per cent increase in productivity in agriculture, minerals, construction, transport, energy, forestry, tourism, banking and insurance industries. This is a wider range of industries than the TCCI report suggested and reflects ACIL Tasman's estimate from consultations on the impact of spatial information on planning. These have been included in the shocks in Table E1 in the economic section later in this report.

The TCCI report also estimated productivity improvements in government administration. Drawing on this discussion, ACIL Tasman has taken a conservative estimate of 0.2 per cent improvement by 2020 attributable to better spatial data. This is broadly consistent with evidence collected for the 2007 report on the value of spatial information in Australia and evidence from the United Kingdom.

Table 3 **Summary of productivity shocks for planning**

	2011	Productivity improvement by 2020 without the investment	Productivity improvement by 2020 with the investment.
Net productivity impact	0.1%	0.1%	5% of productivity shocks in agriculture, minerals, construction, transport, energy, forestry and tourism and banking and insurance. 0.2 per cent improvement in government planning administration

Data source: ACILTasman

5.4 Health and human services portfolios

The Department of Health and Human Services (DHHS) is the largest Tasmanian State Government agency. It is responsible for delivering integrated services that maintain and improve the health and wellbeing of the Tasmanian community as a whole.

The portfolio delivers more than one and a half million service events annually to clients. In addition to the services it provides directly, DHHS also contracts or provides funding for services within the private and non-government sectors.

Service delivery is coordinated across Tasmania through a network of facilities, community services and home-based care. The Tasmanian State Budget includes record spending of more than $1.2 billion on health services in 2009-10.

The demand on the services provided by DHHS and the organisations within its portfolio is growing faster than population growth. Demands are growing as the population ages and access to primary care and public services becomes more difficult, with expanding urban areas and the centralisation of services (DHHS, 2007). For example, the demand for acute care and ambulance services is increasing because of:

- increased centralisation of medical services
- less access to acute care because of increasingly remote urban development
- less access to primary health care.

The growing proportion of people over 65 located in most regions in Tasmania is a trend that will exacerbate these trends (see Box 3).

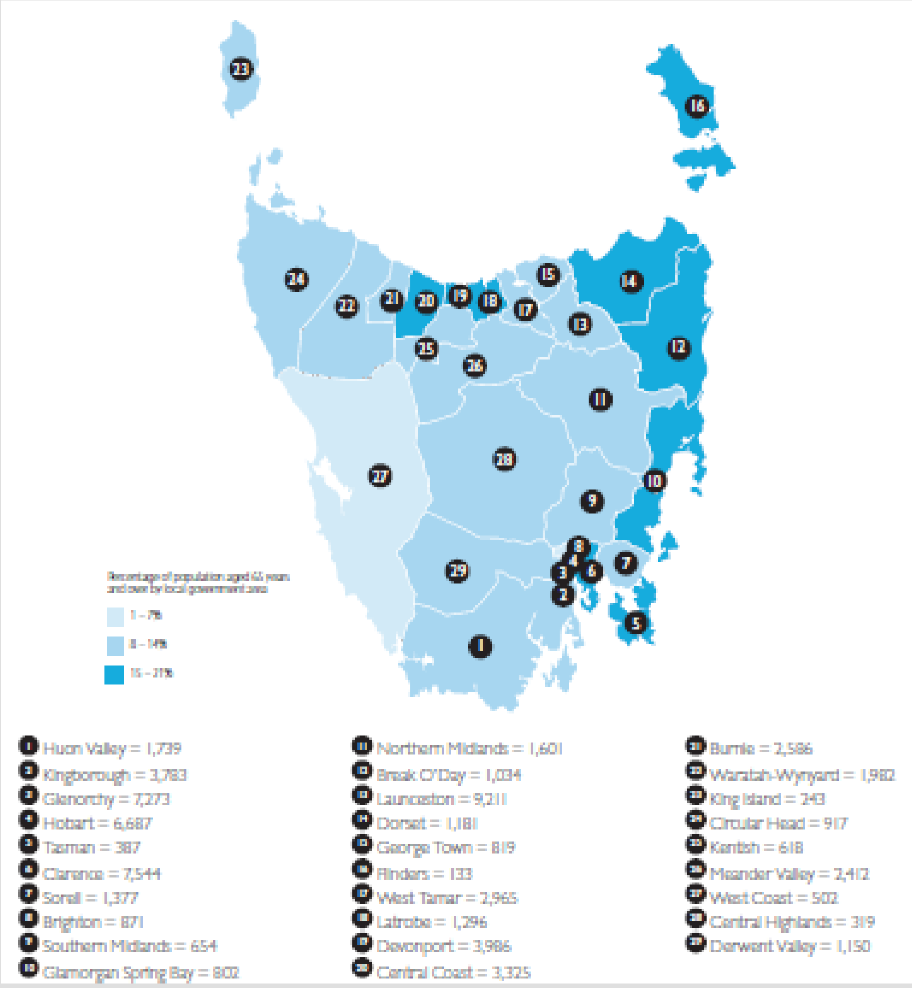
The State Budget included a record funding allocation of more than $433 million for human services in 2009-10. This Budget boost reflected a joint Australian/Tasmanian Government social housing program for up to 2000 new and refurbished homes throughout the State over four years, as well as funding more than 3,000 building and related industry jobs.

According to Tasmania's 2007 Health Plan, the cost to the State of providing public health services increased dramatically between 2002-03 and 2006-07. The average cost of acute care increased from $802 per person to $1,156 per person during the period, representing an annual growth rate over the 5 years of 10% per annum (Services, Tasmanian Health Plan 2007).

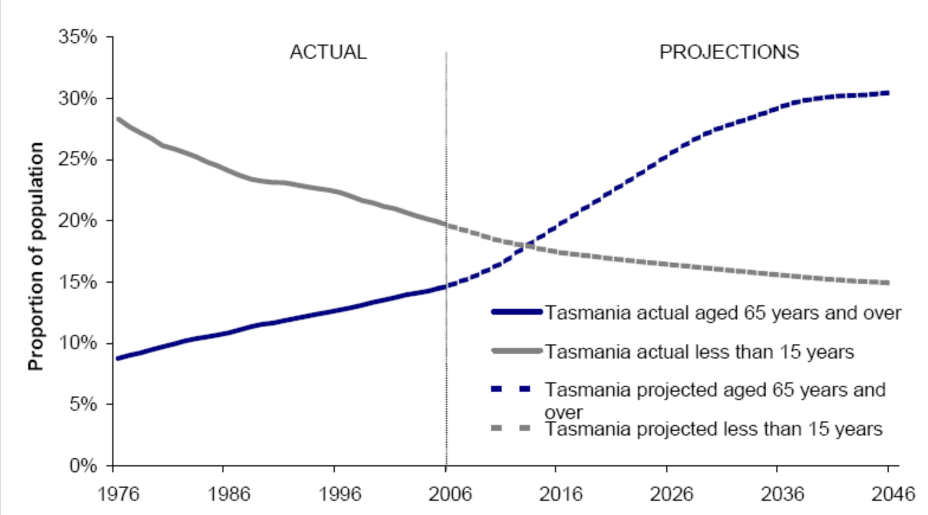
"As the costs of health and human services continue to rise – consuming a growing share of government and consumer resources – greater rigor, stronger accountability and a solid evidence base are required to decide how available funds should be spent. We are striving for a health and human services system that makes the most effective use of the finite resources available, manages costs effectively to ensure financial sustainability and provides high quality systems and information to support sound financial management decisions. Services and infrastructure provided to meet the care and support needs of Tasmanians must be carefully planned with input from clinicians, other professionals and the community. They must also be managed efficiently, based on solid evidence of effectiveness and impact." (DHHS, 2008)

Box 3 **Population aged 65 and over by Local Government Authority**

The diagram below shows the population in Tasmania aged 65 and over as at 2003. It demonstrates not only the demographic characteristics of the Tasmanian population but also the power of presenting data on a mapping base.



Past history and projections of the ageing population are illustrated in the next chart from a briefing prepared by the TCCI in 2008.



Source: (DHHS, 2007), (TCCI, 2008)

5.4.1 Health policy

According to our consultations with DHHS, the cost of providing such services in the future is likely to be unsustainable without new approaches. The Tasmanian Health Plan sets out strategies and policies to address this challenge.

A central component of these policies is better provision of primary care and local community services to reduce the demands on acute care and crisis services. This involves providing more support and information to local doctors and service providers and, in the longer run, better information on and access to these services by the target community.

Some of the actions in the health plan involve decisions about location including:

- greater access to home-based services, including acute post care and specialised community nursing
- increased access to mental health and alcohol and drug programs in rural areas
- increased access to community nursing
- increased day respite services
- integrating general practices with community services
- home and community services to be enhanced through primary care partnerships
- development of clinical networks
- integrating overnight and ambulatory care services.

According to the Tasmanian Health Plan:

> *"Present patterns of service delivery reflect, however, past policy planning and operational decisions. Decisions about the future will be based on the needs of the population and an understanding of good service design rather than on current patterns of service delivery."*

Spatial data systems are a critical foundation infrastructure for both planning and implementation of these plans. They also have a lot to offer in supporting local public health service providers.

DHHS is not currently a significant user of spatial information systems for its general health planning or service delivery areas. Two areas where spatial information systems are utilised by DHHS or its internal organisations are in ambulance services and in the 'Kids Come First' project. Before discussing these areas, we briefly discuss the potential for use of spatial systems in health.

5.4.2 Potential use of spatial mapping

DHHS identified a number of areas where it considered that more coordinated spatial mapping could improve the capacity of DHHS to contain costs for both DHHS and the community. These areas included epidemiology, pandemic mapping, radiation protection, hazardous material monitoring and health service utilisation.

The epidemiology unit of DHHS currently geocodes data such as hospital separation, cancer incidence and other diseases recorded by the Commonwealth disease unit. A web-based reporting system reports 150 diseases by Australian Bureau of Statistics (ABS) local government area. This has the potential to be significantly more valuable if located in a spatial database that would permit analysis of a wider array of data in a spatial framework.

A spatial data framework would also support new approaches to health service analysis, from examining regional access to hospitals, mapping incidences of Legionnaires' disease, and tracking movements of hazardous materials (such as cyanide compounds used in gold mining), to research into correlations between disease and social issues and the location of things like alcohol outlets, areas of disadvantage, areas of high smoking participation and dealing with problem gamblers.

DHHS, in collaboration with the Menzies Institute at the University of Tasmania, is developing a health data linkage unit (Box 4). This work, which will draw on spatial data sources and systems, has the potential to significantly improve the effectiveness of health and social programs in addressing the growing challenge of managing health and human care in Tasmania.

Box 4 **Tasmanian data linkage unit**

Plans for the implementation of a Tasmanian health-related data linkage system are well under way at the Menzies Research Unit. The Tasmanian Data Linkage Unit (TDLU) is a collaborative project of the Department of Health and Human Services (DHHS) and the Menzies Research Institute Tasmania (MRI). DHHS is the lead agency, outsourcing the operation of the unit to the MRI.

Researchers and health service planners will be provided with information from multiple sources, providing a holistic picture of the health of our community and how it changes over time. This opens up new avenues for research and for better management and planning of health services. For example, this information can be used to:

- Assess the safety and quality of health care
- Assess the effectiveness of preventive interventions such as screening
- Obtain follow up information on participants in research studies and surveys, and
- Monitor trends in the patterns and costs of health care
- It is also a very cost effective research tool. Once the linkage infrastructure is in place, linked data can be accessed quickly and cheaply.

Source: Menzies Research Unit, University of Tasmania

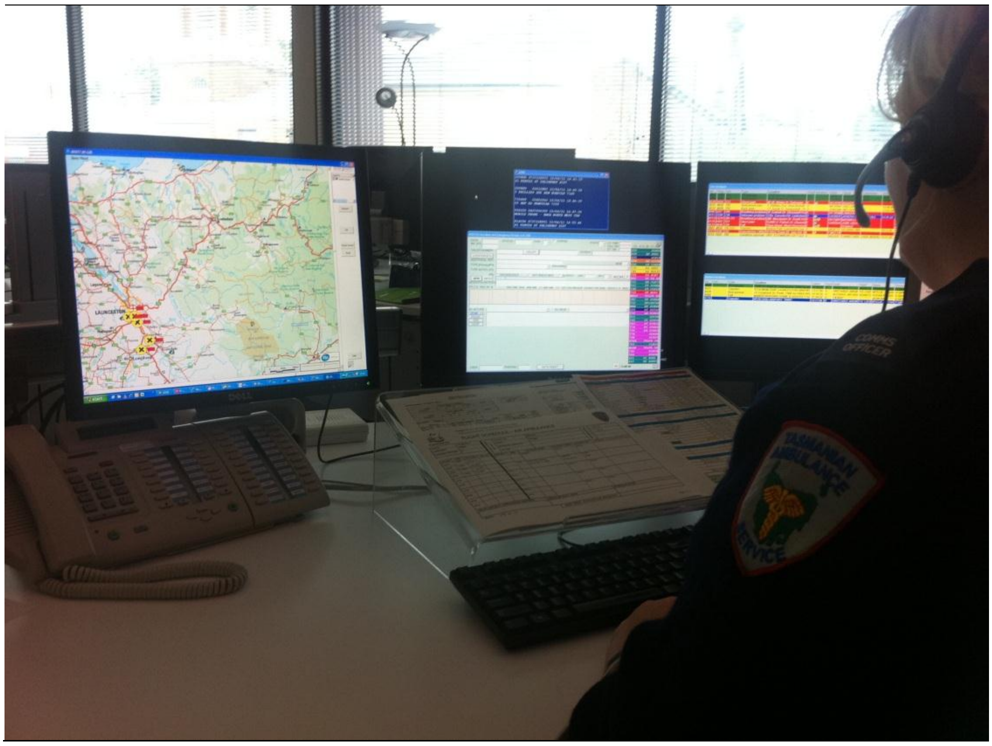
In our assessment, improved spatial information would improve the ability of the Department to use evidence-based policy analysis to lower the cost of delivering health and human services to the Tasmanian community. Some of these benefits would be deliverable within three to five years and would be definitely realised by 2020.

Ambulance service

Ambulance Tasmania provides emergency ambulance care, rescue, aeromedical and medical retrieval and transport services and a non-emergency patient transport service through a network of 50 urban, rural and remote ambulance stations. The annual operating budget for Ambulance Tasmania for 2010/11 was $in excess of $50 million.

The service currently uses a computer aided dispatch system (CAD) that is partially spatially-enabled, drawing on data from LIST. The service believes the technology significantly enhances its operational efficiency. Like all emergency services, Ambulance Tasmania could benefit from greater integration of spatial databases. During the Launceston floods in 2010, the service liaised closely with other agencies as is normal practice to establish areas at risk and vulnerabilities in order to prepare for dispatch in the event of serious flooding of residential areas. Ambulance Tasmania believe that integrated data bases available to the emergency medical dispatchers in real time would have been beneficial for planning purposes.

Figure 21 **Ambulance dispatch**



Data source: Tasmanian Ambulance Service

Integration of the ambulance CAD and emergency and police data would improve responses to incidents such as the Launceston floods

The service believes that it could also use spatial analysis for better planning of resources over the longer term. Ambulance jurisdictions collect large quantities of data that, at times, can be difficult to visually display in a readily interpretable format. Recent advances in spatial mapping could help visualise emergency medical service epidemiological data in more meaningful ways. Mapping of emergency incidents adds the dimension of geographic analysis to the data, which makes it easy to present important information to key decision-makers quickly, efficiently and effectively. Research into the potential for such services has been undertaken at the University of New South Wales.

"Mapping EMS incidents helps to visualise geographic distribution of 'disease', identify populations at risk, identify risk factors, analyse trends and may help in the allocation of ambulance resources. Mapping is a powerful tool to enable high level statistical data to be presented in a readily accessible format. This methodology has been applied to conditions including falls, acute coronary syndromes, cerebrovascular disease and vehicle accidents using data from the Ambulance Service of NSW. While still a relatively new area in pre-hospital research, geospatial mapping techniques shows great promise as a tool for understanding ambulance workload, evaluating resource allocation and is very likely to assist in future service planning efforts." (Middleton, 2010)

Whilst a health economic appraisal would be necessary to truly determine the dollar value of better integration of all emergency service data, it is clear that benefits exist. The demand for ambulance services is growing with the ageing population and the increased centralisation of acute medical services. The service believes that better integration of spatial systems in the dispatch system will be an important performance improvement initiative

Box 5 outlines, for example, how the Northern Ireland Ambulance Service plans to use spatial information systems for route optimisation to improve its achievement of time to patient performance indicator from 50 per cent to 74 per cent. This is an illustration of the potential benefits that could also accrue to Ambulance Tasmania.

Box 5 **Route optimisation in Northern Ireland**

One of the Northern Ireland Ambulance Service's (NIAS) key targets concerns response time to Category A emergency calls.

The current target performance level is for the ambulance to be with the patient within eight minutes of the call, in 75 per cent of cases. In 2006, the Service met this call-out time for approximately 50 per cent of Category A calls.

The Service prepared a business case for the Department of Health Social Services and Public Safety to purchase additional ambulances and invest in a number of new stations to allow them to meet the target. Staff in the Strategic Investment Board (SIB) worked with the Department and NIAS to investigate whether the investment identified in the business case would be capable of improving the service and meeting the national target.

A number of service-improving options were considered and one of these related to reducing the distance that ambulances would have to travel. This required a 'blue-sky' reassessment of need to determine the best positioning of the 60 existing ambulances to allow more rapid response After completing analysis of locations (using desktop software, NIAS database information and census data), 11 possible deployment options were discussed with the optimal option requiring 60 locations (these being dynamic deployment points, moving with time of day).

These locations, when implemented, will allow existing resources to improve performance from 50 per cent to approximately 70 per cent. Further refinement of the service model will allow improvement to 74 per cent without significant additional investment. A business case for this plan is now been compiled.

Source: http://www.communities.gov.uk/publications/communities/locationstrategy

5.4.3 'Kids Come First' project

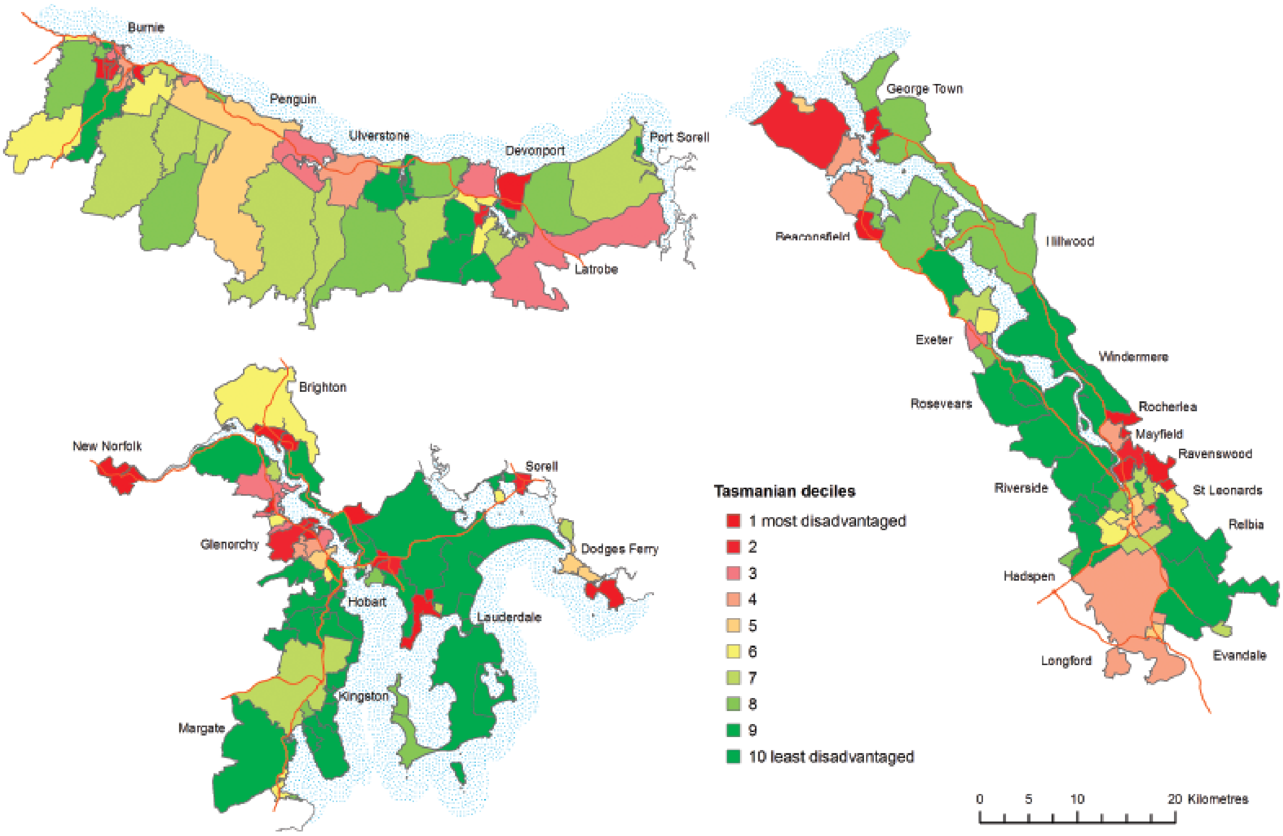
There is one example in DHHS of the use of spatial data in program design and delivery, being the use of a GIS system in the development of the 'Kids Come First' project.

The aim of the project is to provide Government and other service providers with a comprehensive way of monitoring how Tasmania's children and young people are faring, and more accurately identify where action and support are needed.

The project links information from agencies, service providers and case work to map the circumstances and status of children and young people's needs for support. The information draws on data from health services, police, human services and educational institutions, which is mapped in the SIPS database and readable on a commercially available viewer. It provides up-to-date information on a location basis. The project is currently being undertaken on a pilot basis with the support of 1.5 FTE staffing.

An example of output from the database is shown in Figure 22.

Figure 22 **'Kids Come First' spatial database - SEIFA index of relative disadvantage by suburb**



Data source: http://www.dhhs.tas.gov.au/__data/assets/pdf_file/0018/48411/Figure8.pdf, accessed on 2 April 2011

This output maps disadvantaged families by suburb. There is an extensive source of mapping data on demographics and services available in the 'Kids Come First' database.

The potential for better decision-making using layered information linked to location has, in the view of DHHS, significant opportunities for coordination of children support services. It will provide critical location-based information for the planning and location of 30 child and family centres, of which 12 have currently been established. It will also provide a map-based database to facilitate engagement and consultation with local communities on the location and coordination of services

Better coordination and location of child and family centres and services are an obvious example. In the longer term, the potential for spatial databases to provide support to local child care service providers, the police, schools and other support has the potential for better targeting of support through location-based correlation of data and information.

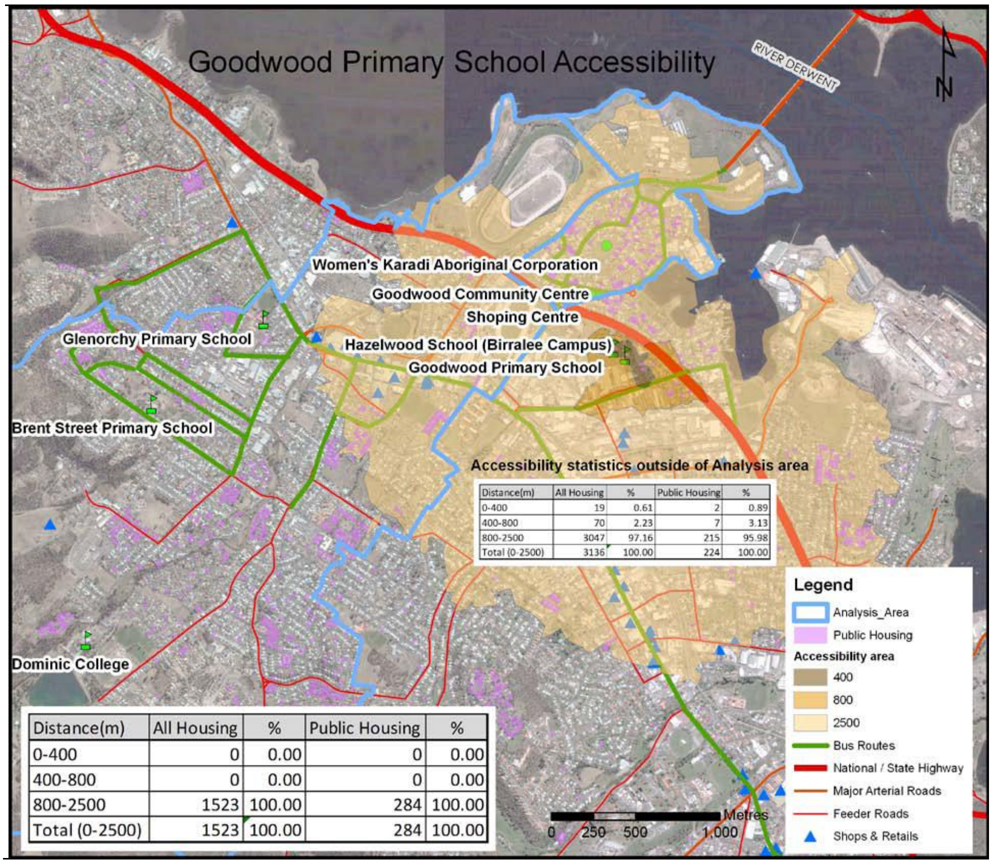
In the longer term, it also provides the potential for greater engagement and ultimately input from community workers and families, changing the way in which the community interacts with these services. This is an example of channel shifting mentioned in the examples of the UK study in section 4.2.

5.4.4 Location of community facilities

The SIPS database is being used to plan the location of child and family health centres and has the potential to be used more widely for decisions on the location of schools, health services and other community support facilities.

An example of a location study using the SIPS system is shown in Figure 23.

Figure 23 **Primary school accessibility**



Data source: (DIER, 2010)

The system can support many aspects and types of location analysis, including accessibility, location of related services, demographics, income levels and public transport.

5.4.5 Social inclusion

The Department of Premier and Cabinet (DPAC) uses spatial information for planning purposes in conjunction with other agencies and in pursuit of social inclusion policy. This ranges from mapping areas of disadvantage and mapping social assets, such as child and family centres, to social economic assessment. An important activity is social inclusion policy.

Social inclusion

The goal of the Social Inclusion Strategy for Tasmania is to provide opportunities for all Tasmanians to participate in social, economic and civic life. The approach involves systems that help people access support services, education and job opportunities, as well as social and community networks.

The strategy aims to generate solutions for people who face multiple challenges, including poverty, geographic isolation, intergenerational disadvantage, poor education, disability, and physical and mental health issues.

Smarter responses to complex social issues informed by evidence-based policy

The strategy aims to approach social innovation in new ways, based on evidence-based decision approaches, early intervention and prevention methods, and better use of data to more effectively and efficiently target actions to implement the strategy.

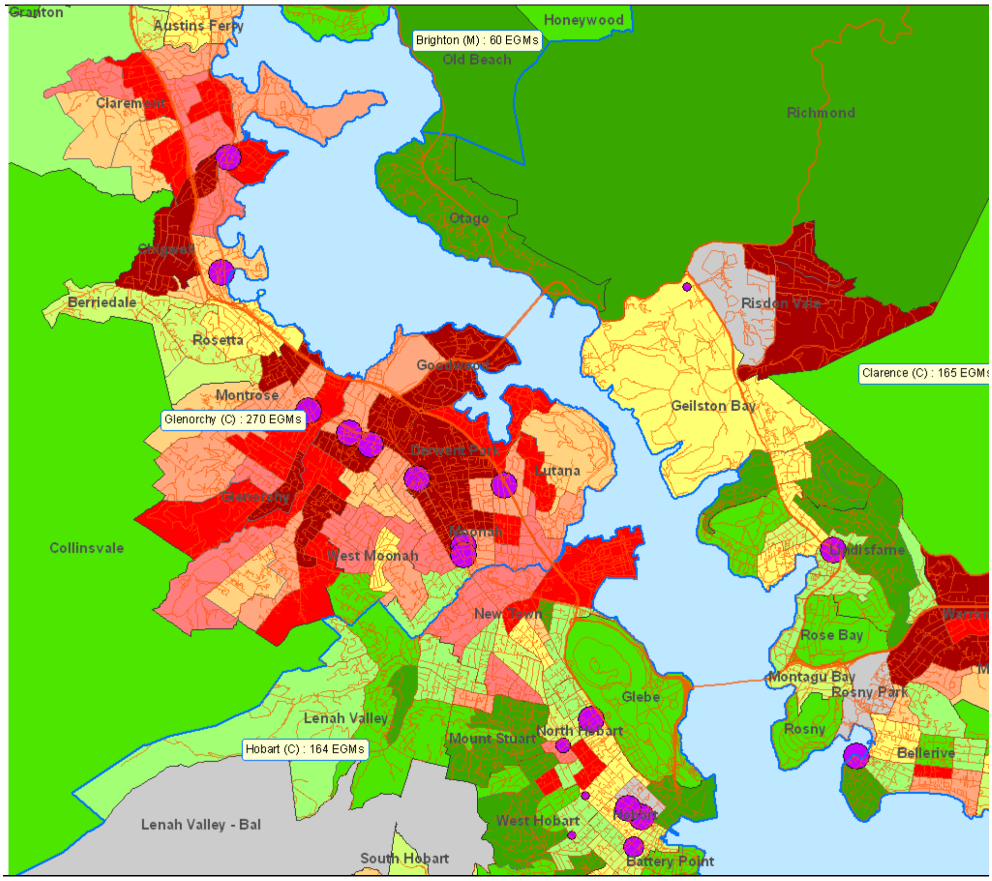
DPAC has used GIS for mapping districts of disadvantage, locating areas of problems, the location or need for service, and for documenting social capital. This work was done through the SIPS database, operated by a data specialist seconded from the ABS.

GIS has also been used to map child and family services resources and community assets. This helps in planning for the location of social support infrastructure, such as child and family centres. It can layer data such as family car ownership, families with children under four, access to public transport, transport timetables and even factors that would influence the location of schools.

The system also supports place-based analysis of social problems, such as poverty, gambling, smoking and health issues. For example, research has revealed that problem gamblers have high rates of psychological disturbance, hazardous alcohol use, smoking and depression, in combination with other social and family problems. The GIS system has been used to correlate disadvantaged areas to the location of electronic gambling outlets (see Figure 24).

The map shows the spatial relationship of areas of disadvantage (indexed by a socio-economic indicator for areas or SEIFA index) and the location of electronic gaming establishments. The map shows, in an easy to read format, the correlation by areas of socio-economic disadvantage and the location of local gambling establishments. Such spatial correlations can assist social policy analysts in understanding causes and effects and planning appropriate policies to address the concerns.

Figure 24 **SEIFA index and location of gambling outlets**



Data source: Department of Health and Human Services presentation.

This type of analysis that layers place, income, disadvantage indexes and the location of establishments that either support or alternatively harm some in the community is an example of how evidence-based policy is empowered by an analysis of place.

Before the use of GIS, decision-making was reported to be ramshackle, with insufficient linking of the disparate range of data that is required for good evidence-based decision-making. There are relatively recent examples of situations where schools have been located in areas where access was not easy for the communities that they were to serve.

The GIS now employed facilitates evidence-based decision in a short time frame. It has also been possible to more effectively engage school groups by sharing the information with them and developing more appropriate place-based solutions.

There is also a land use planning overlay to this work. This is discussed in the subsequent section.

5.4.6 Relevance of proposed actions

The demand side components of the actions proposed are critical for the health, human services and education portfolios. While there is a small number of policy analysts and planners that are aware of the potential for spatial analysis in these areas, the use of and awareness of the potential is at the lower end of the scale. While this is understandable given the magnitude of the challenges the policy makers face each day, extra effort will be required in these areas to develop the planning systems and structures to realise the vision.

The whole-of-government spatial solutions, advocacy and collaborative measures proposed would assist agencies to develop capability and integrate spatial information into business systems.

5.4.7 Economic implications

Benefit to the Department

Current

According to the Commonwealth Grants Commission, Tasmania has high service delivery costs compared with other jurisdictions in the Commonwealth (Commonwealth Grants Commission, 2011). These high service delivery costs reflect the State's above average share of people in areas with low socio-economic status, older people and government school students, and below average non-State provision of community health services. The State also incurs diseconomies of small scale in administration, but with below average wage levels.

The evidence suggests that good spatial information systems have the potential to improve both the productivity of the agencies delivering these services and the effectiveness of the outcomes.

The level of adoption in these agencies is relatively small, confined mainly to acute health services and social inclusion policies. From experience elsewhere, ACIL Tasman estimates that net productivity benefits of up to 0.7 per cent have been achieved from the use of these systems where they are applied.

In England and Wales, productivity improvements both from lower costs and knock-on benefits to the rest of the economy were of the order of 0.3 per cent for local government. (In England and Wales, local government services include some public services such as ambulance and social care that are delivered by State Government agencies in Australia.)

With low levels of adoption at around 2 per cent across health, human services and education areas of expenditure, the total productivity benefit is likely very small at the present time. This is considerably lower than estimates made by ACIL Tasman in its 2008 report on the value of spatial information for Australia (ACIL Tasman, 2008).

In 2020

There is clear evidence from Australian and overseas experience that spatial information systems have the potential to deliver significant productivity improvement and benefits from better planning and delivery of services and resources in government. The orders of magnitude vary. In New Zealand, the estimate was around 1.04 per cent in productivity benefits by 2015 under an ideal policy scenario.

On the basis of ACIL Tasman's consultations and overseas evidence, it is considered that, with good policies, a potential improvement in productivity of up to **1.5 per cent by is possible by 2020**. The two main drivers of this assessment are increased adoption and greater engagement with the community and community organisations. However, this would require good foundation data and improved access to spatial information and services. Without this investment, it is considered that this improvement would not be as effective and would be more expensive to achieve through ad hoc data acquisition and duplication. The net productivity improvement would be significantly lower if investment of the magnitude proposed in the scenario does not occur.

Benefit to society

Most of the benefits to society that can be reaped from the increased use of spatial information in better planning and management of health and human services are extremely hard to value in dollar terms. Methodologies such as sophisticated willingness-to-pay (WTP) approaches are gaining recognition, but good contingent valuation studies are application specific and resource intensive, going well beyond the scope of work that could be covered here.

In the health area, saving five lives using a moderate value of a statistical life year assumption would translate to a benefit of $50 million. If it could be shown that a number of lives have been saved each year because of better/quicker ambulances, search and rescue, fire services, and so on, and if this could then be attributed to spatial information, then one could easily obtain large dollar valuations.

Furthermore, additional lives will have been saved (and will probably be saved in future) by putting hospitals in the right place, and responding more effectively to the incidence of disease and disadvantage through a better understanding of geographic influences. These health benefits could, in turn, be worth a further sum of millions of dollars.

An additional challenge to valuation is how to attribute a share of these benefits to the use of spatial information. Our consultations indicated that such systems would be the foundation of a more holistic and strategic approach to these challenges. However, realisation of these benefits would also require other investments.

This report has not delved into this calculus. However, it would be reasonable to conclude that the potential benefits to the Tasmanian society are very high and that well-developed and supported spatial information is one of the critical elements of approaches that will be required to effectively address future challenges facing the health and human services portfolio.

Summing up

The impacts of scenario investment for the health and human services portfolio are summarised in Table 4.

Table 4 **Summary of productivity shocks and other benefits for health and human services**

	2011	2020 without the investment	2020 with the investment.
Net productivity impact	0.01%	0.3%	1.5%
Benefits to society	Costs to society are high	Cost to budget of health and human services unsustainable.	Benefits extremely high. Significant social benefits from lower mortality and more sustainable communities

Data source: ACILTasman

5.5 Infrastructure, energy and resources

DIER is custodian three spatial important databases:

- Road Information Maintenance System (RIMS)
- State Infrastructure Planning System (SIPS)
- Tasmanian Information on Geoscience and Exploration Resources (TIGER)

More details of these databases are included at Attachment D.

These databases rely on LIST for their foundation data and have Service Level Agreements (SLAs) with a number of other organisations, such as Aurora

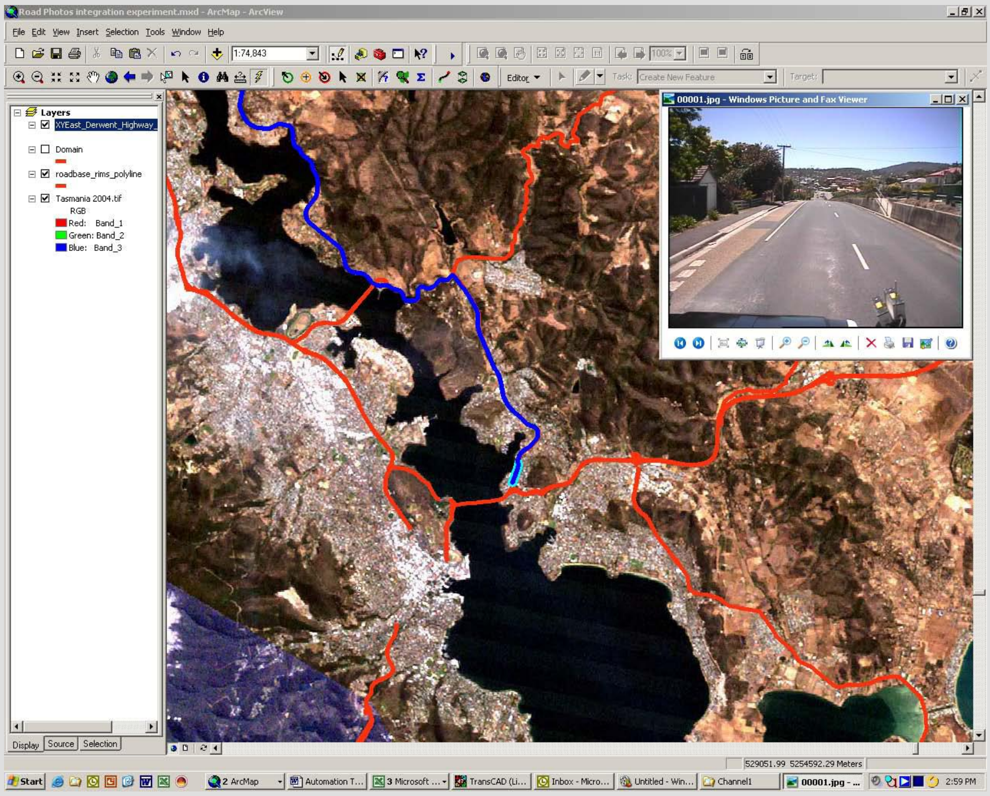
Energy, for data that is collected by others. SIPS also draws on the ABS for demographic, housing and income level data.

5.5.1 RIMS

RIMS is specifically designed around planning and maintaining State roads. It is primarily an engineering support tool. According to DIER, RIMS has realised significant productivity improvements in monitoring and managing State roads. For example, it provides data about road and bridge conditions and technical characteristics, and data to monitor the use of road infrastructure for heavy vehicles. RIMS is also used when issuing permits for heavy cranes and trucks to use bridges and other facilities (see Box 6).

Box 6 **Road video functionality of RIMS**

A video function is available on the DIER intranet. This allows users to view a video of State roads from their desktops. An example is shown below. This allows users to better plan and monitor road maintenance and road condition. The viewing capability has potential use in other sectors such as tourism. This is also the case in New Zealand.



Source: Department of Infrastructure, Energy and Resources

5.5.2 SIPS

SIPS is a more broadly constructed planning database used by DIER for infrastructure and transport planning. It has also been used by several departments including DPAC (social inclusion policy), DHHS (health infrastructure planning), Education (school and student location) and TPC.

In infrastructure for example, SIPS has been used in taxi and bus route zoning and planning. It has also been used for the review of development applications for major projects including the pulp mill, where it has supported scenario analysis.

SIPS reduced data collection for housing analysis from 6 -8 weeks to one afternoon

SIPS has significantly increased the productivity of these activities. For example, it shortened data collection for analysis of public housing that previously took six to eight weeks down to one afternoon.

5.5.3 TIGER

TIGER is primarily a geoscience database used to support the geological surveying activities in Tasmania. Data in TIGER supports work on pre-competitive geoscience, administration of titles, custodianship of drill logging, geochemical and geophysical data, and is also used by exploration companies to plan and implement exploration programs for minerals in Tasmania. Lefroy Minerals, for example, used it to plan aeromagnetic surveys. According to Minerals Resources Tasmania (MRT), it has led to two new commercial discoveries in the past 15 years, including the Avery nickel mine and the Venture Minerals project.

TIGER also used for hazard mapping and planning

The TIGER database is also used for hazard mapping and land use planning. It includes mapping of landslip data that is made available to local government and also used by TPC and local government for land use planning. For example, the database includes information on gravel pits and was used at Railton to assess land use conflicts between the location of a tin smelter and rural land use.

However, the use of this data is not optimal. This is partly because of the degradation of data in LIST and partly because of lack of integration of TIGER data with other spatial databases or lack of awareness of its availability for use. The Dorset Council, for example, approved a subdivision over a gravel resource that alienated an important source of road gravel because it did not consult TIGER data.

5.5.4 Relevance of proposed actions

The users of spatial databases in the mining, energy and resources portfolio areas are more advanced compared with those in the economic and social portfolios. Improvements in foundation data and the provision of a data and services directory are fundamental to extracting the full value from spatial data.

The proposed improvements to data access and coordination will also deliver additional economic benefits. As industry draws on more accurate data, duplication is reduced throughout government and industry, and other datasets, such as environmental data and endangered species, are integrated into the decision support systems of both industry and government.

Demand side actions are, therefore, most important to the realisation of benefits for this portfolio.

5.5.5 Economic implications

The three spatial databases supported by DIER are used across government for the planning and administration of infrastructure energy and resource activities in the state. Consultations suggest that they have delivered productivity improvements in these sectors, and are linked with industry and local government agencies to deliver net benefits from the investment in developing them.

Where the databases have been used in planning, the productivity improvements are large, as illustrated in the dramatic reduction in time required for regional housing analysis referred to above. However, the problem in realising these gains is the low level of adoption across government. This is exacerbated by data degradation in LIST and the lack of integration with other planning support systems.

ACIL Tasman has estimated that productivity improvements of up to 0.3 per cent across agencies could be possible in specific areas of activity.

It is evident, however, that if the problems with the databases could be resolved, with databases integrated into planning systems in government and access to the integrated systems made available to local government, industry and the community more generally, significantly higher productivity and economic benefits would be possible over time.

The proposed actions, if fully implemented, would achieve these objectives. Estimating the productivity impacts for State Government are difficult to assess because it is not certain that all of the savings would be banked in terms of lower running costs for agencies. However, the level of adoption is very low – potentially as low as 10 per cent. Adoption curves from the UK for spatial technology in local government suggests that a 'life cycle' of adoption of each new wave of technology of between 6-9 years (ConsultingWhere and ACIL Tasman, 2010).However, based on experience elsewhere in Australia and overseas, it is would not be unreasonable to assume that productivity of administration could be increased to levels comparable with other government examples of around 1.25 to 1.5 per cent

Without this improvement, the accumulated benefits of spatial information are not likely to increase because of lack of coordination and degradation of data.

Table 5 **Summary of productivity shocks from DIER data bases**

	2011	Productivity improvement by 2020 without the investment	Productivity improvement by 2020 with the investment.
Net productivity impact	0.03%	0.3%	1.25%-.1.5%

Data source: ACILTasman

5.6 Local government

Spatial information systems are used in all of the larger local government organisations. This represents about 80 per cent adoption of modern spatial information across local government. Modern spatial information was first introduced around 1990 and applications have been developing since that time. Its uses now include:

- development approvals and planning
- asset management (including infrastructure)
- coordination with local and regional plans
- linking finance and budget to location
- engineering
- environmental monitoring (threatened species mapping, bushfires, land slips
- trend analysis
- analysis of security and services (e.g. mapping dog attacks or dangerous areas)
- hazard mitigation (including flood mapping, coastal vulnerability assessment, land stability assessment and cross boundary emergency planning)
- some route optimisation for council vehicles including load balancing on garbage trucks (but not yet extended to fuel use reduction).

In the larger councils, the systems have been fully integrated into their activities as a fundamental work tool. In this environment, spatial data has become available to a wider community of users within local government. Spatial information and the supporting IT and software have become mainstream enterprise systems.

The demand for spatial information is increasing. The development of regional planning strategies and the requirement for every council to review and develop their local planning schemes has become a priority. Examples of the challenges that the broader social and health policies represent include setting aside areas for health care, family and community centres, and new schools.

Another area of growing concern is mapping emerging hazards, such as coastal inundation and flooding. Spatial data and its integration with other government databases are not optimal. The councils use and contribute to data available through LIST. However, in most cases the maintenance of this data has declined and there are some deficiencies that are degrading the value and use of the data.

The most advanced users are in the main metropolitan centres, including Hobart, Clarence, Glenorchy, Kingston, Launceston and Devonport Councils. In general, smaller councils have less sophisticated systems. Organisations like the Southern Tasmanian Councils Association (STCA) can help the smaller councils with advice on spatial systems, however, funding the investment in smaller councils will always be a challenge.

Hobart City Council reported that spatial systems had delivered significant productivity improvements in areas of current use. Applications in areas such as bushfire and flood mitigation, valuation modelling and flood mapping had delivered savings in staff time and costs of around 0.5 per cent across their total revenue base. In another example, the time taken for an audit of trees in a local area had been reduced from around 30 minutes to 5 minutes.

While councils are dependent on State-based data, they expressed a need for mapping data more detailed than the 1:5000 maps available via the LIST.

State Government policies for development applications and regional and local planning contribute to a greater demand for spatial information. Legislation relating to development applications sets standards for approval timelines. The councils need to work smarter to meet environmental, social and planning constraints and still meet the timelines demanded. There is also pressure from Government for more evidence-based decision-making. Social inclusion policies and boundary changes underline the need for compatible spatial data and more demographic and social data linked to mapping and location information.

5.6.1 Relevance of proposed actions

Data quality, access and coordination are the most important proposed actions for local government. Local government is a provider and user of cadastral data, as well as a potential user of a wide range of demographic, statistical, community and land use data. To achieve the economic and social policy goals articulated by Government, it is critical that all local government organisations engage with the systems proposed.

Awareness and capability in larger local government organisations is high. However, a challenge for implementation is engagement with the smaller local government organisations. These often face some of the larger land use and social services challenges in the more remote regions and with fewer resources. Demand side actions are critical here.

5.6.2 Economic Implications

Application of spatial information systems in local government in Tasmania is well advanced but has not extended beyond business and operational activities. That said, it is evident that most councils have now become highly dependent of spatial information for the core activities of planning, asset management and risk profiling.

As discussed earlier in this report, various waves of adoption are additive in terms of benefits realised and the largest benefits accrue when systems reach enterprise-wide use as the 'create once, use many' paradigm is maximised.

In its 2008 study on the value of spatial information in Australia, ACIL Tasman quoted that a Queensland Government study of the use of spatially-based online business systems had delivered productivity improvements of 0.7 per cent of total revenue (ACIL Tasman, 2008). Similar systems are now in place in the larger councils in Tasmania.

A study undertaken by ConsltingWhere and ACIL Tasman for the local government association in England and Wales estimated that productivity savings from the use of geospatial systems were of the order of 0.23 per cent in 2009 and are expected to grow to 0.31 per cent by 2015 with increased adoption and extension of some of the geospatial services to the community (ConsultingWhere and ACIL Tasman, 2010). Details of the types of benefits are shown in Table 6. A table of the productivity shocks for the UK study is provided at Appendix E.

Table 6 **Case studies in England and Wales**

Local Service Provider	Application
Newport City Council	Data Sharing
Blackpool Council	Data Sharing
Plymouth City Council	Data Sharing
Huntingdonshire District Council	Data Sharing
Daventry District Council	Waste Collection Route Optimisation
Tendring District Council	E-Planning
Swindon Borough Council	Health and Social Care
ELGIN	Streetworks Management
Nottingham Insight	Local Information System
Derbyshire Partnership	Shared Information Services
London Borough of Barnet	Street Patrol
South Tyneside Council	Customer Interface
East Sussex County Council	Fault reporting
Scarborough Borough Council	Litter inspection
South Yorkshire Police	Crime analysis
London Borough of Islington	Highways Inventory management
Undisclosed Police Authority	Operations

Source: (ConsultingWhere and ACIL Tasman, 2010)

If it is assumed that around 50 per cent of the rate base in Tasmania has applied spatial systems, the productivity impact across local Government in Tasmania has been estimated to be around 0.37 per cent using the results from the ACIL Tasman 2008 study (ACIL Tasman, 2008). The findings of the 2010 UK study suggests that extending these systems more widely could increase this to around 1.5 per cent by 2020 (ConsultingWhere and ACIL Tasman, 2010). Some of these savings would be cashable in the near term.

In addition, the UK study found that other users of local government services also benefit from improved local government use of spatial databases. Beneficiaries included the construction sector, land transport and business services including legal firms and banking.

Another benefit that was identified was the time saved by ratepayers and developers in reduced administration costs from 'channel shifting'. While this is a tangible benefit we have not included this in our estimates.

These estimates have been used for the modelling and are summarised in Table 7.

Table 7 **Summary of productivity shocks for local government**

	2011	Productivity improvement by 2020 without the investment	Productivity improvement by 2020 with the investment.
Net productivity impact	0.37%	0.5%	1.5%

Data source: ACILTasman

5.7 Primary industries, parks, water & environment

5.7.1 Natural resource management and environment

Programs addressing natural resource management, environment and water are heavily dependent on geographic data for baseline monitoring, policy development and compliance monitoring. DPIPWE draws on geographic data for vegetation mapping, climate change and resource information generally. It is responsible for the on-ground management of around one third of the State's land area. Natural resource management issues include the forest, fire planning, vegetation mapping, climate change, vulnerability assessment and management of the state's water resources.

Three examples of spatially-based natural resources management programs administered by DPIPWE are:

- The Climate Futures project
  - This is a good illustration of a project that depends on spatial information for its success. This is a research collaboration between the Tasmanian Government, the Commonwealth Government and Hydro Tasmania to provide future climate information at a local scale.
  - The resulting projections will be used for local decision-making and engage a cross-section of the broader community.
- Vegetation mapping
  - Vegetation mapping is another important example of the use of spatial information to support sustainable resource management.
  - TASVEG is the Tasmania-wide vegetation map, produced under the Tasmanian Vegetation Mapping Program (TVMP). The TVMP uses 154 vegetation communities to produce vegetation maps at a scale of 1:25000.
  - The mapping builds on and incorporates the Regional Forest Agreement (RFA) mapping of forest vegetation communities, as well as World Heritage Area (WHA) mapping that was carried out at 1:25000 scale.
  - Non-forest community types include grasslands, heath lands, scrub, wetlands and salt marshes, as well as riparian and coastal vegetation, woodlands and forest remnants. Recent mapping of plantations by

Forestry Tasmania and Private Forests Tasmania has been incorporated.

- The Natural Values Atlas
  - This is an atlas of natural values information that provides access to authoritative information on plant and animal species in Australia by location.
  - The reports produced by the atlas support planning and decision-making processes across all levels of government and industry.

Spatial information links economic development, land use planning and natural resource management

It is evident that these and similar activities provide a link in the nexus between economic development, land use planning and natural resource management. Access to accurate spatial data is fundamental to maintaining evidence-based decision-making, both for conservation and sustainable resource use and for sustainable economic and social development across Tasmania.

Officers reported that access to the spatial data available through LIST and SIPS was critical to meeting their mission. The degradation of the data was regarded as a concern, limiting the effectiveness of the use of the spatial data for evidence-based decision-making. Sub-optimal data and lack of access diminished the ability for business and the community to engage effectively in decision-making processes.

It was difficult to estimate how improved data might increase productivity. The most significant impact of data degradation was thought to have been less optimal decisions for sustainable resource management. More evident were higher costs in the assessment of major projects from an environment and natural resource management perspective.

5.7.2 Water

Spatial information is fundamental to water resource monitoring, planning and management. Mapping of water resources and water quality has been part of the hydrologists' toolkit for decades. Sustainable management of water for potable purposes, agriculture, power generation and to sustain biodiversity and conservation values requires the ability to combine different classes of data, such as water quality, stream flow and diversions, and to map the interactions.

Such approaches are also fundamental to sustainable use of water for irrigated agriculture, which is one of fundamental applications of spatial systems in Tasmania.

5.7.3 Agriculture

Agriculture is one of the industries identified in the EDP as offering further prospects for economic growth in the State. Some areas of activity that are thought likely to be able to maintain a sustained competitive advantage are irrigated agriculture, wool, meat and horticulture, including an emerging (but niche) grape and wine industry. Irrigated agriculture and controlled environment horticulture have been identified as areas of potential growth in earlier studies that ACIL Tasman has undertaken ((ACIL Tasman, 2004), (ACIL Tasman, 2005)).

The Wealth from Water program is an example of how spatial data is supporting planning in irrigated agriculture. The program is part of the Government's broader Innovation Strategy, which forms part of the EDP. This program is a collaborative venture between DPIPWE, DEDTA and the Tasmanian Institute of Agricultural Research (TIAR). It will provide landowners and potential investors with comprehensive soil, microclimate, crop and enterprise information to support more informed decisions.

The program provides access to this data through an internet-based portal. The portal will include location-based data, as well as links to market information (see Figure 25). The aim of the program is to demonstrate the linkages between natural resource management and economic development.

Figure 25 **An example of the proposed web-based spatial map viewer**

Data source: (DPIPWE, 2010)

Controlled environment agriculture also has potential in northern Tasmania (ACIL Tasman, 2006). The region has a suitable climate, access to natural gas (for heat and carbon dioxide) and transport infrastructure, creating comparative and competitive advantage in a highly differentiated market.

Spatial information has much to offer in decision-making and planning for this potential economic development opportunity. Hothouses can utilise natural gas for heating and as a source of carbon dioxide to promote plant growth. Industry participants also need access to transport infrastructure, including shipping ports and airports, to move high-value products to mainland Australia and Asian markets. Successful development of this industry will require well-coordinated land use and infrastructure planning decisions. If the industry is to reach its potential in Tasmania, it may require significant access to agricultural land in areas contiguous to urban development and infrastructure (see Box 6).

Box 7 **Controlled climate agriculture in Portugal**

Controlled climate agriculture produces specialist horticulture from hothouses. Northern Tasmania has the ideal climate for hothouses, with an emerging industry around the Ulverstone area. Tasmania also offers the advantages of access to natural gas for both heating and as a source of carbon dioxide that is required in the process. It also has good roads and port access. The NASA image, taken around 2003, shows hothouses in Portugal covering a large area of land. The need to link access to land, natural gas and transport nodes illustrates the need for effective land use planning for such industries to grow. Spatial information provides the tools to make better land use decisions.

Source: NASA, (ACIL Tasman, 2006)

5.7.4 Relevance of the business plan

Given the use of spatial information systems is well advanced in the water and forestry sectors and is emerging in agriculture, investment in better data coordination and systems is likely to improve decision-making in a way that better coordinates economic development and sustainable resource management. Reduced duplication of data collection, and data that is easier to access and analyse, can reduce planning costs, as well as lead to better planning decisions. 'Collect once, use many times' is a phrase used in Europe that captures this concept.

For these reasons, both demand and supply side actions are fundamental to achieving potential further gains from the use of spatial information in these areas.

5.7.5 Economic implications for the portfolio

Placing a value on the contribution of spatial data systems for natural resource management is challenging. Improved environmental and ecosystem outcomes are public goods. Being non-rival and non-excludable, public goods are not priced in the market. These valuable but free services include soil formation, habitat, biodiversity, water quality and so on.

One approach would be to assume that a certain standard of sustainable resource management is required by society, and examine the efficiency with which DPIPWE achieves these goals. If this approach were taken, one might assess the cost of achieving these standards with and without access to good spatial information.

Another approach would be to examine the environmental damage costs of not meeting sustainable resource management goals. A full stocktake of the value of non-priced benefits from biodiversity, water quality and sustainable soils management could be done, but the data requirements for an assessment for Tasmania would take more time than is available for this report.

In a recent project on the value of earth observation from satellites (one component of spatial data information systems), ACIL Tasman estimated that the annual value of benefits derived from natural resource management for Australia were of the order of $500 million (ACIL Tasman, 2010). Even if one twentieth of this were attributed to Tasmania, the value would be of the order of $25 million per year. Clearly, this is only a broad indicator of value but an indication that the value is in the tens of millions for Tasmania.

The other side of economic benefit is increased productivity for DPIPWE. In an earlier study, ACIL Tasman estimated that the accumulated productivity impact on public administration was of the order of 0.37 per cent in 2007. There is considerable evidence that this impact has increased since that time. This figure represents a conservative for the value of this information in a portfolio such as DPIPWE, a significant user of spatial information.

This impact would increase if the proposed actions were to be fully implemented. The benefits of improved data reliability and coordination and reduced data duplication are estimated to more than double the use and application of spatial data in decision-making by this department. On the other hand, doing nothing would see a slight deterioration in the accumulated productivity impact.

A summary of the estimated impact for the portfolio area is summarised in Table 8.

Table 8 **Summary of productivity shocks DPIPWE**

	2011	Productivity improvement by 2020 without the investment	Productivity improvement by 2020 with the investment.
Net productivity impact	0.37%	0.3%	1.5 %
Wider value in maintaining natural resource management values	Potentially very high		

Data source: ACILTasman

5.8 Security and emergency management

5.8.1 Background

Protection of national security, protection of critical infrastructure and planning for and managing emergencies is a priority of all governments in Australia. National security and critical infrastructure protection are dependent on spatial information systems. We have not included these areas in the economic assessment because of the difficulty of getting access to sensitive data. However, the benefits of such systems to the security of the Tasmanian community is not insignificant.

Spatial data is used in emergency management in Tasmania by the police, the fire service, emergency services and the ambulance service. Recent natural disasters in Australia, from the fires in Victoria to the flooding events in Queensland, New South Wales, Victoria and Tasmania demonstrate the importance of spatial information in managing and responding to natural disasters.

In the course of our consultations, we were advised that the level of coordination of spatial data in the emergency services in Tasmania is less than optimal. It is not currently possible to share data-rich emergency management information between the larger urban centres such as Hobart, Launceston, Devonport and Burnie.

5.8.2 Tasmanian Emergency Management Spatial Information Support System

Authorities in Tasmania recognise existing deficiencies and are working on solutions to develop a common spatial information operating system, based on the defined business needs of each organisation and agreeing on appropriate data exchange and protocols. With the roll-out of the National Broadband Network (NBN), it will become practical to establish emergency operations centres close to incidents and then share information through central operations to more quickly establish situational awareness at all levels in the response phase. The proposed project to achieve this goal is the Tasmanian Emergency Management Spatial Information Support System (TEMSISS).

The outcomes that are sought from TEMSISS are:

- best available information on natural hazards and risks to the public, developers, industry and planning authorities
- a platform to share and communicate near-real time critical information between emergency services and with local government and the Commonwealth Government during emergencies
- a common point of authoritative information for communities, the media and concerned organisations during emergencies
- solutions to integrate the use of spatial data into existing core business systems that support the prevention of, response to and recovery from emergencies.

The implementation plan aims to ensure that communities also directly benefit by:

- delivery of hazard risk information to local government to support improved land use planning information
- supporting the role of community protection plans to reduce the risks to communities from bushfires
- developing spatially-based forecasting and near-real time warning for flooding in the South Esk catchment
- developing an all-hazards web portal to provide the community with accurate, up-to-date information during emergencies
- delivering spatial information to support the operation of the Australian Government Crisis Centre and Parliamentary Briefing Room.

Benefits identified from TEMSISS include:

- Emergency services
  - a common operating platform that is integrated with existing incident management and dispatch systems that will

    … improve the delivery of emergency services

… support improved planning of investment in emergency services

… add value to investments in vehicle location and tracking technology from improved situational assessment to take account of health and community protection plans and other information

- Government
  - enhanced management of emergency risks by

    … improved local responses to and recovery from emergencies

    … improved situational awareness to the Commonwealth to support regional coordination of resources, and support response and recovery arrangements
- Community
  - improved understanding and preparation for emergencies by the community
  - provide a single source of authoritative data.

A fully integrated system of this kind would have productivity benefits for emergency service agencies and local government in the form of faster response times and more efficient use of resources in times of emergency.

However, the greatest benefits will accrue from reducing the consequences of emergencies, such as fires and floods, reducing costs to the community, public infrastructure, local government assets, and reducing emotional impact for the victims of natural disasters.

5.8.3 The cost of natural disasters

The Bureau of Transport and Regional Economics (BTRE) undertook a comprehensive assessment of the costs of disasters in 2001 (BTRE, 2001). The report makes the following findings:

- The average annual cost of natural disasters occurring between 1967 and 1999 (with a total cost per event over $10 million) was $1.14 billion, including the cost of deaths and injuries ($1.45 million in $2010).
  - This estimate is strongly influenced by three major events – Cyclone Tracey in 1974, the Newcastle Earthquake in 1989 and the Sydney hailstorm in 1999.
- The average annual cost of natural disasters excluding these extreme events was estimated to be $860 million.
- The total cost of most disasters is between $10 million to $50 million.
  - There was some evidence that the number of reported disasters per year was increasing.
- Floods were the most costly of all disasters (29 per cent of total cost).

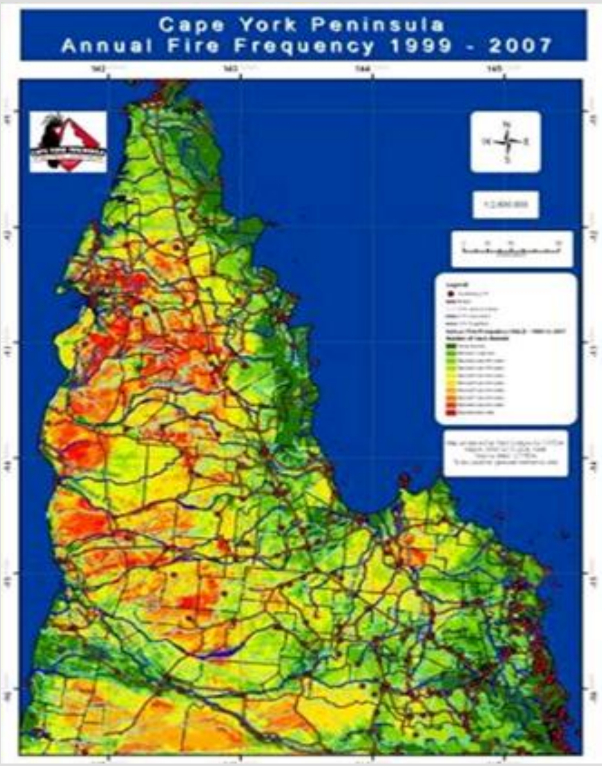
- Storms (26 per cent) and cyclones (24 per cent) caused similar levels of damage.
- The costs of bushfires were a relatively small proportion of total disaster costs. However, bushfires are the most hazardous type of disaster in terms of deaths and injuries.

The likelihood of potential natural disasters is not known with certainty. Past patterns of bushfire incidents and extreme weather events provide some indication of the probability that such events will occur in the future.

Fire

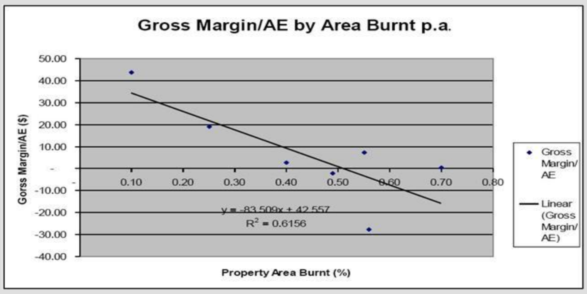
Bushfires may sometimes result in lower production but no loss of life or property, as in the case of periodic fires in rural Queensland (see Box 8). Conversely, fires can have major consequences through loss of life and property, as in Canberra in 2003 and Victoria in 2008.

Box 8 Use of satellites for rural fire research and management



This fire frequency map was produced using shows the land that has been burned over time. The dark green areas represent areas that have not been burned from 1999 to 2007. The bright red areas have been burned every year in the same period, with various degrees of burning represented by the lighter shades of orange, yellow and green.

The project combined 8 years (1999-2006) of satellite image mapping and interviews with land managers to assess the relative use of no fire management, fire fighting only, early dry season and/or storm burning in achieving property management objectives (such as restricting dry season fires, maintaining healthy cattle, preventing/reversing woody thickening).



CYSF and natural resource management agencies like the Rural Fire Service have gained valuable economic insights regarding fire management on pastoral properties and, by implication on conservation areas and indigenous lands as well. The project showed that lower gross margins (GM)/Adult Equivalent (AE - 400kg animal) were associated both with increasing average annual burn areas and lower stocking rates.

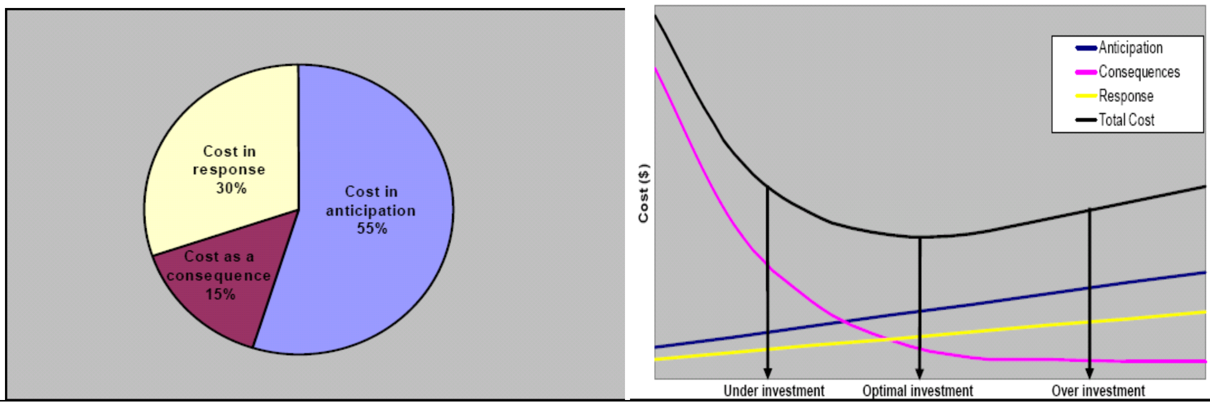
Source: Drucker, 2008

The total annual cost of fires in Australia has been estimated in a report prepared by Ashe, McAneney and Pitman at $8.5 billion (Ashe, 2006). This is significantly higher than the BTRE estimates cited above, but includes the cost of all fire-related activities, including fire services and mitigation measures. The report found that 55 per cent of fire mitigation activities occurred in anticipation of bushfires, 30 per cent in response and 15 per cent in consequences (see Figure 26).[3] The national cost of 'consequences' was therefore around $1.3 billion.[4]

Positive marginal return on investment in anticipation of and response to fires

It also noted that the marginal return on investment in consequences was negative, whereas marginal returns to investment in anticipation and response investments were positive. EOS supports the latter activities. If this observation is correct, future public investment in EOS should deliver increasing returns compared with public spending on the consequences of fires.

Figure 26 **Distribution of costs of fire mitigation**



Data source: (Ashe, 2006)

Services used for planning and preparation activities, monitoring of fires, movement of fire-fronts in advance of fire incidents and ongoing reporting during fire events can significantly reduce the cost of the consequences of fires.

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3 Anticipation related to costs of preparation, fire services etc. Response related to mobilization of activities to fight the fires. Consequences related to the cost of the fires to the community.

4 This estimate is significantly higher than the estimate referred made by the BTRE mentioned previously. The latter did not include the cost of anticipation of the fire event (planning and preparation) which may have accounted for some of the difference. Costs associated with consequences the expected annual cost of fires would be around $1.3 billion.

The effectiveness of planning and preparing for fire mitigation, establishing warning systems and developing response plans draws significant benefits from spatial information.

Monitoring vegetation cover or hazard incidents significantly improves the development of warning systems and management strategies. There are no estimates in the literature of how much less effective fire management might be without spatial systems. However, based on interviews, ACIL Tasman believes that a conservative estimate is likely to be in the order of 20 per cent. This is based on the fact that spatial information assists in mitigation measures but this is not the only factor in reducing the consequences of fire. Depending on the estimates of costs, this could mean that spatial systems deliver benefits in excess of $32 million and $255 million per annum[5].

ACIL Tasman has not found studies of the annual average damage cost from fires in Tasmania, but the national estimates above suggest that the costs could be in the millions of dollars. Even if these costs were reduced by 5 per cent through better use of spatial data, the annual benefits would be in the millions of dollars.

5.8.4 Floods

The annual damage costs of flooding were estimated to be the most costly of all the natural disaster categories studied in the BRTE report – representing 29 per cent of the estimated annual damage costs of $1.14 billion in 2001 dollars (BTRE, 2001). This is equivalent to $331 million in 2001 dollars or $430 million in 2011 dollars.

Flood mitigation measures comprise both structural and non-structural activities. Structural activities include the construction of levies, control structures and flood mitigation dams and storages. Non-structural activities are also important in reducing average annual damage. Non-structural activities include better planning for developments in the floodplain, floodplain mapping and flood zoning. Hazard warning systems are also important non-structural activities that focus on response measures.

Spatial information services are important for non-structural activities. Most imagery around metropolitan and town areas is acquired by airborne photograph or airborne LiDAR for digital elevation models. In remote areas satellite acquisition is also used.

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5 The first estimate is based on 20 per cent of $164 million being the 2001 BTRE estimate in 2011 dollars. The second estimate is and 20 per cent of $1,280 million which is a 2006 Macquarie University estimate in 2010 dollars

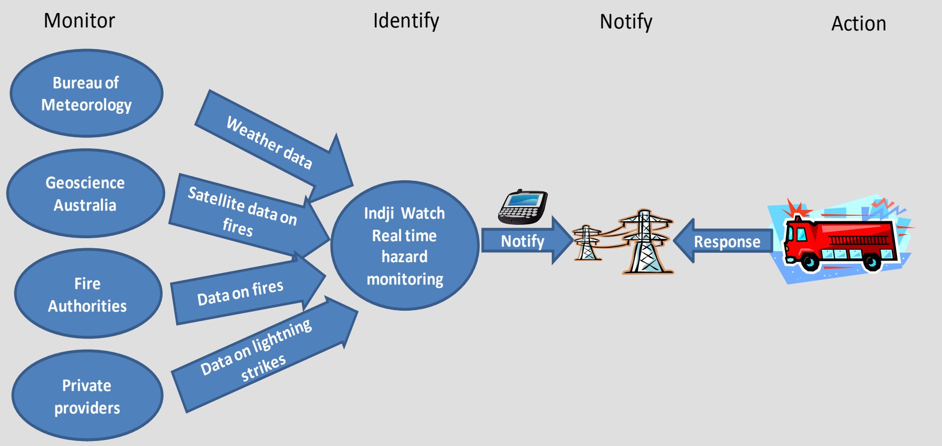
Using a conservative estimate, these systems could reduce average annual damage costs by around 5 per cent net on ACIL Tasman's estimates – equivalent to around $20 million nationally. The avoided costs in Tasmania would be much lower than this. Nevertheless, if a systematic analysis were done they would still be in the millions of dollars.

5.8.5 Value added services

There are also benefits that can accrue in value-added services that build on spatial databases. An example of an Australian application that is now finding markets overseas is provided in Box 3. This application warns users of the proximity of hazards. It depends on data from fire services, the Bureau of Meteorology and Geoscience Australia. The effectiveness of such systems is determined in no small measure by access to reliable data, as will be provided if the proposed actions are implemented.

Box 9 Indji Watch hazard warning system

The Indji Watch web-based hazard monitoring system uses spatial information to deliver real time analysis of risks and hazards against the physical location of fixed or mobile assets, and initiates intelligent actions and warnings when assets are under threat. Based on research supported by the CRC for Spatial Information (CRC SI) and developed by an Australian geospatial company.

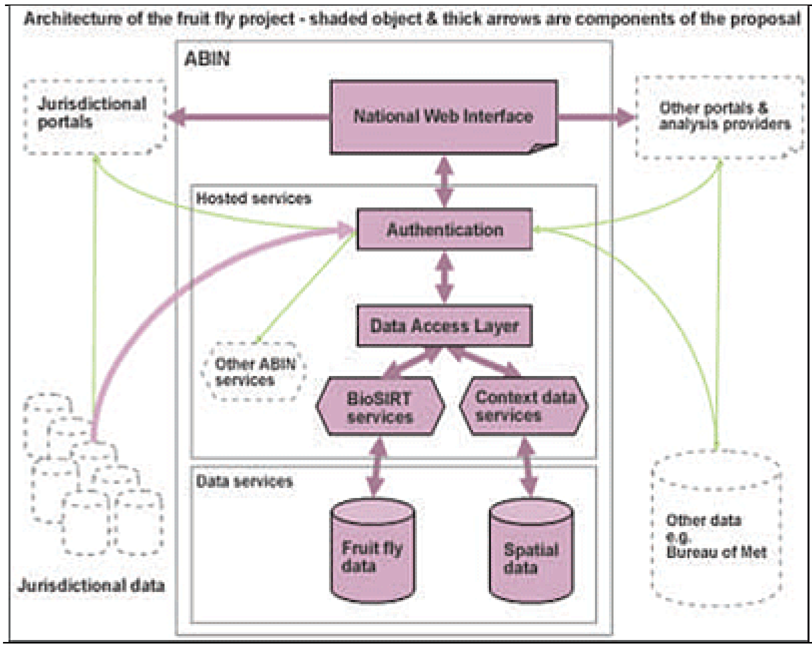


Source: NGIS

5.8.6 Biosecurity

Biosecurity is another area of critical importance to Tasmania. Tasmania participates in the nationally-coordinated BioSIRT response and planning system that is supported by a national spatial database. The system supports the monitoring and tracking of incursions of pests and diseases, and would be activated, for example, in the event of an outbreak of Fireblight in apples, an incidence of Foot and Mouth Disease in the sheep industry, or an outbreak of Abalone Viral Ganglioneuritis.

Figure 27 **BioSIRT architecture**



Data source: (DAFF, December 2009)

There is a large body of literature on costs associated with outbreaks. Costs vary by crop, disease type, pathogen, duration, and so on, but in many cases the potential impact runs into millions of dollars.

The efficient biosecurity action plans:

- reduce the time to act or decide on action to be taken during an emergency response, thus reducing the impact of the incursion
- support industry sustainability and market access by increasing capacity to report pest and disease status
- reduce duplication across animal and plant emergency response and routine biosecurity activities, resulting in operational efficiency and savings.

Tasmanian data is fully integrated into BioSIRT.

5.8.7 Relevance of proposed actions

All the proposed actions are important for emergency services. However, accurate data is a central imperative. If the ambulance service has the wrong location, the cost in terms of lost lives is high. If firefighters are sent to the wrong address, ensuing delays magnify the damage costs.

However, the greatest short term gains accrue to database coordination and good data access systems. This does not just mean portals to support access, it means flexibility and consistency of standards to allow innovation in applications that both government and the private sector have shown they can achieve with better access.

Finally, a solutions-based approach to integrating these systems is high on the priority list. The ultimate provision of access by the community at large to the information that these systems can provide will be important to the community's ability to respond to threats. This would enhance the effectiveness of action by the emergency service organisations, through better informed communities and better mobilisation of community resources.

5.8.8 Economic implications

There were no estimates available on the likely implications for productivity improvements that would be possible from the TEMSSIS system when fully operational. It is likely that productivity benefits would accrue and would be spread across emergency service organisations, local government and community support groups such as St John Ambulance and the Salvation Army.

One of the biggest beneficiaries from the use of spatial information is the insurance industry. In the wake of the recent floods in Queensland, the industry has now recognised the importance of floodplain mapping. The finance and insurance sector is potentially a big beneficiary of the use of spatial information to mitigate the risks associated with natural disasters.

From consultations and comparison with experience from our studies in England, we consider that a net productivity improvement for affected government agencies (emergency services, ambulance, fire services, local government) of around 0.2 per cent to 0.4 per cent would not be unreasonable and probably conservative. This is consistent with the high level of adoption, albeit standalone, in the emergency management agencies and productivity improvements observed in our Australian and UK studies ((ACIL Tasman, 2008), (ConsultingWhere and ACIL Tasman, 2010)).

The benefits to the community and the economy are not known, but from examination of current literature are probably in the order of millions of dollars annually.

The benefits are summarised in Table 9.

Table 9 **Summary of benefits for management of emergencies**

	2011	Productivity improvement by 2020 without the investment	Productivity improvement by 2020 with the investment.
Net productivity impact	Small	0.3%	1.25% to 1.5%
Wider value in maintaining natural resource management values			In the order of millions of dollars annually

Data source: ACILTasman

6 Tasmanian industry

6.1 Forestry

Forestry Tasmania (FT) manages 1.5 million hectares of State forest. It is a mature user of modern spatial information, having first invested in GIS systems in 1985. Its data requirements include:

- aerial imagery
- satellite imagery
- topographic data
- digital elevation models
- GNSS (satellite positioning) data
- cadastral data.

Spatial information has become essential for FT operations and underpins competitiveness in the forestry industry as a whole. Around 75 per cent of the 400 employees now use spatial data or derived products for their everyday work. Manual mapping has been replaced. LiDAR data has replaced aerial photography for forest classification, canopy measurement and inventory modelling.

With the assistance of spatial information systems, staff resources formerly used in field assessment have been reduced through better prediction of constraints.

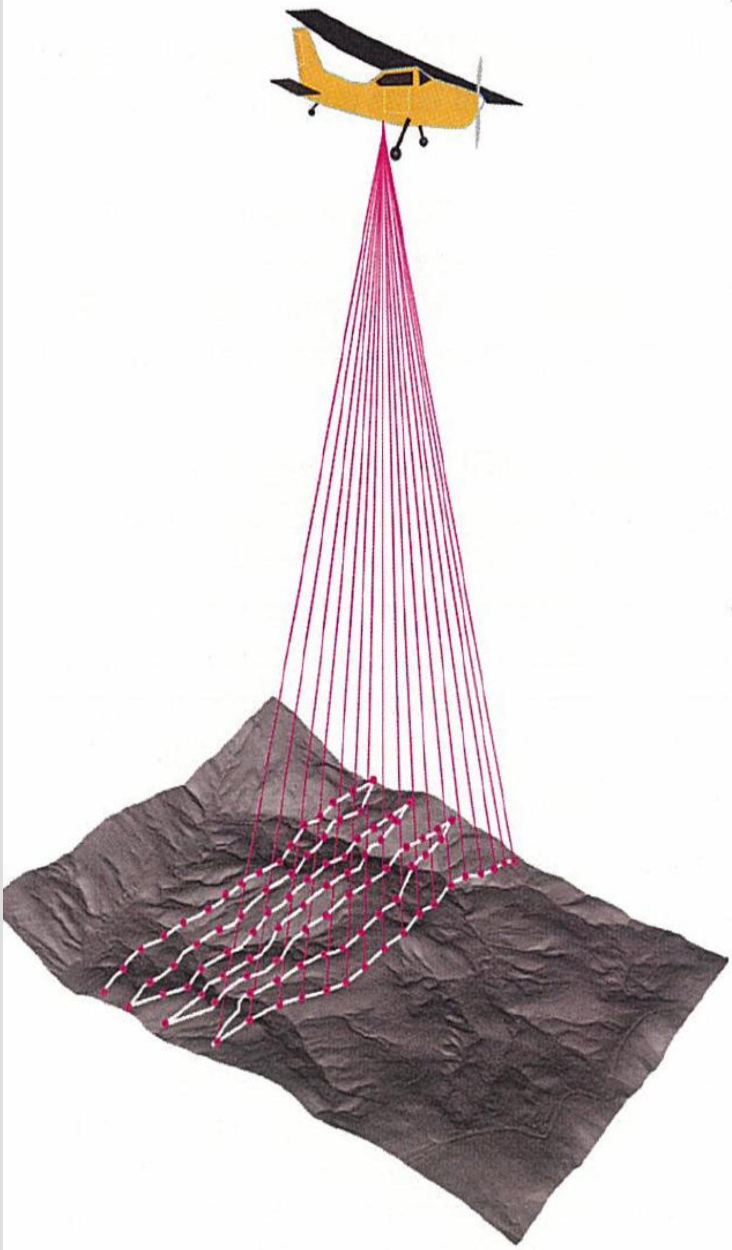
Spatial information has been responsible for 20 per cent in labour savings and around 5 per cent to 20 per cent in capital requirements. It delivers less wastage in spraying of herbicides and more targeted field work.

A study of the use of LiDAR by FT showed that the capital investment was recouped in five years. Benefits include:

- a 75 per cent reduction in operational inventory to inform the planning of thinning and harvesting
- 40 per cent reduction in temporary plot measurements required for strategic inventory to support sustainable yield estimates
- greater accuracy in volume measurement.

Improved volume measurement is relevant to the monitoring of sequestered carbon dioxide for the calculation of carbon credits in any carbon trading scheme.

Box 10 **LiDAR**



*LiDAR stands for **L**ight **D**etection **A**nd **R**anging. Airborne LiDAR scanning is a remote sensing technology that can be used to directly measure the 3-dimensional structure of a forest and the underlying terrain. It is this ability to sense and measure structural features directly that constitutes the principal advantage of LiDAR scanners over optical instruments such as frame cameras, as used in traditional strategic aerial photo interpretation (API), and satellite sensors, (eg Landsat, Quickbird).*

LiDAR scanners generate narrowly focused laser pulses and direct these across a wide swath beneath an aircraft. This is depicted visually in the figure at left. The reflected laser pulse is digitally sampled and recorded for further analysis.

Forest vegetation typically reflects a first return from the top of the canopy and subsequent returns from either within the canopy, the under-storey, or the terrain beneath. The returns are represented as spatially accurate point data. These points can be filtered to discriminate between ground and non-ground sources. The ground-return data is used to develop map of the terrain surface. The non-ground return data points are each assigned an above-ground height value based upon their elevation difference relative to the modelled terrain elevation at the same location. This data can be further analysed to develop measures of forest structure such as canopy density and height.

Source: (Forestry Tasmania, 2010)

6.1.1 Future directions

If the State Government improves access to spatial information, the forest industry in Tasmania will be able to reduce costs delivered by the resultant economies of scale. Without this investment, the forestry industry will have to compensate through its own investment, which will result in more duplication and less sharing of information between the industry and Government.

The delivery and access mechanisms proposed are extremely important to realising these outcomes. For a mature user of spatial information such as FT, increased access to data and value-added systems will deliver incremental increases in productivity and savings. In a new or potential user of spatial information, the benefits can be very high.

6.1.2 Economic implications

Based on the evidence from Tasmania and research elsewhere in Australia undertaken by ACIL Tasman, it is concluded that the productivity benefit for forestry that has been delivered by spatial information systems in Tasmania is around 20 per cent, in terms of labour productivity in specific applications. However, taken across all forestry activities in Tasmania, ACIL Tasman believes that this would represent a productivity improvement of around 1.93 per cent, similar to our estimate for Australia generally.

Given that FT represents about 50 per cent of forestry production in Tasmania, we now believe that the net labour productivity shock would reasonably be around 3 per cent by 2020 with ideal policies, and 1.5 per cent without.

Table 10 **Summary of benefits for management for the forestry sector**

	2011	Productivity improvement by 2020 without the investment	Productivity improvement by 2020 with the investment.
Net productivity impact	1.93%	1.5%	3%
Wider value in maintaining natural resource management values			In the order of millions of dollars annually

Data source: ACILTasman

6.2 Energy

The energy industry is comprised of three sub-sectors: generation, transmission and retail. The case studies have compiled data from transmission (Transend Networks) and retail (Aurora Energy).

6.2.1 Transend Networks

Transend Networks was formed following the disaggregation of the former Hydro Electric Commission in the 1990s, and is responsible for bulk power supplies and delivery in Tasmania.

Transend has approximately 280 staff, of which approximately 10% use core spatial data and derived products. Spatial information is "very important" to the normal functioning of the organisation. Data requirements include:

- aerial imagery
- satellite imagery
- topographic data
- GNSS data
- cadastral data.

Spatial information is widely used in energy transmission organisations in Australia, however, Transend considers that it has a lower level of take-up than most. Reasons include Transend's relative size and the inheritance of previous 'legacy' systems from its predecessor.

The primary use of spatial data is for planning, the collation of multi-datasets, data integration and customer enquiry. Spatial information has enabled income streams to be established from customer queries through the modernisation of their query search tools. Spatial data is particularly critical for risk assessment, and for long tern (30 year) infrastructure planning.

Transend does not believe it could meet its reporting requirements without spatial information, particularly as the regulatory and legislative environment becomes more onerous and complex. Nevertheless, Transend is a relatively small spatial information user. The organisation has no specialist staff, but several competent users who deal with spatial in addition to their regular jobs.

Future directions

As a smaller player in the sector, Transend believes it could gain most from sharing of core data.

Transend notes that it would use LiDAR data for remote area engineering assessment and planning if that data was available. This is because the placement of transmission towers and catenary (wires to ground) clearance design is presently dependent on ground survey. LiDAR would introduce significant field cost savings on a project basis.

Transend has been examining the usefulness of a CORS system to support its fleet operations and assist with OH&S and search/locate systems. This is an example of where a system built for some main players (e.g. agriculture) could have flow-on effects for others, thus magnifying the benefits.

Table 11 **Summary of benefits for management for the energy sector**

	2011	Productivity improvement by 2020 without the investment	Productivity improvement by 2020 with the investment.
Net productivity impact	1%	1%	2.19

Data source: ACILTasman

6.3 Mining

A company involved in mining was interviewed to assess the impact of spatial information systems on their operations. This indicated that mining is a significant user of modern spatial information, in particular:

- satellite imagery
- topographic data
- digital elevation models (DEMs)
- GPS data.

The principal uses are for forward planning for resource and infrastructure needs, and very importantly, for quantity management, payments, safety and compliance.

Quantity management is particularly important for project cost monitoring. Quantities are measured using sophisticated surveying/remote sensing techniques, firstly prior to blast, then after crushing, and again in transit.

It was estimated that a 'one stop shop' concept for government data and assessment would significantly reduce the complexity and duration of mineral industry applications. They estimate this would save 20% of project application time and cost.

Table 12 **Summary of benefits for management for the mining sector**

	2011	Productivity improvement by 2020 without the investment	Productivity improvement by 2020 with the investment.
Net productivity impact	0.05	0.15	0.47%

Data source: ACILTasman

6.4 Agriculture

In 2008-09, crops made up 48 per cent of total agricultural production in Tasmania. Livestock products and slaughtered livestock made up 31 and 21 per cent of total production respectively (Table 13).

Table 13 **Agriculture in the Tasmanian economy**

Commodity	Gross value ($)	Percentage of total gross agriculture value (%)
Crops	556,903,669	48%
Slaughtered Livestock	245,113,493	21%
Livestock Products	358,971,203	31%
Agriculture - Total Value ($)	1,160,988,365	

Data source: As mentioned in an earlier section Agriculture, Forestry and Fishing made up 6.9 percent of total GSP in 2009-10.

Tasmania occupies a land area of 68,300 square kilometres, of which nearly a third is committed to agriculture. A temperate climate, high quality water, fertile soils, four distinct seasons and a clean atmosphere make Tasmania an ideal place for producing pure, high quality products. Coupled with this is the advantage of cheap land, irrigation development and capacity, and reliability of supply of products.

The major agricultural activities in Tasmania are:

- beef farming - mainly in the Northern and North-western regions
- dairy farming - mainly in the Northern and North-western regions
- sheep farming - mainly in the Greater Hobart-Southern and Northern regions
- vegetable production - mainly in the Northern and North-western regions
- fruit production - mainly in the Greater Hobart-Southern region.

Tasmania's highly diversified food and agricultural sector has a reputation for products that are internationally competitive and among the finest and cleanest in the world. Sustainable agricultural practices are in place to enhance Tasmania's clean and green image, chemical usage is being reduced, and best practices for the use of chemicals have been adopted.

Current use of spatial information in agriculture in Tasmania appears to be lower than in the rest of Australia. According to DPIPWE, there is some use of assisted guidance for tractors and some use of variable rate fertiliser application. Consultations between DPIPWE and industry have been undertaken as part of an innovative farming practices program.

Agriculture producers are users of some spatial information such as:

- aerial photography
- satellite imagery
- DEMs
- soil mapping.

The recent proliferation of machinery that is enabled to receive satellite broadcast navigation signals (GNSS) has already seen a marked uptake in precision guidance. There is anecdotally a "massive" potential benefit to agriculture with this technology.

Skills are a potential choke point for greater adoption

The accuracy and precision of DEMs is a big issue for potential users. DEM use would increase significantly if delivery and ease of use were improved. At present, cost is a small barrier, however the 'choke point' is the skills required to turn available data into useable data at the farm level.

Farm mapping is the fundamental basis for whole farm planning. Integration of the various data sources (DEM, imagery, soil mapping, geology etc) requires specialist skills, which is limiting the uptake. In the future, farm productivity and competitiveness is going to rely ever more heavily on quality spatial information.

Recover investment in 1 to 2 years

An example is in variable rainfall potato growing in North-eastern Tasmania and parts of the Northern Midlands. Investment to set up irrigation systems reliant on spatial information is about $15,000 to $20,000. Anecdotally, farmers are able to recover this investment in 12 to 24 months.

Machine guidance systems have also meant that unskilled labour can more easily be taught to operate machinery. Machines can operate at night due to the automatic guidance. Productivity and efficiency is significantly lifted.

The respondent considered that the most important investment for government is in the area of data quality, data delivery and coordination of data formats. Value-adding at source could greatly reduce the barriers to farmers acquiring spatial information for whole-farm planning.

Tasmania is participating in a national program to establish high accuracy satellite positioning in Tasmania. A state-wide CORS network (Continuously Operating Reference Stations) has been designed to provide positioning accuracy of 6 cm or better across all of Tasmania[6]. Accuracy at this scale can support applications in precision agriculture that were not previously possible.

The stated objectives of the program are to increase the adoption of innovative farm practices in Tasmania, of which precision agriculture using spatial information systems was identified as a central enabling technology.

Figure 28 **Controlled traffic farming using spatial information**

Data source: Figure 28

Potential applications include assisted guidance and controlled traffic techniques (automated steering of tractors), yield monitoring, variable rate fertiliser applications, irrigation planning and operations horticulture monitoring and marketing.

These methods were shown to deliver productivity improvements of up to 20 per cent in studies in Australia and New Zealand. The impact on industry productivity depends on levels of adoption.

6 Allens Consulting estimated the value of the CORS system in 2007. The study estimated that a CORS system would add $32 billion in productivity benefits to the Australian economy over the following 20 years (Allens Consulting Group, 2007).

Table 14 **Summary of benefits for management for the agriculture**

	2011	Productivity improvement by 2020 without the investment	Productivity improvement by 2020 with the investment.
Net productivity impact	negligible	0% to 0.05%	0.38% to 2.25%

Data source: ACILTasman

6.5 Water

An interview with the water sector indicated that the industry's use of spatial date includes:

- aerial imagery (at high resolution)
- satellite imagery
- topographic data
- DEMs
- GNSS
- cadastral data.

Spatial information is used for data collection (GPS plus remote sensing), query and site location of physical assets, asset management which is linked to the finance system, and for forward planning.

Spatial information has replaced some paper-based systems, including those used for customer enquiry, outage reporting and field procedures (i.e. field sheets).

6.5.1 Benefits / Savings

It has been estimated that spatial information has been responsible for an estimated 25% savings in labour costs.

As is evidenced in the rest of Australia, modern spatial information allows water authorities to do more without staff increases, and to rationalise inherited staff as it appropriate to do so.

6.5.2 Future Directions

The industry is likely to continue to adopt modern spatial information in Tasmania.

6.5.3 Economic impacts

The consultants estimated that the net impact of improved data access could have delivered around 1.75 per cent in productivity improvement by 2011.

However, we consider that this could increase to 2.19 per cent by 2020 under scenario 2. Such investment would allow for wider application of spatial information in metering, water accounting, asset management, route optimisation and operations improvement, resulting in further savings being achievable by 2020. Without the investment, the water sector is likely to still invest, but less efficiently. We estimate that this would reduce benefits by up to 1 per cent on the basis of interviews and our analysis. These results are summarised in Table 15.

Table 15 **Summary of benefits for management for the water sector**

	2011	Productivity improvement by 2020 without the investment	Productivity improvement by 2020 with the investment.
Net productivity impact	1%	1%	2.19
Wider value in maintaining natural resource management values			In the order of millions of dollars annually

Data source: ACILTasman

6.6 Tourism

Tourism Tasmania advised that the tourism sector had not yet taken full advantage of the potential of spatial information systems. The industry used mapping technology that was currently available on the internet for destination planning. However, the industry recognised that there was potential to do much more with spatial information.

The industry was working with local government to improve the marketing of their tourist features to assist travel advisers and clients with destination planning. The Huon Council, for example, was using spatial systems in support of tourism strategies.

6.7 Geospatial industry

The geospatial industry can loosely be defined as those specialist users and value adders for which spatial information is their core expertise. Such players include surveyors, GIS administrators and technicians, remote sensing and photogrammetry specialists, and cartographers.

As a proportion of those who use spatial information in Tasmania, this group is relatively small, however the expertise that resides in these specialists is required to maximise the benefit of any expansion of government investment.

This group has a key understanding of the principles underpinning the collection, dissemination and value-adding of spatial information. Issues such as accuracy, fitness for purpose, data specifications, scope, etc. can only be properly implemented and monitored by experts in the field.

Large organisations, such as FT and energy sector entities that are mature and core users of spatial information, rely on a small group of spatial specialists to advise and direct them on the development and implementation of relevant, business-focused spatial information systems.

Within the construction environment, for example, surveyors may represent only two or three persons on site amongst hundreds of construction workers, however, their role has always been critical to the success of the project.

In the modern era, as machine guidance systems are increasingly being introduced to large scale construction projects, surveyors are responsible for the manipulation, upkeep, troubleshooting and quality control of the machine data and software. Without such expertise, the construction industry could not capitalise on the advances in technology that are having a significant effect on project cost control and design compliance.

Therefore, whilst the geospatial industry is relatively small, increased government investment in spatial information has the potential to allow spatial professionals to help *other* players achieve economic growth and productivity gains, both incremental and exponential.

In addition, spatial industry professionals are usually at the forefront of innovation with technology and systems, so a vibrant sector is critical to the flow-on benefits that can be demonstrated to accrue to government.

One of the key benefits to the geospatial industry that will be achieved with the proposed investment is the ability to usefully combine improved and more diverse datasets. At present, due to the widely variant nature of accuracy and consistency within datasets, it is problematic to combine and rely on such combinations. However, increased reliability can flow through to faster project evaluation and estimation, less 'field time' for survey projects and lower costs for geospatial professionals, with a corresponding improvement in economic performance.

This also increases the competitiveness of Tasmanian-based firms in interstate and overseas markets. Many Tasmanian firms operate in such markets, and improved profitability 'at home' can facilitate increased options for working 'abroad'.

In addition, geospatial professionals tend to be the first port of call for interstate and overseas investors, whether in the property, minerals or other markets. Therefore, having a world-class spatial information sector in Tasmania, both in terms of spatial infrastructure and geospatial industry professionals, is likely to facilitate the Government's bigger picture economic growth ambitions.

At present, the education of spatial professionals is undertaken at both the university and technical college levels in Tasmania. In particular, the University of Tasmania undergraduate and postgraduate offerings are well-regarded nationally. These courses rely on the continued requirement from industry for graduates, and it is likely that increased investment by Government will strengthen course intakes by creating additional demand from industry.

The geospatial industry considers the development of a digital cadastre of significant importance in the proposed investment. Land as the foundation of wealth and economic prosperity is underpinned by its accurate representation in the various registers. An accurate cadastre has many flow-on benefits, and is absolutely critical to the responsibilities that service entities have to their customers and clients.

In conjunction with an accurate digital cadastre, the industry considers efforts to coordinate modernisation of other registers, such as the Land Titles Office and Central Plan Office, of equal importance. New Zealand, and to some extent other Australian States, have embrace the concept of electronic registration or survey information or 'ePlan'. The efficiencies and productivity gains from full implementation of such systems are impressive, and flow through to the local government planning and assessment process as well. Hence, the whole development environment is streamlined, which is an attractor to investment and economic growth.

The geospatial industry should be considered as a small but critical beneficiary of any future Government investment in spatial information, however, the benefits being expounded for the other sectors, particularly the hitherto non-traditional users of spatial information, will rely heavily on the skills within the geospatial industry to be realised.

The economic and productivity benefits for this sector are included in the business services sector in the economic modelling and have not been separately identified here.

7 Economic impacts

For this report, ACIL Tasman's Computable General Equilibrium (CGE) model, *Tasman Global*, was used to estimate the impacts that spatial information induced productivity enhancements have had on the Tasmanian and Australian economy to date. Further, an estimate was made of the potential benefits that could arise by 2020 for Scenarios 1 and 2 assuming that the identified opportunities are continued to be pursued by businesses and governments.

Tasman Global is a large scale, dynamic, computable general equilibrium model of the world economy that has been developed in-house by ACIL Tasman. *Tasman Global* is a powerful tool for undertaking economic analysis at regional, state, national and global levels.

General equilibrium models, such as Tasman Global, mimic the workings of the economy through a system of inter-dependent behavioural and accounting equations, which are linked to an input-output database. These models provide a representation of the whole economy, set in a national and international trading context, using a 'bottom-up approach' – starting with individual markets, producers and consumers and building up the system via demands and production from each component. When an economic shock or disturbance, such as an increase in a sector's rate of growth, is applied to the model, each of the markets adjusts to a new equilibrium according to the set of behavioural parameters[7] which are underpinned by economic theory.

In addition to recognising the linkages between industries in an economy, general equilibrium models also recognise economic constraints. For example, increased demand for labour may increase real wages if there is full employment.

A key advantage of general equilibrium models is that they capture both the direct and indirect impacts of economic changes, while taking account of economic constraints. For example, Tasman Global captures the expansion in economic activity driven by an investment, and at the same time accounts for the constraints faced by an economy in terms of availability of labour, capital and other inputs. Another key advantage of general equilibrium models is that they capture economic impacts across a wide range of industries in a single

[7] An example of a behavioural parameter is the *price elasticity of demand* – the responsiveness of demand for a commodity to a change in the price of that commodity. Each of these markets, for example the market for a commodity or a factor such as labour or land or the market for capital goods, is then linked through trade and investment flows.

consistent framework that enables rigorous assessment of a range of policy scenarios.

More detail of the *Tasman Global* model is provided in Attachment C.

7.1 Database aggregation

The database which underpins the model contains a wealth of sectoral detail. The foundation of this information is the input-output tables that underpin the database. Industries and commodities in the model can be aggregated or disaggregated as required for a specific project. For this project the model has been aggregated to:

- three economies, namely Tasmania, the rest of Australia and the rest of the World
- 38 industries/commodities as presented in Table 16.

The aggregation was chosen to provide the maximum detail possible for the applications of modern spatial information technologies, as well as identifying the key industries in the Tasmanian economy.

Table 16 **Industry/Commodity aggregation used in *Tasman Global* modelling**

	Industry/Commodity		Industry/Commodity
1	Cereal grains nec	20	Iron and steel
2	Sugar cane, sugar beet	21	Iron Ore
3	Plant-based fibres	22	Non-ferrous Metals
4	Bovine cattle, sheep and goats, horses	23	Other heavy manufacturing
5	Wool	24	Primary Aluminium
6	Other Agriculture	25	Electricity
7	Forestry	26	Water
8	Fishing	27	Construction
9	Coal	28	Trade
10	Oil	29	Transport nec
11	Gas manufacture, distribution	30	Water transport
12	Other Mining	31	Air transport
13	Food	32	Communication
14	Lumber	33	Financial Services
15	paper products, publishing	34	Insurance Services
16	Petroleum, coal products	35	Business services nec
17	Chemicals, rubber, plastics	36	Recreational and other services
18	Nonmetallic minerals	37	Government services
19	Other light manufacturing	38	Dwellings

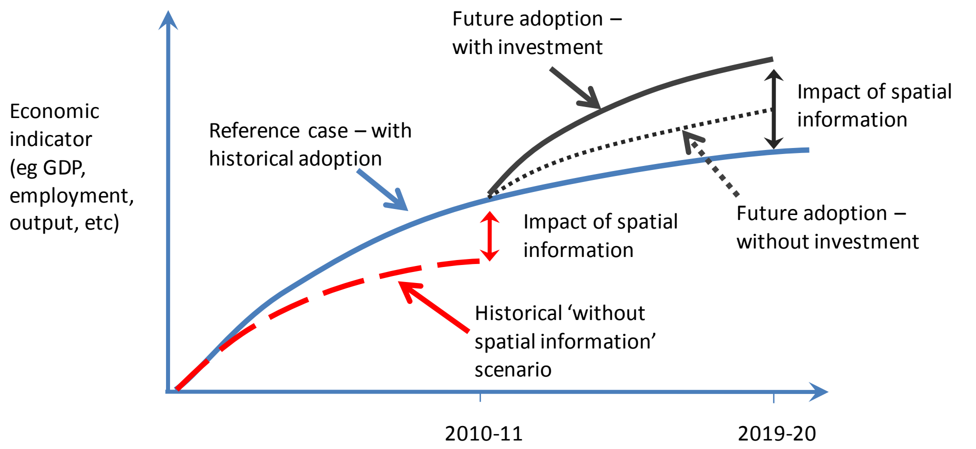
Note: nec = not elsewhere classified

Data source: ACIL Tasman aggregation

7.2 Scenarios

In CGE analysis, the outcomes of the policy simulation modelled are reported as deviations from the 'business as usual' reference case (see Figure 29). To eliminate the impact of price movements in the results, economic variables such as the change in Gross Domestic Product (GDP) are reported as deviations from their real rather than nominal values.

Figure 29 **Illustrative scenario description**



Data source: ACIL Tasman

For this study, the reference case is the situation where the Tasmanian and Australian economies grew as per historical records. This reference case is then compared to the three alternative policy scenarios:

- A historical 'without spatial information' scenario. In this scenario, the quantifiable productivity benefits identified from the case studies (see Figure 29) have been removed. The difference between this scenario and the base case with spatial information scenario provides an estimate of the economic benefits that access to, and use of, spatial information has had on the Tasmanian and Australian economies.
- Two future 'with spatial information' scenarios. In these scenarios the potential unrealised productivity benefits identified from the case studies (see Figure 29) have been added. The two alternative futures are Tasmania specific sensitivities where there is:
  1. Scenario 1 - investment proposed under the scenario does not proceed
  2. Scenario 2 - investment proposed under the scenario proceeds.

  The difference between these scenarios and the reference case provides an estimate of the economic benefits that could arise if the uptake of current spatial information technologies continues. (It should be noted that the estimated productivity benefits do not account for any potential benefits from future improvements to spatial technologies or from new applications of spatial information technologies within the economy.)

7.3 Productivity impacts

The case studies reported in the previous chapter(s) discussed a wide range of benefits to government and industry from the use and application of spatial information systems. The direct impacts are summarised in Table 18 showing the size and type of shock applied.

Due to the complexity of estimating the productivity improvements by specific input, all productivity improvements have been implemented as:

- a labour productivity improvement which has only been applied to the use of labour
- a total factor productivity improvement which has been applied uniformly to the use of factors of production (land, labour, capital and natural resources)
- a total productivity improvement where the productivity improvement has been applied uniformly across all inputs, including the use of goods and services
- a resource availability improvement which has only been applied to use of the industry specific stock of natural resource.

In reality, many applications of the spatial information technologies will have had a differential impact on the demand for each input (such as the demand for labour versus the demand for capital).

To isolate the economic impacts of productivity improvements associated with the uptake of spatial information technologies within the Tasmanian and Australian economy, all other settings in *Tasman Global* have been held constant across the scenarios (including population, tax rates, natural resource supplies and all other productivity improvements).

Table 17 **Assumed productivity improvements in Tasmania by sector by type under each scenario**

	Type of shock applied	Historical scenario productivity (2010-11)	Scenario 1 – No investment (2019-20)	Scenario 2 – With investment (2019-20)
Productivity shocks				
Grains (specialist growers)	Total productivity	n/a	n/a	n/a
Mixed (grain & sheep/cattle)	Total productivity	Nil to low	Nil to low	2.25%
Sugar cane	Total productivity	n/a	n/a	n/a
Cotton	Total productivity	n/a	n/a	n/a
Other agriculture	Total productivity	Nil to low	0.05%	0.38%
Forestry	Labour productivity	1.93%	1.93%	3.86%
Fisheries	Total factor productivity	5.14%	5.14%	5.14%
Construction	Total productivity	0.25%	0.25%	1.00%
Business services (surveying, engineering, accounting etc)	Labour productivity	0.20%	0.20%	0.91%
Coal	Total factor productivity	n/a	n/a	n/a
Iron ore	Total factor productivity	n/a	n/a	n/a
Minerals nec	Total factor productivity	0.01%	0.15%	0.47%
Oil & Gas	Total factor productivity	n/a	n/a	n/a
Government	Labour productivity	0.37%	0.37%	1.58%
Road Transport	Total productivity	1.58%	1.58%	2.37%
Rail Transport	Total productivity	n/a	n/a	n/a
Air Transport	Total productivity	1.04%	1.04%	1.04%
Other transport	Total productivity	n/a	n/a	n/a
Electricity/gas/water	Total productivity	1.00%	1.00%	2.19%
Communications	Total productivity	Nil to low	0.50%	1.98%
Trade (including retail and tourism)	Total productivity	Nil to low	0.02%	0.10%
Manufacturing	Total productivity	0.02%	0.01%	0.02%
Other	Total productivity	0.02%	0.02%	0.02%
Resource availability shocks				
Oil	Resource availability	n/a	n/a	n/a
Gas	Resource availability	n/a	n/a	n/a
Iron ore	Resource availability	n/a	n/a	n/a
Minerals nec	Resource availability	0.05%	0.05%	0.06%
Coal	Resource availability	n/a	n/a	n/a

Data source: ACIL Tasman estimates

7.4 Tasmanian economic impacts

The results for the two modelled scenarios on the Tasmanian economy are summarised in Table 18 and Table 19. Table 18 shows the changes in a range of macroeconomic variables, while Table 19 presents a detailed breakdown of the estimated changes in Tasmanian real GSP and real income. To simplify interpretation, all results have been presented as changes due to the adoption of spatial information technologies.

Table 18 **Tasmanian macroeconomic impacts of adoption of spatial information technologies**

	Units	Quantifiable historical productivity scenario	Scenario - without investment	Scenario 2 - with investment scenario
		2010-11	2019-20	2019-20
Real GSP	%	0.42	1.29	1.62
	2010-11 A$m	104.6	401.7	505.2
Real income	%	0.32	1.26	1.57
	2010-11 A$m	80.5	394.2	490.6
Real private consumption	%	0.23	1.14	1.35
Real investment	%	0.45	1.39	1.71
Capital stock	%	0.06	0.27	0.36
Real wages	%	0.38	1.69	1.88
Real exports	%	0.93	1.50	1.67
	2010-11 A$m	104.7	216.0	242.3
Real imports	%	0.62	1.07	1.25
	2010-11 A$m	61.6	153.5	180.6
Net real foreign trade	2010-11 A$m	43.1	62.5	61.6

Data source: Tasman Global modelling estimates

Table 19 **Decomposition of changes in Tasmanian real GSP and real income (2010-11 A$m)**

	Quantifiable historical productivity scenario	Future - Without investment scenario	Future - With investment scenario
	2010-11	2019-20	2019-20
Change in value added	15.5	86.8	105.3
Change in tax revenues	5.9	27.3	31.8
Productivity effects	83.2	287.6	368.1
Total change in real GSP (income side)	**104.6**	**401.7**	**505.2**
Change in terms of trade	–24.5	–9.9	–16.6
Change in net foreign income transfers	0.4	2.4	1.9
Total change in real income	**80.5**	**394.2**	**490.6**

Data source: Tasman Global modelling estimates

7.4.1 Quantifiable historical impacts of spatial information

Real GSP

Drawing from discussion in sections 5 and 6 and supporting evidence from Australia and overseas, the use of spatial information has delivered productivity improvements in the adopting sectors of the Tasmanian economy. These productivity improvements have resulted in more effective use of Tasmania's scarce labour and capital and allowed the economy to increase overall output compared to what would have otherwise been possible. Based on our conservative estimates of the productivity improvements, *Tasman Global* modelling estimates that, in 2010-11, Tasmania's real GSP increased by 0.4 per cent, or A$105 million, as a direct result of the uptake of spatial technologies (Table 18 and Table 19).

Changes in real GSP can be analysed in more depth by decomposing the changes in value added, tax revenues and productivity effects (i.e. changes in income side of GSP). As shown in Table 19, approximately 80 per cent of the increase in real GSP is directly associated with the estimated productivity improvements, 5 per cent is associated with increased net tax revenues due to increased economic activity. The remaining 15 per cent of the increase in real GSP is due to increased real returns from factors which results from the higher resources availability, higher accumulated capital stocks and allocative efficiency benefits associated with the reallocation of factors around the economy.

Real income and terms of trade

Although changes in real GSP is a useful measure for estimating how much the output of the Tasmanian economy has changed, changes in the welfare of Tasmanians is of more importance. In *Tasman Global,* changes in real welfare is measured by real income[8] and, at a national level, is synonymous with real gross national disposable income (RGNDI) reported by the ABS.

The changes in real income are equivalent to the changes in real GSP, plus changes in net foreign income, plus changes in terms of trade (which measures changes in the purchasing power of a region's exports).

The productivity improvements associated with the adoption of spatial technologies has clearly reduced production costs and boosted total

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[8] More specifically, in *Tasman Global*, changes in real GNP are equivalent to changes in equivalent variation (using the Slutsky measure of income effects). See Pant (2007) for more details.

production. However, (most, but not all, of) these cost reductions are passed on to final consumers including foreigners – and this results in a decline in Tasmania's terms of trade compared to the situation without the spatial information related improvements. The decline in terms of trade (of an estimated –25 per cent, see Table 18) means that Tasmanians have had to export more real goods and services to pay for their imports[9]. Although the decline in terms of trade offsets the growth in real GSP, total welfare of Tasmanians is still significantly greater as a result of the historical adoption of modern spatial information technologies. In particular, real income in 2010-11 is estimated to have increased by 0.3 per cent, or A$81 million, as a direct result of the quantifiable productivity improvements generated from the use of modern spatial information technologies (see Table 18 and Table 19).

Other macroeconomic variables

Household consumption and investment increase by 0.23 and 0.45 per cent, respectively, while capital stock is estimated to be 0.06 per cent higher as a result of the productivity increases associated with the adoption of spatial technologies (Table 18).

A notable result is that the productivity improvements associated with the adoption of modern spatial information technologies is estimated to have increased real exports by A$105 million in 2010-11. The increased exports have enabled Tasmanians to purchase more foreign goods and services (largely manufactured goods such as cars, electronic goods, clothing etc) with real imports estimated to have increased by A$62 million. In aggregate, net foreign trade (exports minus imports) is estimated to have been improved in real terms by A$43 million (see Table 18).

The modelling assumption that labour supply and unemployment remains constant means that the modelling results show no employment gains. However, workers are clearly better off due to an estimated real wage increase of 0.38 per cent due to the productivity improvements associated with the uptake of spatial information technologies (Table 18).

7.4.2 Future adoption scenarios

Due to the larger productivity gains under the two 'future adoption' scenarios, the overall economic impacts under this scenario are larger with real GSP in 2019-20 increasing by an estimated:

[9] Note, however, that total production has also increased, but part of the increased production needs to be used to support demand for foreign products.

- 1.3 per cent, or approximately A$402 million, under Scenario 1 (in real 2010-11 terms)
- 1.6 per cent, or approximately A$505 million, under Scenario 2 (in real 2010-11 terms).

In welfare terms (i.e. real income), under the two 'future adoption' scenarios, the overall economic impacts under this scenario are larger with real income in 2019-20 increasing by an estimated:

- 1.3 per cent, or approximately A$394 million, under Scenario 1 (in real 2010-11 terms)
- 1.6 per cent, or approximately A$491 million, under Scenario 2 (in real 2010-11 terms).

Similar proportional gains are apparent in all other macroeconomic aggregates, with real household consumption and real wages estimated to be:

- 1.1 and per cent 1.7 per cent higher under Scenario 1, respectively
- 1.4 per cent and 1.9 per cent higher under Scenario 2, respectively.

7.5 Return on investment

The proposed investment is $8.3 million in present value terms in 2011.

The economic analysis indicates that this investment could lead to significantly higher GSP ($103.6 million) and real income ($93 million) by 2020.

It is not possible to attribute this increased return solely to the proposed scenario investment. The projected productivity improvements also assume that Government agencies will also invest in their own spatial information support systems and local governments and government-owned enterprises will also invest to realise these productivity gains.

Nevertheless, the investment scenario provides the foundation on which the systems that deliver the productivity benefits will be built. The counterfactual (Scenario 1) does not mean that future productivity benefits cease, but that they are less effective or arrive later than under Scenario 2 (with the investment).

The magnitude of the benefits to the economy and incomes in Tasmania suggest, however, that the return on investment in the proposed actions will be strongly positive.

Some of the benefits are likely to be cashable in the short term (for operational organisations such as emergency services and local government) and there are potential productivity benefits for Government departments. Realisation of these benefits will only be achieved if resources freed up are either reallocated to other productive tasks in Government or the resource requirement reduced for the same output. Given the growing demands on portfolios such as Health and Human Services, the reallocation of resources rather than a reduction of resources is a likely outcome.

Evidence from Australia, New Zealand and the UK suggests that there is a pent-up demand for value-added spatial information services. Investment by the private sector in these services is highly likely if the investment in the foundation data is effectively implemented. The risk that the productivity benefits identified for industry will not be forthcoming is therefore low. Consultations with the agriculture, energy, water, mining and forestry industries suggests that the response to improved spatial data foundations will bring forward productivity benefits that would not otherwise occur in the timeframe.

8 Social and environmental impacts

Putting a dollar value on the benefits derived from spatial information is extremely difficult for a number of reasons, one of them being that there is little agreement about how to value the community wellbeing, the environment, biodiversity and ecosystem services. These 'valuable but free' services include soil formation, regeneration of habitat, provision of shade and shelter, pollination, water filtration, erosion control, regulation of river flows and ground water, and so on.

8.1 Natural resources management and the environment

A famous paper by Costanza *et al.* (1997) put the global value of ecosystem services as US$33 trillion which was nearly twice as high as global GNP at the time the paper was published. Translated to the Australian context in 2008-09, this might suggest a reference value of around $44 billion per annum for ecosystem services in Tasmania. NRM policies aim to maintain this value, or at least avoid major reductions in this value. If a $44 billion valuation is accepted then even a marginal improvement in managing Tasmania's natural resources leading to, say, a 1% reduction in the loss of valuable ecosystem services would be worth $88 million per year.

Costanza *et al.*'s figure has been subject to widespread criticism, notably from within environmental science, where many believe it reduces the complex array of ecosystem processes to a single meaningless number. Hence the view, for example, that:

> A better alternative is to assess the real array of ecosystem responses so that causes can be diagnosed, future states can be predicted, and benefits of treatments can be compared. (Suter, 2009)

Another way to approach the value of spatial information in NRM is to examine the possibility of avoiding costly decisions, especially costly and irreversible decisions such as large scale investments in public infrastructure.

The Tasmanian water sector expects to invest in additional water and sewerage treatment. The three regional water corporations spent around $57 million on water and sewerage infrastructure in 2009-10 (OTTER, 2011). Avoiding unnecessary expenditures, then the contribution of spatial information might well be worth $6 million or more per year if a 1 per cent improvement in the design and location of infrastructure was achieved. This is not considered unreasonable from ACIL Tasman's experience.

Total water consumption in Tasmania in 2009-10 was 192,991 ML per annum. A 1 per cent reduction in Tasmanian water consumption itself (not the infrastructure investment) would potentially be valued at around $1 million at current estimates of the opportunity cost of water. This figure is likely to increase in future as the lower cost uses and water efficiency measures are exhausted and as higher cost supply sources are required.

A number of further aggregate downstream impacts of land degradation were determined for increased severity of salinity, erosion, sedimentation and turbidity over the 20 year period from 2000 to 2020 using data available from the National Land and Water Resources Audit. Together, these ranged from $2 billion to $4 billion over the 20 year period (mid-point $150 million per year). These estimates would not have been possible without spatial information, although the extent to which costs can be avoided because of the use of spatial information is unclear.

Taking these estimates into account, it would not be unreasonable to conclude that improved spatial information resulting from the proposed investment and associated actions could deliver benefits in improved natural resource management of the order of $5million to $10 million. However, $1 million from improvement in water resources management would be a prudent lower bound estimate.

8.2 Biosecurity

A report by ACIL Tasman (2007) on the economic and social value of biodiversity and functioning ecosystems in Australia provides some case studies showing how different economic valuations can be arrived at. Bees, for example, provide free pollination services to Australian agriculture valued at up to $2 billion per annum.

To take another example, tourists spend $2-3 billion each year in Australia, with major motivators for visiting Australia being its unique wildlife, nature-based activities and wilderness areas, the outback and bushwalking (Hundloe and Hamilton, 1997). If better use of spatial information assists better NRM, this should help to maintain some of these values – again, a precise proportion cannot be arrived at, but the value could certainly be in the tens of millions of dollars per year in these two case studies alone.

Biosecurity in general is a major potential area of application for spatial information, as discussed earlier in this report. By monitoring the spread of different types of mosquitoes or ticks, it is, for example, possible to better plan for and manage human as well as animal health issues related to disease outbreaks, which have the potential to cause very widespread damage, affect rural communities and cause economic disruption. There is a large body of literature on costs associated with outbreaks – costs vary by crop, disease type, pathogen, duration, and so on – but in many cases the potential impact runs into several billion dollars. Spatial information plays a role in reducing the probability of having an incursion.

Protecting Australia's biosecurity is one of the nation's highest priorities. The costs of incursions of exotic diseases and invasive plants and species can be very high. Invasive species are costing Australia billions of dollars annually, mainly in terms of costs of control and the value of lost production.

According to the Department of Agriculture, Fisheries and Forestry (DAFF):

- Estimated costs of control and the value of production foregone for plant diseases and invertebrate pests of plants is at least $0.7 billion and as high as $2 billion per annum.
- For animal diseases and invertebrate pests of animals the estimate is at least $1.2 billion per annum.
- The economic impact of weeds and the main vertebrate pest animals already established in Australia has been calculated at approximately $4 billion and $0.7 billion per annum respectively. (These figures primarily represent production losses and control costs, as the cost of weeds to the environment and biodiversity is largely incalculable.)
- Invasive species are now identified as the greatest threat to Australian biodiversity after habitat loss.
- The total cost of control and the value of production protected by biosecurity is estimated to be around $8 billion per year ((Agtrans Research, 2005).

The Australian Government and the State governments jointly manage monitoring and control programmes to protect Australia from incursions of exotic pests and diseases. There are many elements to these activities including quarantine inspections, monitoring, mitigation programs and emergency response plans.

Agriculture emergency management involves well-established coordination arrangements and pre-prepared plans including AUSVETPLAN, PLANT PLAN, and AQUAVETPLAN. Increasingly, coordination and planning arrangements draw on spatial information systems to research, plan, control and mitigate the impacts of incursions when they occur.

8.2.1 Use of spatial models in controlling Foot and Mouth Disease

Foot and Mouth Disease (FMD) is a virus that attacks farm animals such as cattle, pigs, sheep etc. It kills young animals and reduces livestock productivity. Although it has been found to have no health impact on humans, an outbreak of FMD could have large trade effects, especially on Australia's meat export to FMD-free countries such as Japan and the United States of America.

In 2001, the UK experienced an outbreak of FMD, which affected more than 2000 farms and resulted in the culling of more than 6 million animals. The direct cost to the economy was estimated at more than £ 8 billion.

In 2002, the Productivity Commission estimated the impact of an FMD outbreak in Australia (Productivity Commission, 2002). The main impact (based on a 12 month outbreak scenario) included:

- revenue loss to the livestock industry (especially the beef industry) of about $12.8 billion (NPV based on a 10 year timeframe)
- the cumulative impact on Australian GDP in the first year of the outbreak alone would be between $2 billion to $13 billion depending on the length of the outbreak. Other effects included employment, tourism, social and environmental impacts.

Spatial models are used to prepare Australia for any impact of an FMD outbreak and to avoid a similar impact on the Australian economy. Such models incorporate spatial attributes, such as farm locations, into their computation and provide high quality outputs useful for disease control exercises.

The main benefits of spatial models over other non-spatial models in reducing the impact of an FMD outbreak include:

- retrospective analysis of past FMD outbreaks
- exploring strategies to reduce the impact of FMD in different outbreak scenarios
- assessing resource needs in different outbreak scenarios
- assessing high risk prone areas and production systems in the event of an outbreak
- evaluating effectiveness of monitoring and control strategies
- providing exercises and training before an actual outbreak.

An Australian example of a spatial model used for reducing the impact of an FMD outbreak is AusSpread which is a regional spatial simulation model, designed by DAFF in 2004, that operates within a GIS framework. The datasets include real farm boundary or point-location data based on agricultural census and land use information. It represents different species and production systems, which allows the Department to follow targeted mitigation strategies in the event of an FMD outbreak. Strategies in the model are based on the

AUSVETPLAN[10] for FMD. Outputs include outbreak parameters/settings, outbreak maps and outbreak costs/statistics[11].

Although there is no indication of the economic impact of using spatial models to reduce the impact of an FMD outbreak, it is clear from the Productivity Commission's estimates that reducing even 5% of the costs of an outbreak using effective mitigation strategies through spatial modelling could save several millions of dollars for the livestock industry and the wider Australian economy.

8.2.2 Over impact on biosecurity

There has been some research into the economics of plant and animal disease outbreaks, but it is not sufficient to draw conclusions on the aggregate economic impact of biosecurity programs – and the likely contribution of spatial information.

The economic impact of spatial information is threefold:

- reducing the costs of managing the biosecurity programs
- reducing duplication in data management
- contributing to reducing the average annual damage from disease incursions.

Both case studies showed how spatial systems support management programs for monitoring and responding to threats. They are important elements of the operating systems. The benefits from biosecurity programs are very high in terms of damage avoided and in maintaining the quantity and quality of Australia's agricultural production and exports.

The case studies showed, for example, that the 'net' annual value of the activities of the Australian Plague Locust Commission was in the region of $25 million, and we estimated in this case study that the contribution of spatial information was worth at least $5 million each year.

There are up to 20 exotic diseases or major concern to Australian agriculture producers. There is no estimate of the annual value of biosecurity control programs in terms of reducing the expected annual damage of incursions of pests and diseases. However, noting the magnitude of the potential damage, it is possible that this might be in the order of $1 billion to $2 billion dollars.

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10 http://www.animalhealthaustralia.com.au/programmes/eadp/ausvetplan_home.cfm

11 http://www.epicentre.massey.ac.nz/acvsc/scwk_05/Beckett_FMD_modelling.pdf

If this were the case, and using the case studies as an indicator of the role of spatial information in control strategies, it is possible that the contribution of spatial information to reducing the expected damage could potentially be in the hundreds of millions of dollars. (One estimate suggested an order of magnitude of around $400 million based on the expected potential economic loss from disease outbreaks and reduction in annual control costs and lost production.) The implementation of BioSIRT will provide the framework to fully realise the potential of spatial information in disease control strategies.

8.3 Community benefits

There are few studies available that place a value on community wellbeing. However, the Government has recognised the value of social inclusion to Tasmanian society and of linking health and human services to education. The costs to society of dysfunction in the community arising from disadvantage, unemployment, illiteracy and problems due to the abuse of alcohol and drugs or from gambling are high.

The high proportion of the Tasmanian community on pension and welfare benefits, and the ageing population, present significant challenges for the health, human services and education portfolios. It was considered by the officers interviewed that the cost of meeting these demands could become prohibitive with the current approaches to these challenges. New strategies were required.

Better planning and engagement with the targeted community and community organisations are possible with the support of better evidence-based planning. Spatial information systems are central to such approaches.

Estimates of the value of lives saved through better delivery of health and human services suggest benefits might be in the tens of millions of dollars using statistical techniques mentioned in section 4. However, a lower bound estimate might be made by considering the value of a 1.5 per cent improvement in the productivity of expenditure in the health and human services portfolio, which would be around $20 million. This report concludes that such an improvement would not be unreasonable through the optimal use of spatial information.

9 Concluding comments

This report estimated that spatial information is likely to have added around $104 million in productivity benefits to the Tasmanian economy. It also found that Gross State Product is likely to be higher by around $105 million by 2020 with investment at the level (and in the areas) proposed than without this investment.

Other (non-productivity) benefits linked to the increasing use of spatial information are probably worth multiples of the economic benefits.

These results are consistent with findings in Australia, New Zealand and the UK

The value of spatial information is likely to increase in Tasmania, as in the rest of the world, as adoption in government and industry progresses. However, the effectiveness of its application as a source of productivity depends on access to quality foundation data and greater awareness of its use and potential.

Spatial information delivers productivity improvements in waves of innovation. It is the accumulation of these improvements that delivers value to the economy over the longer term.

Experience in the UK has also demonstrated that, by providing spatially-based information to the community, the costs of service delivery by local governments and local public services can be reduced. Some of these benefits are likely to be cashable in the medium term in service areas of government such as local government, health and emergency services. This trend is likely to continue over the next ten years.

To realise these benefits, it is important that Government agencies have access to foundation data at an appropriate level of accuracy, and can draw on and add value to this data. This requires good coordination of systems across Government and clear priorities for custodianship and maintenance of data. This also applies to industry and ultimately the community.

It is also important that the resources freed up through productivity improvements from the use of spatial information are reallocated to productive activities elsewhere in Government or the economy.

While there appears to be pent-up demand for spatial data in many sectors of industry, awareness of the potential to use spatial data, to analyse and formulate policy and deliver programs is variable across Government agencies. Increasing awareness of its potential is a basic requirement to realising future value for government services, the economy and the community.

A Glossary of terms

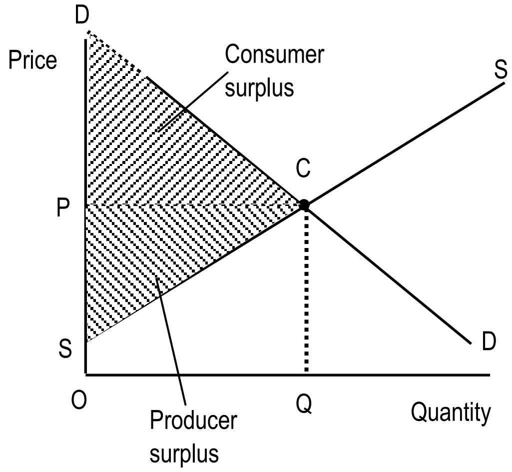
GNSS	Global Navigation Satellite System
BTRE	Bureau of Transport and Regional Economics
CORS	Continuously operating reference system
DPAC	Department of Premier and Cabinet
GPS	Global Positioning System (satellite positioning system operated by the US Department of Defense)
SDI	Spatial data infrastructure

B Assessing economic impacts

B.1 Theoretical underpinning

The economic values of market goods to the community are measured by consumer and producer surplus. The conceptual base for providing an understanding of consumer and producer surplus is the supply and demand, or market, model (Figure B1).

Figure B1 **Standard concepts of producer and consumer surplus**



ACIL Tasman chart

The interaction of demand and supply determines the market price for a good and the quantity that is produced in any given time period.

This market model provides the basis for identifying and estimating the net economic values to consumers and the net economic values to producers, referred to as consumer surplus and producer surplus, respectively.

Consumer surplus is the difference between what an individual would be willing to pay (demand) for a good or service (the total benefit to the consumer) and what they have to pay (the cost to the consumer i.e. consumer expenditure (price times quantity). In Figure B1 it is the area between the demand curve and the price line.

Producer surplus is the difference between the revenue (consumer expenditure) received for a good or service (total benefit to producer) and the costs (supply) of the inputs used in the provision of the good or service (economic cost to producer). In practical terms, it is the net revenue (before tax) that is earned by producer of goods and services. In Figure B1 it is the area between the price line and the supply curve.

While these concepts provide the economic framework for estimating economic value of spatial information they present difficulties when attempting to value the economic impact. Spatial information often delivers public goods and intangible benefits that are either unpriced or which may be intangible for which there is no monetary market.

B.2 Methods for assessing economic value

There are several methodologies that can be applied to assess the economic impact of goods and services. Those discussed below are practical approaches to the task consistent with the above theoretical underpinning.

B.2.1 Willingness to pay

Willingness to pay is a common approach to estimating the economic value of a good or service. This in effect attempts to infer a demand curve from which an estimate of the benefits can be made.

In many cases the geographic information services exhibit strong public good characteristics where price is difficult to determine or strong externalities where additional value is created but not reflected in price. Assessing willingness to pay can therefore require an estimate by proxy rather than an observation of a price determined in a market.

There are many credible techniques for estimating the willingness to pay. ACIL Tasman used survey techniques in a study of the economic benefits of the Western Australian Land Information System in 2004 (ACIL Tasman, 2004).

This approach requires the conduct of user surveys and is more suitable for assessment of a focussed product or service. In the case of this project however the number of sectors to be reviewed is likely to lead to unacceptable costs and time requirements. A willingness to pay approach was not suitable for this report.

B.2.2 Estimating value-added

An alternate approach to estimating the value of the economic contribution of a sector is to make high level estimates of its contribution to Gross Domestic Product (GDP) and other aggregates such as consumption, investment and real wages.

GDP is based on the concept of *value added*, which is the unduplicated value of goods and services produced in any given period. Gross value added is equal to a producer's value of outputs from the production process less the value of commodity inputs (intermediate consumption) plus taxes on products payable less subsidies receivable (ABS, 2000).

Estimates of value-added can be direct – that is the direct impact of the specific good or service – and indirect – that is for other industries that use the good or service. Direct value-added can be assessed from studies of the net benefits delivered by a sector compared with the counterfactual (the situation that would arise without the input from that sector). These are then used to estimate changes in outputs between the two scenarios which are then used to change assumptions in a Computable General Equilibrium (CGE) model of the economy.

CGE models provide the capability to model the economy wide impacts of changes in outputs on a national or regional level (the characteristics of ACIL Tasman's CGE model are discussed in Section 3.6).

General equilibrium models are an accepted means of estimating the direct and indirect impacts of changes in output of goods and services such as geographical information.

B.2.3 Valuing options

Another approach to valuing the impact of spatial information is in the options created for government and industry to realise higher levels of productivity, grow markets and move into higher value areas of economic activity. An options approach to valuation (referred to as real options in the non financial sector) can overcome weaknesses in traditional assessment approaches for activities subject to high levels of uncertainty.

Such an approach may well apply to assessing the future economic, environmental and social benefits that are possible from spatial information. It is particularly useful for accounting for benefits of an environmental, security or social nature.

B.3 Literature review of previous impact studies

There is a growing body of literature, both Australian and international, which documents how business and government use spatial information, and the impacts it has had in specific. ACIL Tasman is has employed a CGE model to calculate economy wide economic impacts of spatial information. There are, however, studies that have explored the impacts of spatial information in specific sectors or applications. The literature recognises the need for a systematic assessment of aggregate impacts (Alexander, 2003).

In reviewing these studies, it is important to appreciate that most have estimated the direct use values (such as those found in a cost benefits analysis), as distinct from those also capturing flow on values (as captured in a CGE model). Some of them capture impacts on an annual basis, while others report on cumulative impacts over times. Some of them also describe the impacts of a small subset of the spatial information (such as government spatial data infrastructure) rather than the whole spatial information industry.

Being a relatively new industry, and part of the rapidly growing information and communication sector, the spatial information industries of the world are growing at a rate far faster than that of general economic growth. Some estimates have the average annual growth rate of spatial information worldwide as high as 20 percent per annum (Spatial Information Action Agenda, 2000; Daratech, 2006). Some examples of the value of this investment in spatial information to developed economies include:

- OXERA estimated that the value of the geographic infrastructure to the Europe, as crudely measured by the amount invested, as ECU 10 billion per year (OXERA, 1999).
- A similar measurement of the amount invested in geographic infrastructure in Great Britain by NOP (1998) was £204 million in 1997. This equates to approximately .03 % of Great Britain GDP at the time.
- The total output value of China's geographic information industry was estimated to be over US$ 3 billion in 2005, and it is expected to grow to over $10 billion by 2010. The industry is expected to stimulate value in other related industries of around US $63 billion by 2010 (GIS Development News, 2006).
- In 2000, the Spatial Information Industry Action Agenda estimated that global expenditure on spatial information was $34 billion, and growing at the rate of 20% per annum.
- The value of the British Geological Survey alone to the United Kingdom economy alone was estimated to be well in excess of its annual turnover of £40 million (Roger Tym & Partners, 2003).
- The value of the GIS industry in Australia, as indicated by total GIS budgets across all industries, is estimated to be A$1 billion in 2006 (Corporate GIS Consultants, 2003).
- Halsing and Theissen (2004) estimated that the US Government's "The National Map" initiative had a net present value (NPV) over 30 years of US$2.05 billion was found.
- ACIL Tasman (2004) used a combination of case study research and contingent valuation to estimate the direct use value of the Western Australian Land Information System alone at approximately $14 to $15 million a year to the WA economy (ACIL Tasman, 2004).

- Price Waterhouse (1995) examined the economic aspects of establishing a more up to date digital mapping data base for use in NSW land information systems, and found that the benefit-cost ratios ranging from the updates to be significant; between 9:1 to 2:1 depending upon the reform options chosen. The major benefits from an accelerated program related to: additional sales of data by existing suppliers; those suppliers being able to provide data at a lower cost than if (relatively inexperienced) users attempted to digitise their own information; digital data substantially reducing the manpower needed in the longer term to produce and apply mapping output; and, new digital data.
- A Western Australian Government Taskforce (1990) found that substantial gains were likely from integrating land and geographic data held by State agencies. This integration would include steps to clarify data custodianship, the establishment of a land information directory, standard procedures for data collection, and improved marketing of data. The annual costs of integrating land information were estimated at $1.8 million and the potential annual benefits at $10.7 million – resulting in a benefit/cost ratio of 5.9:1 (Western Australian Department of Land Information, 1990).
- Allens Consulting estimated the value of the CORS system in 2007. The study estimated that a CORS system would add $32 billion in productivity benefits to the Australian economy over the following 20 years.

C Computable General Equilibrium Modelling

C.1 The *Tasman Global* model

***Tasman Global* – a state, national and global scale model**

ACIL Tasman's computable general equilibrium model *Tasman Global* is a powerful tool for undertaking economic impact analysis at the regional, state, national and global level.

There are various types of economic models and modelling techniques. Many of these are based on partial equilibrium analysis that usually considers a single market. However, in economic analysis, linkages between markets and how these linkages develop and change over time can be critical. *Tasman Global* has been developed to meet this need.

Tasman Global is an analytical tool that can capture these linkages on a regional, state, national and global scale. *Tasman Global* is a large-scale computable general equilibrium model which is designed to account for all sectors within an economy and all economies across the world. ACIL Tasman uses this modelling platform to undertake industry, project, scenario and policy analyses. The model is able to analyse issues at the industry, global, national, state and regional levels and to determine the impacts of various economic changes on production, consumption and trade at the macroeconomic and industry levels.

A Dynamic model

Tasman Global is a model that estimates relationships between variables at different points in time. This is in contrast to comparative static models, which compare two equilibriums (one before a policy change and one following). A dynamic model such as *Tasman Global* is beneficial when analysing issues where both the timing of and the adjustment path that economies follow are relevant in the analysis.

In applications of the *Tasman Global* model, a reference case simulation forms a 'business-as-usual' basis with which to compare the results of various simulations. The reference case provides projections of growth in the absence of the changes to be examined. The impact of the change to be examined is then simulated and the results interpreted as deviations from the reference case.

The database

A key advantage of *Tasman Global* is the level of detail in the database underpinning the model. The database is derived from the latest Global Trade Analysis Project (GTAP) database which was released in 2008. This database is a fully documented, publicly available global data base which contains complete bilateral trade information, transport and protection linkages among regions for all GTAP commodities.

The GTAP model was constructed at the Centre for Global Trade Analysis at Purdue University in the United States. It is the most up-to-date, detailed database of its type in the world.

Tasman Global builds on the GTAP model's equation structure and database by adding five important features: dynamics (including detailed population and labour market dynamics), detailed technology representation within key industries (such as electricity generation and iron and steel production), the ability to repatriate labour and capital income, a detailed emissions accounting abatement framework and explicit representation of the states and territories of Australia.

Nominally, the Tasman Global database divides the world economy into 120 regions although in reality the regions are frequently disaggregated further.

The GTAP database also contains a wealth of sectoral detail (Table C1). The foundation of this information is the input-output tables that underpin the database. The input-output tables account for the distribution of industry production to satisfy industry and final demands. Industry demands, so-called intermediate usage, are the demands from each industry for inputs. For example, electricity is an input into the production of communications. In other words, the communications industry uses electricity as an intermediate input. Final demands are those made by households, governments, investors and foreigners (export demand). These final demands, as the name suggests, represent the demand for finished goods and services. To continue the example, electricity is used by households – their consumption of electricity is a final demand.

Each sector in the economy is typically assumed to produce one commodity, although in Tasman Global, the electricity, diesel and iron and steel sectors are modelled using a 'technology bundle' approach. With this approach, different known production methods are used to generate a homogeneous output for the 'technology bundle' industry. For example, electricity can be generated using coal, petroleum, gas, nuclear, hydro or non-hydro renewable based technologies – each of which have their own cost structure.

Table C1 **Sectors in the Tasman Global database**

	Sector		Sector
1	Paddy rice	32	Diesel (incl. nonconventional diesel)
2	Wheat	33	Other petroleum, coal products
3	Cereal grains nec	34	Chemical, rubber, plastic products
4	Vegetables, fruit, nuts	35	Mineral products nec
5	Oil seeds	36	Ferrous metals
6	Sugar cane, sugar beef	37	Metals nec
7	Plant- based fibres	38	Metal products
8	Crops nec	39	Motor vehicle and parts
9	Bovine cattle, sheep, goats, horses	40	Transport equipment nec
10	Animal products nec	41	Electronic equipment
11	Raw milk	42	Machinery and equipment nec
12	Wool, silk worm cocoons	43	Manufactures nec
13	Forestry	44	Electricity
14	Fishing	45	Gas manufacture, distribution
15	Coal	46	Water
16	Oil	47	Construction
17	Gas	48	Trade
18	Minerals nec	49	Road transport
19	Bovine meat products	50	Rail and pipeline transport
20	Meat products nec	51	Water transport
21	Vegetables oils and fats	52	Air transport
22	Dairy products	53	Transport nec
23	Processed rice	54	Communication
24	Sugar	55	Financial services nec
25	Food products nec	56	Insurance
26	Beverages and tobacco products	57	Business services nec
27	Textiles	58	Recreational and other services
28	Wearing apparel	59	Public Administration, Defence,
29	Leather products		Education, Health
30	Wood products	60	Dwellings
31	Paper products, publishing		

Note: nec = not elsewhere classified

The other key feature of the database is that the cost structure of each industry is also represented in detail. Each industry purchases intermediate inputs (from domestic and imported sources) primary factors (labour, capital, land and natural resources) as well as paying taxes or receiving subsidies.

Factors of production

Capital, land, labour and natural resources are the four primary factors of production. The capital stock in each region (country or group of countries) accumulates through investment (less depreciation) in each period. Land is used only in agriculture industries and is fixed in each region. *Tasman Global* explicitly models natural resource inputs as a sector specific factor of production in resource based sectors (coal mining, oil and gas extraction, other mining, forestry and fishing).

The labour market

By default, *Tasman Global* assumes that the economic changes do not raise unemployment above the so-called natural rate of unemployment in the long term. Any shifts in the demand for labour are assumed to be offset by changes in real wages sufficient to prevent the emergence of unemployment above the natural rate. This is the 'full employment assumption'. This assumption can be relaxed over the short to medium term.

Carbon emissions

The model also has a detailed greenhouse gas emissions accounting, trading and abatement framework that tracks the status of six anthropogenic greenhouse gases (namely, carbon dioxide, methane, nitrous oxide, HFCs, PFCs and SF_6). Almost all sources and sectors are represented; emissions from agricultural residues and land-use change and forestry activities are not explicitly modelled.

The greenhouse modeling framework to not only allows accounting of changes in greenhouse gas emissions, but also allows various policy responses such as carbon taxes or emissions trading to be employed and assessed within a consistent framework. For example, the model can be used to measure the economic and emission impacts of a fixed carbon tax in single or multiple regions whether trading is allowed or not. Or, it can used to model the required carbon tax needed to achieve a desired cut in emissions based on various trading and taxation criteria.

Highly detailed energy sector

Tasman Global contains a detailed representation of the energy sector, particularly in relation to the interstate (trade in electricity and gas) and international linkages across the regions represented. To allow for more detailed electricity sector analysis, and to aid in linkages to bottom-up models such as ACIL Tasman's *GasMark* and *PowerMar*k models electricity generation is separated from transmission and distribution in the model. In addition, the electricity sector in the model employs a 'technology bundle' approach that separately identifies different electricity generation technologies (brown coal, black coal, oil, gas, hydro, nuclear and other renewables).

Model results

Tasman Global solves equations covering industry sales and consumption, private consumption, government consumption, investment and trade. The model therefore produces detailed microeconomic results, such as:

- output by industry
- employment by industry; and
- industry imports and exports.

Tasman Global also produces a full range of macroeconomic results, for each Australian state and the rest of the World including:

- total economic output
- total employment
- gross national product (GNP)
- gross domestic product (GDP)
- gross state product (GSP)
- private consumption
- public consumption
- investment
- imports; and
- exports.

The model can also produce details of greenhouse gas emissions, measured in thousand tonnes of CO_2 equivalent per annum.

All of these results (and more) are produced on a year-by-year basis. Frequently a 20 year projection is produced; however, this can be altered to fit the needs of the particular economic impact assessment being undertaken.

D Spatial information data bases in Tasmania

There are an increasing number of spatial data delivery systems in Tasmania. Most of them rely to some degree on the Land Information System Tasmania (LIST). However, spatial data can be derived from a wide range of sources both within and outside of Government.

A non exhaustive list of the databases supported by Government includes:

- LIST
- Road information management system (RIMS)
- State Information Planning System (SIPS)
- Tasmanian Information on Geoscience and Exploration Resources (TIGER)

The Department of Primary Industries, Parks, Water and Environment (DPIPWE) is the custodian for LIST but also other databases that support its policy and planning objectives. There are other spatial databases held by the security and critical infrastructure arms of Government that draw on or contribute to LIST. There are also a large number of spatial data systems outside of the State Government that draw on LIST and sometimes contribute data to it. These include databases held by:

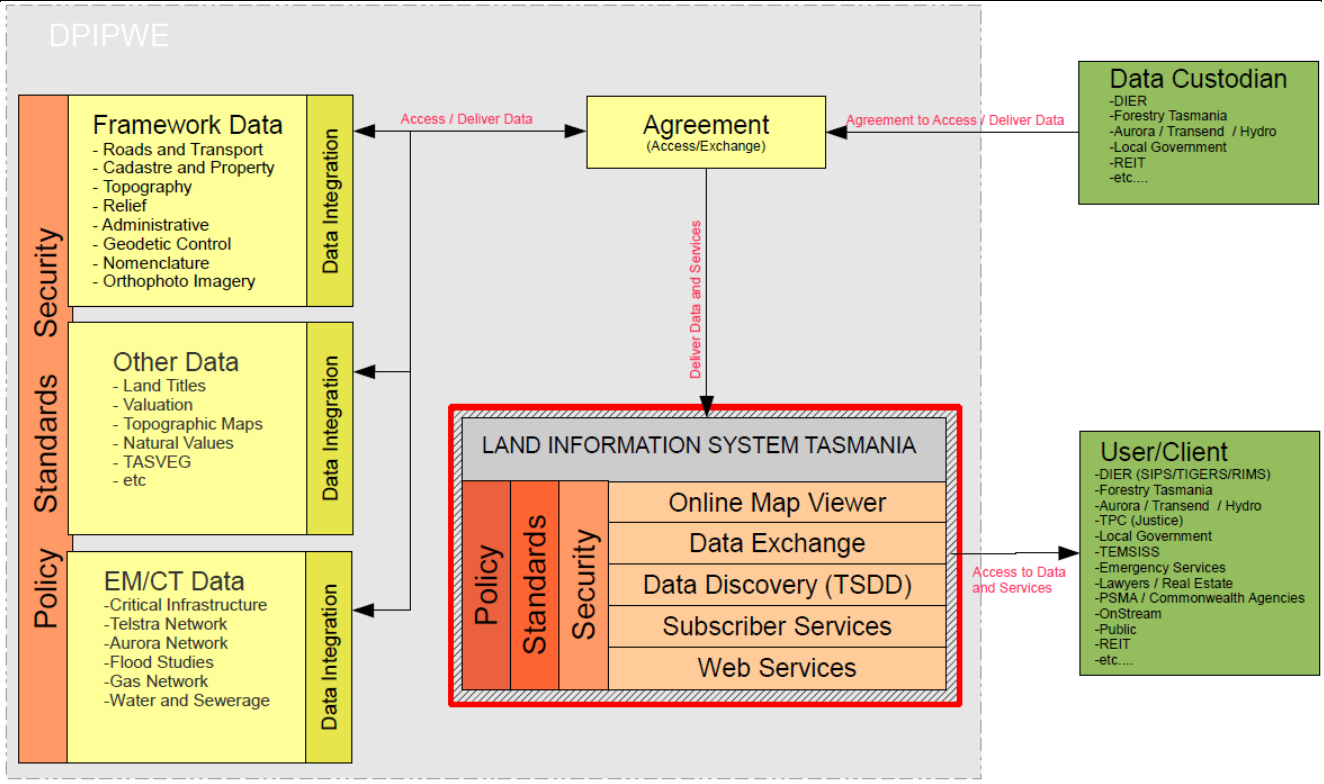
- the forestry industry
- the energy sector
  - Aurora Energy, TasGas, Transend and Hydro Tasmania
- local government
- agriculture organisations
- emergency services
- ambulance services.

In the next sections, we outline the major features of these main components of the spatial data infrastructure, to provide a context for readers not familiar with them.

D.1 LIST

LIST is a whole-of-government infrastructure that facilitates the discovery and delivery of integrated Tasmanian land information and services. It provides a secure platform from which a wide range of government spatial data and services can be managed, discovered and delivered in accordance with recognised standards, maximising the social, environmental and economic benefits of land information for all Tasmanians. A schematic of its operating elements is shown in Figure D1.

Figure D1 **LIST**



Data source: Department of Primary Industries, Parks, Water and Environment

The LIST is managed by the Information and Land Services Division of DPIPWE). Information available through the LIST includes

- Online access to title and property information held by the DPIPWE.
  - This service is available to both subscribers and the general public.
- Online delivery of spatial information through LISTmap, including a wide range of administrative, topographic, environmental and socioeconomic data.
  - This includes information on natural resources, roads and community facilities, cadastre (property boundaries), aerial imagery and survey control points.

LISTmap is an internet-based map viewer for the LIST. It enables users to view and create maps from spatial datasets stored in the LIST. Users can create maps and interrogate features within the datasets to find out information about the features.

Current users of LIST include:

- land use planners
- local government
- emergency services
- police and security services
- natural resource managers
- planners
- surveyors
- mining and energy industries
- forestry
- real estate agents
- valuers
- financial and legal institutions
- agriculture.

Most of these are frequent users. Agriculture is a large user on the mainland and use is growing in Tasmania.

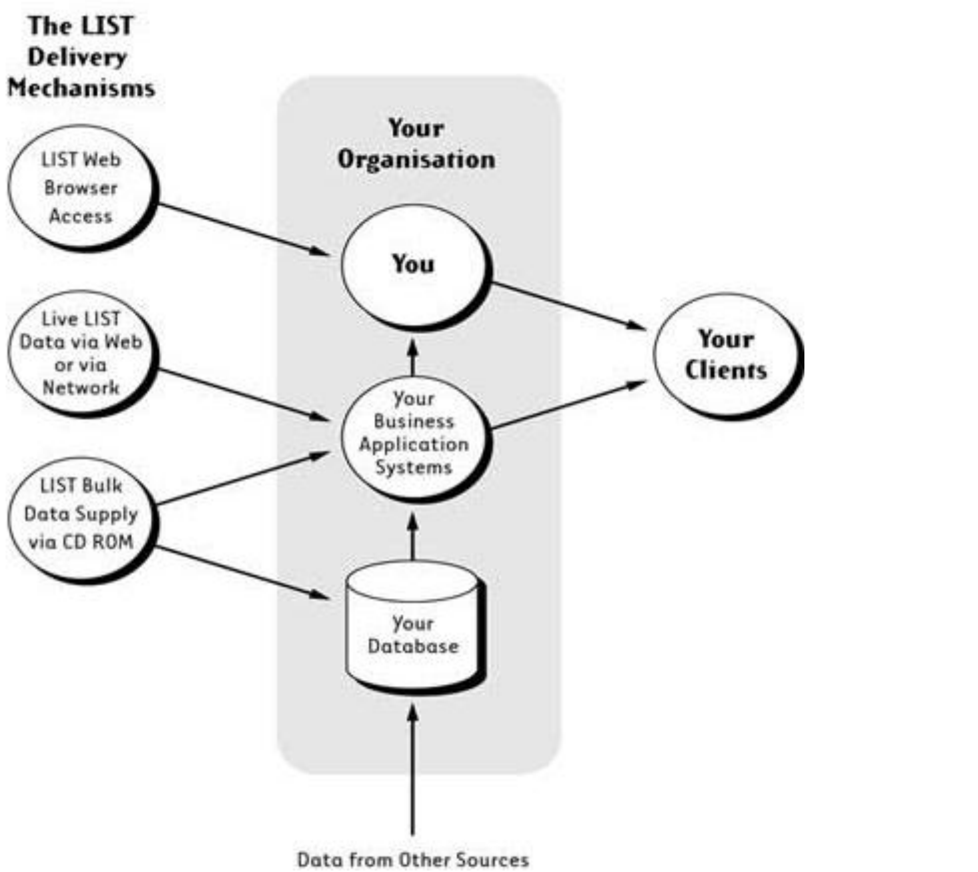
D.1.1 Data access

Users can access data through one of three channels:

- public access or subscription through a web interface
- purchasing digital data tailored to client requirements
- on-line, real time access by off-site applications.

A diagram of the various delivery systems is provided in Figure D2.

Figure D2 **LIST delivery mechanisms**



Data source: DPIPWE

The LIST can be accessed via the internet from any computer, including publicly accessible points such as Service Tasmania shops and community Online Access Centres.

LIST spatial data can be tailored to the client's specifications and is available in most digital formats. This data is made available under licence.

Data can also be used as the core background for business applications. This type of facility is also available, under licence, to government and non-government organisations.

D.1.2 Tasmanian Spatial Data Directory

The Tasmanian Spatial Data Directory (TSDD) contains metadata that describes datasets that originate, or may be of use, in Tasmania. It includes both current and archived data. Contribution and maintenance of entries is undertaken by the data custodian. TSDD is managed by Information and Land Services Division of DPIPWE.

When first developed in the mid 1990's, TSDD was a state-of-the-art spatial data infrastructure system. However, in recent years the quality of the data under its custodianship has deteriorated, according to some of the users consulted.

A common problem with metadata databases is that unless they are an integral part of fully functional system, they become an overhead for contributors to maintain the currency of metadata that is of limited benefit to them.

D.2 TIGER

TIGER (Tasmanian Information on Geoscience and Exploration Resources) is Tasmania's geological and mineral exploration knowledge base and is integrated into the Mineral Resources Tasmania (MRT) website (www.mrt.tas.gov.au).

MRT is a division of the Department of Infrastructure, Energy and Resources (DIER). The purpose of MRT is to give effect to government policy in relation to minerals and petroleum resources, and the division provides essential information for land management in Tasmania. The focus of MRT is to produce and promote up-to-date geoscientific information on Tasmania as an aid to the mineral and petroleum exploration industries, other government agencies and the general public, in order to improve Tasmania's economic position, and to promote sustainable land use planning and environmental management.

Mapping information from TIGER may be integrated into a website or desktop GIS via the Open GIS Consortium Web Map Server interface.

By using the Mineral Resources Tasmania website as a portal to TIGER you can:

- view and download technical reports and documents
- query databases on a range of geoscientific and tenement information
- search with and browse information with interactive maps
- download datasets in commonly used file formats
- use online services, such as applying for a mineral exploration licence.

TIGER is an archive of historical information and is updated daily with the latest information on:

- mineral tenements
- reports on mineral exploration and other geoscientific studies
- exploration drilling and drill core library contents
- geohazard assessments and maps

- groundwater quantity and quality
- mineral resource descriptions
- bedrock and soil properties.

TIGER is a useful resource for:

- local government and land-use planning
- mining and mineral exploration
- transport and energy infrastructure planning
- civil engineering and construction
- forestry planning and operations
- agriculture and water management.

TIGER may answer questions such as:

- Where are the closest gravel and sand resources to a construction site?
- What is the quality of groundwater on or near my property?
- What studies document the petroleum potential of Tasmania's offshore basins?
- Who holds the mining leases in my municipality?
- When will current mineral exploration licences expire?
- Is core drilled near my prospect available for inspection?
- Is an investigation for ground stability recommended for my building site?
- What rock types have anomalous gold values?
- Where have airborne magnetic surveys been conducted recently?

D.3 RIMS

Road Information Management System (RIMS) holds transport infrastructure-related information along with socio-demographic data owned or managed by the Department of Infrastructure, Energy and Resources (DIER) in Tasmania. RIMS is a custom-built application facilitating workflow, data entry, quality assurance, management and reporting (analytical, statistical & forecasting capabilities). RIMS is a bespoke web enabled application, designed to provide business functionality across a number of DIER branches and other stakeholders such as the Motor Accidents Insurance Board (MAIB), councils and Tasmania Police. The RIMS application has been spatially-enabled through the Exposure and Oracle map viewers and it makes use of Oracle OGC standard, Linear Referencing and spatial coordinates for the majority of its assets holding.

RIMS is an established road management system comprised of many modules:

- Road Network Management

- Bridge Module
- Bus Route Manager
- Crash Data Manager
- Traffic Statistic Module
- Forward Program
- Environment Module
- Traffic Signals (upcoming).

RIMS applications are designed and managed to assist asset and project managers to maintain the road network, as well as assist in road safety and passenger transport activities.

The RIMS business model is aimed at high volume, widely dispersed operational users requiring a sophisticated reporting facility as well as access to low level data. It incorporates both specific nomenclature such as 'Linkage' and 'Chainage' to describe road segments and specific point of interest and assets along the road network, with their spatial coordinates.

D.3.1 Data management

RIMS manages State road network and other related data on behalf of the data owners. It delivers functions at the operational, management and strategic levels, for use by those requiring regular access to road management, maintenance, programming and design data, crash, school buses and traffic statistics data. RIMS provides access to a range of datasets, not limited to its own data repository. While some datasets are being imported i.e. Aurora's Poles, others are being accessed online, such with the web mapping service (WMS & WFS) to the LIST.

D.3.2 Spatial mapping

RIMS provides a range of interfaces to its information holdings such as the tabular format, a proprietary web-based mapping interface (developed by Geometry using the Exposure enterprise edition Map viewer), the Oracle map viewer, custom designed reports and ad-hoc reporting. RIMS uses the Oracle spatial data format which is OGC compliant. It allows MapInfo and ESRI tools to provide additional interfaces to RIMS power users.

The RIMS custom built web-based mapping interface enables the presentation of RIMS information in the context of other standard spatial datasets obtained from other sources such as The LIST and Aurora Energy, which provides simplified geographical tools for spatial interrogation. Complex ad hoc spatial analytical capability has not been a requirement, yet as most of it has been built in the advanced reporting capability, but can be achieved with the MapInfo and ESRI tools if required.

D.4 SIPS

The State Infrastructure Planning System (SIPS) holds state-wide infrastructure-related information, along with socio-demographic data owned and managed by a range of external data providers.

The SIPS business model is directed at a low volume, targeted user group who require high level spatial data and the ability to access associated attribute data.

D.4.1 Data management

SIPS acquires data from a range of sources and undertakes only limited day-to-day data management and maintenance responsibilities. It is not currently structured, nor focused at operational data management, nor could undertake the data management responsibilities relating to the various road inventory items or applications currently managed by RIMS, with the exception of the Freight Demander Survey (FDS).

D.4.2 Spatial mapping

The SIPS mapping environment is capable of simple through to cartographic quality mapping products, whereas RIMS is not designed for high end map production.

Complex analytical tools are available to SIPS users through some of the tools and by using the commercial software upon which SIPS is built.

E UK study into the value of geospatial information

Due to the complexity of estimating the productivity improvements by specific input, the productivity improvements in the UK study were implemented as total factor productivity improvements. In reality, many applications of the geospatial information technologies will have had a differential impact on the demand for labour versus the demand for capital as well as affecting the demand for a range of other inputs such as construction, business services and transport.

Table E1 **Shocks and scenarios**

Sector #	Sector Name	2009 shock	Notes	2015 shock BAU	2015 shock Optimal
1	**Local government**	**0.233%**	Based on case studies	**0.311%**	**0.331%**
2	**Primary care trusts**	**0.000%**	BAU conservative assessment of future potential at 25% of current shock in local government by 2015, based on staffing level and application range comparison.	**0.023%**	**0.029%**
11	**Construction**	**0.060%**	Based on evidence from comparative studies and apportioning the shock according to the proportion that local government makes up of the national economy.	**0.080%**	**0.085%**
14	Land Transport	**0.009%**	Based on reduction in road closure due to street works	**0.012%**	**0.013%**
18	Business services	**0.0026%**	Based on efficiency savings for solicitors resulting from NLIS.	**0.0035%**	**0.0037%**
PLUS Labour supply shock	*Extra FTEs made available*	**1500**	Accumulation of estimated efficiencies from improved citizen and business interaction with local service providers.	**2000**	**2124**

Data source: (ConsultingWhere/ACIL Tasman, 2010)

F References

ACIL Tasman. (2004). *Industry development opportunities based on natural gas.*

ACIL Tasman. (2005). *A review of the economics of Meander Dam.*

ACIL Tasman. (2006). *Industry development 0pportunities based on natural gas.* Department of Economic Development.

ACIL Tasman. (2008). *Value of spatial information in Australia.* Melbourne: Cooperative Research Centre for Spatial Informatin.

ACIL Tasman. (2009). *The Value of Geospatial Information in New Zealand.*

ACIL Tasman. (2010). *The value of Earth observation from space.* Canberra: Geoscience Australia.

Agtrans Research. (2005). *Review of progress of invasive species.* . Brisbane.

Allbrook. (1998). *A Survey of GIS in Local Government.* Cardiff: University of Glamorgan.

Allens Consulting Group. (2007). *The Economic Benefits of Making GPS net available in Victoria.*

Ashe, M. (2006). *The cost of fire in Australia. Sydney: Macquarie University.* Macquarie University.

CLG. (2010). *Government Response to the Consultation on the future of Ordnance Survey.* London: CLG.

Commission, P. (2009-10). *Report on Government Services.*

Commonwealth Grants Commission. (2011). *Update of how GST is to be shared.* Commonwealth Grants Commission.

Concept Economics. (December 2008). *Economic Efficiency of the Tasmanian Planning System* . Hobart: Tasmanian Chamber of Commerce and Industry.

ConsultingWhere and ACIL Tasman. (2010). *The value of geospatial information in local government in England and Wales.* London: Local Government Association of England and Wales.

ConsultingWhere/ACIL Tasman. (2010). *Value of geospatial information in England and Wales.* London: Local Government Association of the UK.

DAFF. (December 2009). *Biosert newsletter.* Canberra: Department of Agriculture Fisheries and Forestry.

Department of Economic Development Tourism and the Arts. (December 2010). *Tasmanian Economic Development Plan - Discussion Paper.* Department of Economic Development Tourism and the Arts.

Department of Premier and Cabinet. (March 2011). *Spatial information foundations - program business case.* Hobart: Depatment of Premier and Cabinet.

DHHS. (2007). *Tasmanian Health Plan.* Hobart: Department of Health and Human Services.

DHHS. (2008). *Strategic Directions 09-12.* Hobart: Department of Health and Human Services.

DIER. (2010). *Child and family centre location report - New Norfolk.* Hobart: Department of Infrastructure, Energy and Resources.

DPAC. (2011). *Spatial information foundations business case.* Hobart: Department of Premier and Cabinet.

DPIPWE. (2010). *Wealth from Water Program Informaiton Guide.* Hobart: Department of Primary Industries, Parks, Water and the Environment.

Foley, P. (2010). *Local information systems.* http://www.communities.gov.uk/publications/communities/establishlocalinfo.

Forestry Tasmania. (2010). *Operational Trial to Operational Reality - LIDAR at Forestry Tasmania.* Hobart: Forestry Tasmania.

Gilfoyle I, T. P. (2004). *GIS and Local Government.* London: CRC Press.

Mayo E, S. T. (2007). *The Power of Information: An independent review.* London: OPSI.

Middleton, P. (2010). Uitility of geospatial Inforamtion and Mapping to better understand ambulanced oparations. *Journal of Emergency Primary Health Care*, 50.

OTTER. (2011). *Water and aewerage in Tasmania - state of the industry report.* Hobart: Office of the Tasmanian Economic Regulator.

Oxera. (1999). *The economic contribution of Ordnance Survey.* Southampton: Ordnance Survey.

Parliament of Victoria. (2009). *Inquiry into access to information.* Melbourne: Parliament of Victoria.

Services, T. D. (n.d.). *Strategic Directions 09-12.*

Services, T. D. (n.d.). *Tasmanian Health Plan 2007.*

SocITM. (2010). *Better Connected 2010.* Northampton: SocITM.

SocITM Insight. (2010). *IT Trends.* Northampton: SocITM.

TCCI. (2008). *Economic Briefing.* Hobart: Tasmanian Chamber of Commerce and Industry.