

# Australia and New Zealand CRC for Spatial Information Year in Summary 2014-15



Australian Government  
Department of Industry,  
Innovation and Science

**Business**  
Cooperative Research  
Centres Programme



## Acknowledgements

The CRCSI wishes to acknowledge image contributions by the broader CRCSI team and the spatial information research community.

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Currency quoted in Australian dollars.



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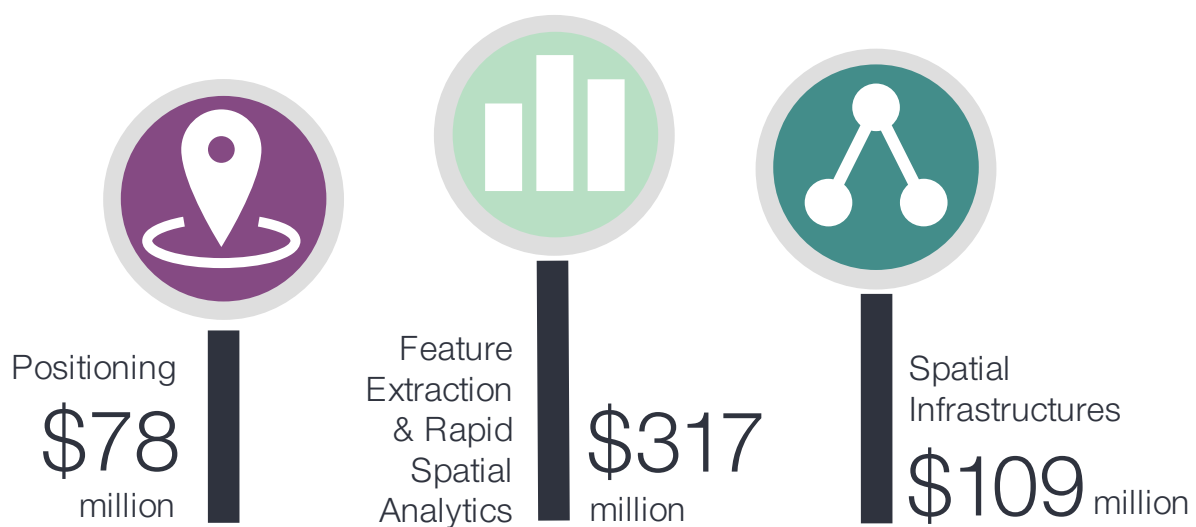
**Business**  
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# Impact from Research Investment 2010-24



## Applications



\$156  
million



Improved health services through geospatial information and visualisation that informs preventative health



Better planning outcomes, cost savings in sustainable urban development tools and improved skills in spatial analysis



Improved decision making tools in agriculture and environment



\$9  
million

## Education



The Education Program is on track for 55 PhD and Masters completions

## Our Purpose and Impact

The purpose of the CRCSI is to find robust solutions to three major challenges:

- Solving the technical challenges that will permit Australia and New Zealand to use all global and regional navigation satellite system signals to deliver 2cm positioning accuracy to anybody, anywhere outdoors in real-time. This will support the development of Australia's National Positioning Infrastructure
- Developing research capability to enable Australia and New Zealand to be world leaders in the generation of semi-automated spatial information products from terrestrial, airborne and satellite sensors, using existing data sources
- Identifying and solving the research challenges to build spatial data infrastructures and service

supply chains that will enable the CRCSI partners to create value-added applications using semantic web technologies.

The solutions to these challenges will lead to innovation and productivity advances in key industry sectors: Agriculture, Natural Resources and Climate Change; Defence; Energy and Utilities; Health and Sustainable Urban Planning.

The investment in our research has reached \$178M (cash and in kind) since CRCSI-2 operations began in 2010. We are on track to achieve a benefit of \$2.08 for every \$1 invested as the research programs mature to the end user market.

### Some Future Impacts to 2024



Creating the eFAS system that led to Fugro ROAMES and Ergon ROAMES reducing aircraft flight times to capture LiDAR data to manage large tracts of regional infrastructure such as powerlines. The resulting impact is **\$221M**.



Establishing the National Elevation Data Framework and Urban Data Elevation Model working with 50 partners to develop high resolution DEMs across 200 000 km<sup>2</sup> of urban Australia. The resulting impact is **\$92M**.



Facilitating the creative commons licencing of open source information for the governments of Australia, the private sector and the broader community. The impact of this work is **\$88M**.



Helping to create and establish the National Positioning Infrastructure to bring into being high resolution (2cm) outdoor real-time positioning capabilities to Australia. The resulting impact is **\$78M**.



Developing and implementing agricultural spatial tools to farmers covering 80% of Australia and 47 000 red meat producers accessing green feed sensors. The impact of this work is **\$78M**.



Commissioning **\$11M** to date of research to 43pl members through projects such as:

- QA4 LiDAR tool in three states and three companies
- Coastal Urban Digital Elevation Model in High Priority Areas project
- Capacity Building in the Pacific
- Flight Assist System Demonstrator
- Natural Resources Management Hub
- Savanna Carbon Farming Tool.

## Foreword by Dr Peter Woodgate

During 2014-15 we worked with the equivalent of 113 full-time researchers and staff drawn from over 500 individuals from Australia, New Zealand, Japan, China and the Netherlands amongst other countries. We partnered with 124 organisations of which 52 are equity partners in the CRCSI, holding equity rights in the CRCSI intellectual property.

Our commitment of resources (cash and in kind) grew to a cumulative \$178M over the eight and a half year joint venture period to June 2018. This year saw a total commitment of \$25.3M, including a cash investment of \$10.9M, 73% of which was directed to research. Commissioned research continues to grow as the private sector and government agencies seek specific spatial solutions.

The impact of the CRCSI over 15 years is expected to reach \$669M, a benefit of \$2.08 for every dollar invested in our research. This impact is expected to continue to grow as our Research Program matures and reaches the market.

The Commonwealth Government report from the Miles Review of the CRC Programme was published in May 2015. Whilst there were some changes to the CRC Programme including increased linkages with Growth Centres and further CRC reviews, the core of the Programme remains unchanged. All of the review recommendations were accepted by the Federal Government. Our SME management company, 43pl, was highlighted as an excellent case study for encouraging private sector engagement in collaborative research.

Our three colleges – Research and Education, Government and 43pl – have been working to develop a post 2018 future for the CRCSI once our CRC Programme funding ceases. This funding represents about a third of our annual cash flow. The plan of transition to a sustainable structure is coming together and an updated discussion paper will be available to all participants and partners of the CRCSI in November 2015.

**Dr Peter Woodgate**  
CEO



We are working towards a sustainable  
research based organisation



# Strategic Plan

## VISION: SPATIALLY ENABLING AUSTRALIA AND NEW ZEALAND

The CRCSI strategic vision 2015-18 is to be widely recognised for undertaking high impact, collaborative research that leads to accelerated industry growth, improved social wellbeing and a more sustainable environment.

## SUCCESS BY 2018

By 2018 the CRCSI will be recognised world-wide for the high impact of our research. A thriving spatial information industry will acknowledge the central role of the CRCSI. We will be considered an essential partner for complex spatial information research collaboration both locally and international.

## OUR VALUES

We are strongly collaborative in our relationships, strive for excellence in our research, and aim to be transformational in our impact.

## STRATEGIC OBJECTIVES

### Program 1: National Precise Positioning

To conduct research that solves the signal processing and economic impediments to the creation of a sparse, continental-scale, precise positioning multi-GNSS network operating at 2cm (x and y) accuracies.

### Program 2: Rapid Spatial Analytics

To conduct research that improves the ability and efficiency of government and industry to rapidly create and value-add spatial information products, manually or through automation, from devices and cloud-based infrastructure.

### Program 3: Spatial Infrastructures for Australia and New Zealand

To identify and exploit the emerging capabilities of the Semantic Web to enable Foundation Spatial Data and spatial data supply chains to create value-added applications.

### Program 4: Applications

To realise high impact use of the CRCSI's research in the following areas: Agriculture, Natural Resources and Climate Change (4.1) through the creation of a biomass and carbon monitoring system for high resolution and high frequency application on farms and through improved environmental monitoring; Defence (4.2) by adapting the capabilities of the CRCSI's research portfolio; Health (4.4) by helping agencies to spatially enable clinical databases; and Built Environment (4.5)<sup>1</sup> to develop new tools and strategies to support sustainable urban planning and built infrastructure development.

### Program 5: Education

By 2018 the CRCSI will have over 50 PhD and Masters completions through our university partners.

### Program 6: Industry Development and Sustainability

Industry development; assist our partners, in particular 43pl, develop and exploit the CRCSI intellectual property.

Commissioned research and other funding; generate an additional \$11M of activity to June 2018 tackling complex research needs involving multiple partners from both public and private sectors.

## Performance Indicators

1. A solution for the impediments of multi-GNSS signal processing and economic arguments for a continent-wide, ubiquitous, sparse, precise positioning network

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<sup>1</sup> The Energy Program (4.3) was restructured into the Built Environment Program (4.5) in 2014.

2. Adoption by our partners of new methodologies and software tools that enhance the level of rapid automation of data fusion, feature extraction and analysis
3. Wide recognition by partners of the CRCSI's role in helping establish and value-add critical supply information chains
4. High impact end user applications adopted in each Application Program.

## Future Impact

The expected benefits from the work of the CRCSI over the period 2010-18 will total \$669M at a benefit: cost of 2.08 for each \$1 invested with the CRCSI. This joint venture approach to research investment has generated impact across our five core programs.

The impact across the five program areas is:

**Positioning Program (\$78M):** The future benefits as a result of the National Positioning Infrastructure are estimated at \$78M.

Benefits will flow through the accelerated uptake and utilisation of the National Positioning Infrastructure and the avoided cost to the nation through the establishment of optimally deployed and networked positioning infrastructure. It is now recognised this Program will facilitate economic and social impacts across multiple industries including mining, transport, maritime, aviation, land management and surveying, utilities and location based services.

**Rapid Spatial Analytics (\$316M):** This Program estimate takes into account the previous Automated Spatial Information Generation (Program 2) which is estimated to have an impact of \$124M across three areas:

- \$76M through the implementation of the National Elevation Data Framework data distribution portal, publicly downloadable sea level rise maps, government oriented sea level rise visualisation tool, CRCSI commercial receipts, and implementation of the SAVBAT tool
- \$41M through the introduction of software and improved technology solutions at Ergon Energy resulting in a reduction of annual costs of the vegetation management program
- \$7M through labour savings from deploying more effective software solutions to more efficiently process data into information in government and industry.

Over the life of the CRCSI and until 2025 it is expected the Rapid Spatial Analytics Program will deliver \$316M of benefits relating to:

- \$211M benefits resulting from the reduction of costs of the vegetation management program through the introduction of software and improved technology solutions Australia wide
- \$92M from the Urban Digital Elevation Modelling in High Priority Regions (UDEM) project, commercial receipts and the use of the SAVBAT tool
- \$13M of benefits resulting from savings in labour used from deploying more effective software solutions into organisations to more efficiently process data into information. This cost saving and efficiency gain will translate into either more productive capacity or a reduced labour requirement. The ability to process data into information faster through automated processes will alleviate the largely



manual processes that exist in identifying, extracting and compiling information from a multitude of data sources.

**Spatial Infrastructures (\$109M):** An estimated \$36M of benefits have been delivered by the influence and adoption of policy through creative commons frameworks. It is estimated \$109M of benefits (up from \$42M as originally estimated) will arise from the Program as a result of the adoption of new policies and online infrastructure technologies in government and industry.

The Program will create further impact by improving discoverability and interoperability, simplifying access and publishing arrangements, streamlining the efficiency of processing and by creating a fertile environment for value-adding data, apps and other services.

**Applications (\$156M):** Although the general thrust of the activities has not changed, outputs have been better tuned to partner needs and re-phased closer to timelines that can be achieved in conjunction with partners.

This Program has delivered benefits of \$17M across three key areas:

- \$12M in savings from increased staff efficiency and improved health services via new geospatial visualisation tools that collate and analyse disease, provide risk factors for preventative health and through avoided costs for early disease detection

- \$3M cost savings through the use of the desktop spatial planning tool ENVISION. Cost reductions through better planning of capital infrastructure, the creation of sustainable living and working spaces and the delivery of transport, health and open space areas
- \$2M in labour savings from the introduction of tool sets by government agencies and research organisations to prepare, manipulate and extract information.

**Education (\$9M):** Four postgraduate students commenced in 2014-15 with either full or top-up Scholarships, bringing the total cohort of active students to 29. During the year 12 students completed their studies (two students withdrew) which brought our total of 30 completed post-graduates since 2010.

Of the students who have graduated, 28 students have stayed connected to the CRCSI and this is where they are today:

- Three are working for a 43pl member company
- Seven are working in the private sector
- 10 are in CRCSI partner research institutions
- Three are working in non-partner research institutions
- Four are working in government agencies or departments
- One is between jobs

The impact of the Education Program through the work of the students is estimated at \$9M across the 51 or more PhD and Masters students with our university partners.

# Intellectual Property Registry

In April 2015 the CRCSI launched its online intellectual property registry, a platform that allows our partners to investigate, explore and seek further investment and commercialisation opportunities with intellectual property held by the CRCSI.

Detailed information about the opportunities in *global navigation satellite systems, feature extraction and remote sensing tools*, and *big data and applied solutions* can be found at [www.crcsi.com.au/commercial](http://www.crcsi.com.au/commercial)

*Table 1: Brief overview of selected intellectual property items held by the CRCSI which are either under licence or being pursued.*

Description	Pathway
Real-Time Quality Control Software for Positioning	Licenced to interested CRCSI Partners
Photogrammetric software for the generation of spatial information products from satellite imagery (Barista)	Licenced to interested CRCSI Partners and third parties
Aircraft guidance and path planning software	Licenced exclusively to CRCSI Partner
National Nested Grid Standard, Workflow Management System Software Platform and data model based on a grid cell (raster) approach for management of spatial information	Made available for use under Open Source licences <a href="https://github.com/VPAC/rsa">https:// github.com/VPAC/rsa</a>
Health Software Spatial Augmentation Module for increased analytical and GIS capability	Licenced to interested CRCSI Partner
Laser Scanning Segmentation Software (NN Clean)	Licenced to interested CRCSI Partners
Optimised flight management through planning, aircraft control and in-flight point capture with this 2D and 3D quality assurance capture technology	Currently seeking licencees for this technology
Australian Provisional Patent Application No. 2013904709	
Toolkit to assist in urban planning, and the understanding and analysis of economic, social and environmental impacts in suburbs (Envision)	Continuing project – exploring opportunities
Easy-to-use tool for graziers to determine feed availability in improved pastures	Continuing project – exploring opportunities
Tools (Total Green Biomass & Biomass estimation and Pasture Growth Rate) and methodology to estimate the forage availability	Licenced to CRCSI Partner
An approach for automatically aligning overlapping mobile mapping system (MMS) data.	Currently seeking licencees for this technology
Epiphane <sup>TM</sup> – a powerful spatial query and visual analytics tool that uses sophisticated privacy filters to maintain anonymity compliance and a novel data agent approach to identify and intelligently join data.	Seeking partnering relationships to undertake market development and commercialisation
Provisional patent filed (Australian Patent Application No. 2014259493, USSN is 62/074,970)	
Software to (1) automatically reconstruct city-scale building footprints from classified airborne LiDAR point clouds and (2) detect buildings and created building masks from complex scenes and fused LiDAR and aerial imagery	Currently seeking licencees for this technology
Quality Assurance – LiDAR Capture. This software is used to enable an automated and detailed quality assurance (QA) check of captured data for compliance supply and audit purposes	Commercial options to be fully explored after completion of beta trialling

## Program Overview

The central focus of the CRCSI is a research infrastructure that delivers commercially applicable end user outcomes.

The three overarching research themes – Positioning, Rapid Spatial Analytics, and Spatial Infrastructures – support the four key program areas. These program areas are:

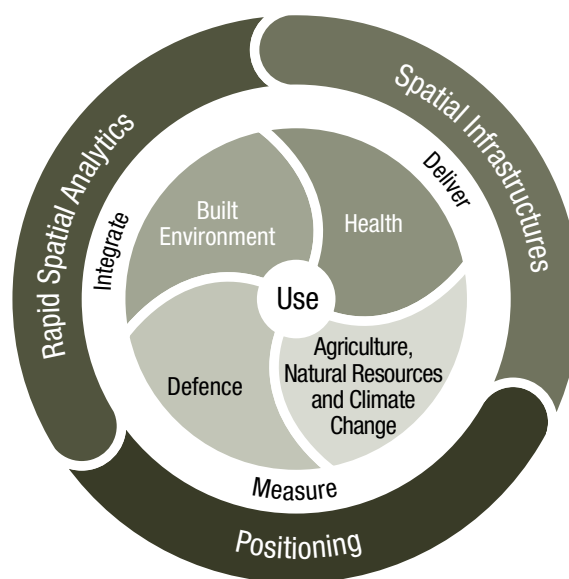
**Agriculture, Natural Resources and Climate Change** through the creation of a biomass and carbon monitoring system for high resolution, and high frequency application on farms and through improved environmental monitoring.

**Defence** by adapting the capabilities of CRCSI's research portfolio.

**Built Environment** to build new tools to support sustainable built infrastructure development.

**Health** by helping agencies to spatially enable organisational clinical databases.

At the centre of our research focus is use; the end user of the technology, systems, models,



methodologies and standards we develop.

The end user may be government agencies, research institutions, the private sector or the broader community.

There are currently 32 projects funded through the CRCSI research program, nine of which were funded this year. Fifteen projects were completed and one was terminated due to underperformance.

*Table 2: CRCSI Projects*

*\*Newly funded projects in 2014-15    ^Completed projects in 2014-15*

Project Title	Lead Researcher(s)	Number of Partners
<b>POSITIONING PROGRAM</b>		
New carrier phase processing strategies for achieving precise and reliable multi-satellite, multi-frequency GNSS/RNSS positioning in Australia	Prof Peter Teunissen, Curtin University	12
Next Generation Australian and New Zealand Datum	Prof Chris Rizos, University of NSW	8
Multi GNSS processing strategies and services NB: This project was terminated in May 2015 due to underperformance.	Prof Yanming Feng, Queensland University of Technology	11
GNSS Measurement and Quality Control: Initiating the development of a test track for positioning system validation and certification	Dr Allison Kealy, University of Melbourne	4
High accuracy real-time positioning utilising the Japanese Quasi-Zenith Satellite System (QZSS) augmentation system	Dr Suelynn Choy, RMIT University	5
Development of the Analysis Centre Software	Dr John Dawson, Geoscience Australia	1

Evaluating the positioning capabilities of Locata terrestrial signals in GNSS unfriendly environments – Phase 1	Prof Chris Rizos, University of NSW	1
*Multi-GNSS PPP-RTK Network Processing	Prof Peter Teunissen, Curtin University	10
<b>AUTOMATED SPATIAL INFORMATION GENERATION PROGRAM</b>		
Multimodal data acquisition and feature extraction from multi-sensor terrestrial mobile mapping systems	Prof Geoff West, Curtin University	13
Feature extraction from multi-source airborne and space-borne imaging and ranging data	Dr Chunsun Zhang, RMIT University	14
^Australian woody vegetation landscape feature generation from multi-source airborne and space-borne imaging and ranging data	Dr Andrew Haywood, DELWP (VIC) & Prof Simon Jones, RMIT University	4
^Close-range photogrammetry technology for defence	Prof Clive Fraser, CRCSI	1
Development of a standard software procedure and tool to quality assure elevation data	Dr Nathan Quadros, CRCSI	5
^Building change detection using imagery and height data	Dr Mohammad Awrangjib, Monash University	1
<b>SPATIAL INFRASTRUCTURES PROGRAM</b>		
Semantic web technologies for next generation spatial infrastructures	Prof Geoff West, Curtin University	6
Semantic web technologies for supply chain management of spatial infrastructures	Prof Geoff West, Curtin University	10
Optimising the supply chain for geocoded addressing in Australia	Kylie Armstrong, CRCSI	2
<b>AGRICULTURE, NATURAL RESOURCES &amp; CLIMATE CHANGE PROGRAM</b>		
Biomass Business	Prof David Lamb, University of New England	11
**‘Intelligence Bottler’ – capturing spatial know-how for agriculture – Phase 1	Tim Neale, Precision Agriculture	2
Big data solutions for environmental monitoring	Prof Kim Lowell, CRCSI & Adam Lewis, Geoscience Australia	5
Biomass Business II – Tools for real-time biomass estimation in pastures	Prof David Lamb, University of New England	5
*Natural Resource Management Spatial Hub	Phil Tickle, CRCSI	20
*Spatially Enabled Livestock Management: Maintaining ground cover in mixed farming systems	Dr Mark Trotter, University of New England	1
<b>HEALTH PROGRAM</b>		
^Spatial-temporal modelling of cancer incidence, survival and mortality	Prof Kerrie Mengersen, Queensland University of Technology	7
Geographic variations in natural disaster impact and spatial links to non-injury related health outcomes	Prof Simon Kingham, University of Canterbury	4
Place as a vital sign of health	Prof Moyes Jiwa, Curtin University	1
Technology transfer and utilisation of Epiphaneae	George Curran, CRCSI	1
*^3D FAST (Facial Analysis Streamlining for Clinical Translation) workflow optimisation	Hedwig Verhoef, Curtin University	2
<b>BUILT ENVIRONMENT PROGRAM</b>		
Understanding barriers, bottlenecks and opportunities for adoption of spatial information tools in land use planning in Australia and New Zealand: A visual analytics usability approach	A/Prof Chris Pettit, University of Melbourne	5
Greening the Greyfields: Precinct visualisation and community engagement	Prof Peter Newman, Curtin University, Prof Peter Newton Swinburne University, & Prof Simon Kingham, University of Canterbury	9

# Research and Award Achievements

## RESEARCH HIGHLIGHTS

Seven selected research achievements for 2014-15 highlight the breadth of work the CRCSI conducts across the three research themes. The application of this work has resulted or will result in significant commercial and societal impact. In brief, these are:

1. Real-time position will enable 24 hour positioning accuracy
2. First response mapping allows coastal communities to understand and prepare for sea level rise
3. The Spatial Hub provides farmers with better tools to increase profitability know-how and reduce the cost of capital borrowings
4. Handheld sensors determining biomass have already seen farmers reduce the cost of farm inputs such as supplementary feeding and fertiliser
5. Spatial tools that build sustainable suburbs have achieved recommendations by government planners to make policy changes to create better places to live
6. Canterbury (NZ) recovery has led to better preparedness for recovery health services
7. Earth changes to land boundaries means councils can more readily reorganise land ownership and boundaries after earthquake displacements.

### 1. Real-time Positioning

Australia achieved 5cm real-time accuracy during a trial of Japan's QZSS (Quasi Zenith Satellite System) for precision agriculture in January 2015 using a robotic tractor for rice growing operations.

This Australia-Japan collaboration evaluated Japan's QZSS for real-time positioning on a property near Jerilderie in southern NSW during

routine precision farming operations. Partners of the project include Japan's space agency JAXA, Rice Research Australia, Yanmar, Hitachi Australia and Hitachi Ltd.

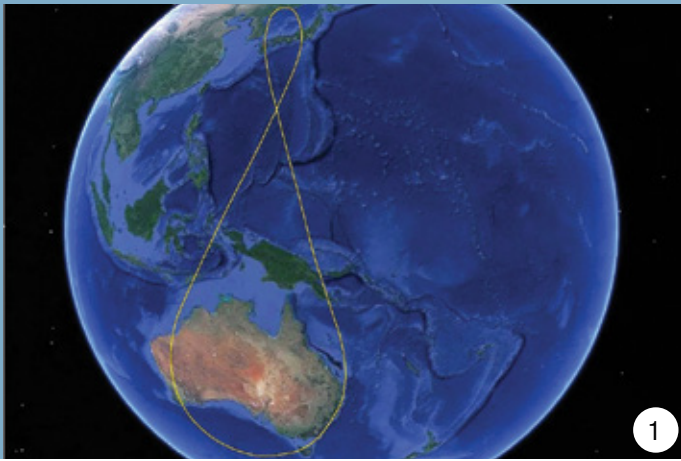
A demonstration of this activity can be found online on the CRCSI YouTube channel (CRC for Spatial Information/National Precise Position).

The success of the CRCSI Positioning Program will lead to real-time Precise Point Positioning (PPP) solutions in Australia. By 2018 the QZSS will provide 24 hour coverage across East Asia and the Oceania region that covers Australia and (with extension) New Zealand.

The economic impact of this real-time positioning capability for Australia through productivity improvements and better resource efficiencies are estimated at around \$13.7 billion by 2020.

QZSS is a regional navigation satellite with an orbit designed to offer increased positioning coverage in Japan. However, due to its unique orbit, it also almost perfectly covers Australia. In addition to navigation signals similar to GPS, QZSS transmits two augmentation signals, L1-SAIF and LEX. While L1-SAIF is similar to existing augmentation signals and can provide sub-metre accuracy, LEX is unique to QZSS and is designed to enable real-time centimetre to decimetre level accuracy.

The LEX signal is capable of transmitting correction messages, including detail of the local troposphere and ionosphere. With these details the troposphere and ionosphere influence on the position signal can be removed, increasing position accuracy. The project team developed specific correction messages for Australia, as the troposphere and ionosphere information transmitted by the satellite only covered Japan.



Besides the precision agriculture trial, fixed point and vehicle tests were performed to deliver PPP solutions through the LEX signal. Commercially available GNSS antennas were used and a position accuracy of 5cm horizontal and 10cm vertical was achieved, confirming the potential of QZSS LEX use for Australia.

Currently, QZSS only consists of one satellite and is therefore only available when above Australia. When the four-satellite QZSS constellation is completed in 2018, Australia will have continuous coverage.

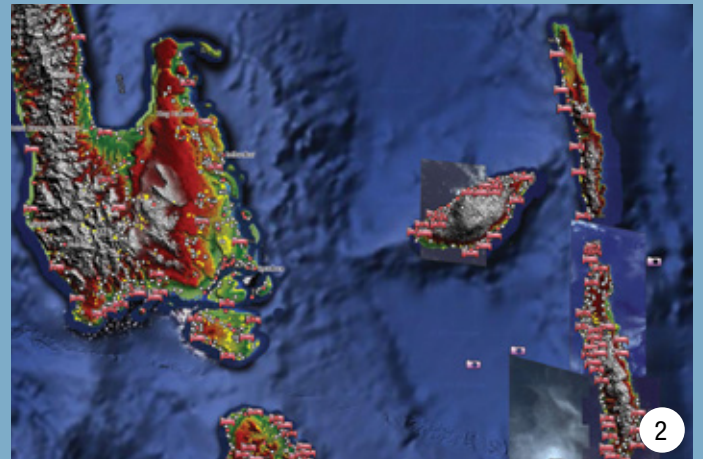
## 2. First Response Mapping

The Vanuatu Globe (a Google Earth platform used to display digital elevation in the Pacific Islands) became the first response mapping tool for hundreds of users including the Vanuatu Government, the World Bank, non-government first responders and the people of Vanuatu in the days following Cyclone Pam – a category 5 cyclone that hit Vanuatu in March 2015.

Known as the Cyclone Pam Crisis Map, it can be found online [bit.ly/CyclonePamCrisisMap](http://bit.ly/CyclonePamCrisisMap)

Cyclone imagery of damaged areas, affected houses and inundated roads along with population data, geotagged twitter photos and food drop information were added in real time to this open source globe platform.

Accessed by thousands of people in the days after Cyclone Pam, it was only possible because of the



preceding *Pacific Islands Coastal Inundation Capacity Building Project* which was completed in 2014.

With funding through the Department of Foreign Affairs and Trade and in partnership with 43pl member NGIS Australia, the *Pacific Islands Coastal Inundation Capacity Building Project* was led by the CRCSI.

The Project worked with Pacific Island governments in Tonga, Samoa, Papua New Guinea and Vanuatu to capture detailed digital elevation data for the analysis of sea level rise impact.

LiDAR data was used to update digital elevation models. These models allowed the creation of coastal inundation models that provide a risk assessment of priority coastal areas. The risk assessment identified more than 10 000 buildings as ‘at high risk’ of coastal inundation within 80 years including schools, hospitals and critical infrastructure.

195 people from 95 organisations – a range of government and local agencies in the Pacific Islands – received training on the coastal inundation models and analysis of the risk maps. These agencies now have the tools to understand and communicate climate change risk to local communities and put adaptation plans in place.

Of the four Pacific Islands involved in this Project, Vanuatu was the only country using Google Earth for GIS purposes. Using Google Earth as the platform, the Vanuatu Globe was





developed as a visualisation tool for the display of digital elevation. The Globe was subsequently used by the Education Department of Vanuatu for teaching purposes.

The Vanuatu Globe gave access to LiDAR data and imagery making it a ground breaking open data portal for publicly sharing elevation and sea level rise information.

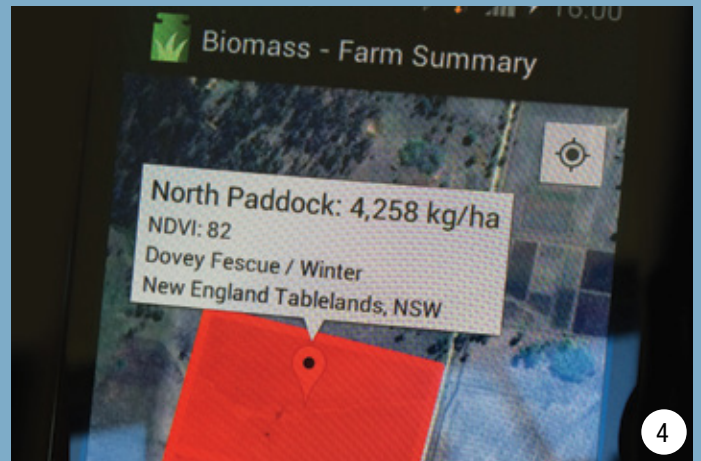
The Project has received significant media attention and won several awards. The Vanuatu Globe was featured at the White House Climate Data Initiative Announcement where the United States Government announced the Climate Data Initiative.

In Australia, the Project has won a number of state and national spatial industry awards and in October 2015 won the United Nations Lighthouse Activities Momentum for Change Award for Mapping Sea Level Rise.

### 3. The NRM Spatial Hub

This online tool has developed a world first by taking 30 years of mapping and surveying data and processing it within seconds against user-determined criteria to produce best practice options in agricultural land management for producers and natural land managers.

The project partners – the Rangeland NRM Alliance (a consortium of 14 organisations that collectively farm the rangelands of Australia, an area covering around 80% of the nation)



– developed the Online Property Planning and Information System (OPPIS) to provide graziers, land managers and regional bodies with data and mapping tools to allow the consistent development of extensive digital property plans, infrastructure maps and plans of on the ground work.

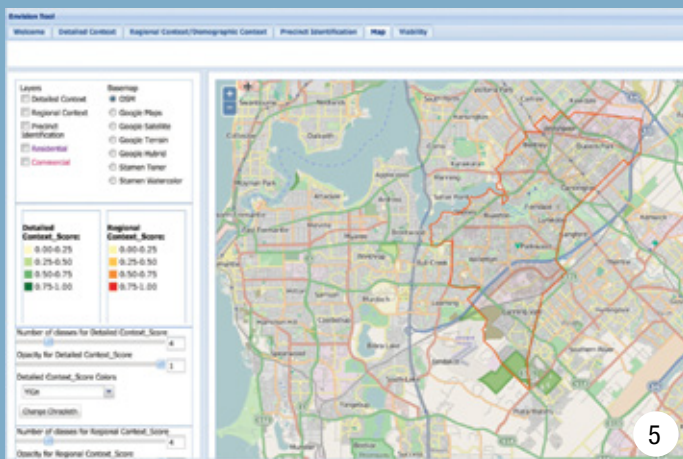
Producers and land managers can access spatial data over their land, such as high resolution and innovative time series satellite imagery products, and use the tools to analyse land condition, water access and plan infrastructure.

Customised and easy to use mapping, reporting and analysis tools guide users to analyse the condition of properties over time, and better understand how well current infrastructure such as fences and water points affects pasture utilisation and long-term safe carrying capacity. It also provides tools to assist with strategic decisions that increase productivity and sustainability.

More details about the NRM Spatial Hub and involvement can be found online <http://www.nrmhub.com.au/>

### 4. Handheld Sensors Determine Biomass

Using a handheld device, producers and land managers can better estimate on-farm biomass (the level of available green feed) to match with livestock feed needs. This Meat & Livestock Australia (MLA) and University of New England project has achieved accurate results of biomass prediction which allow



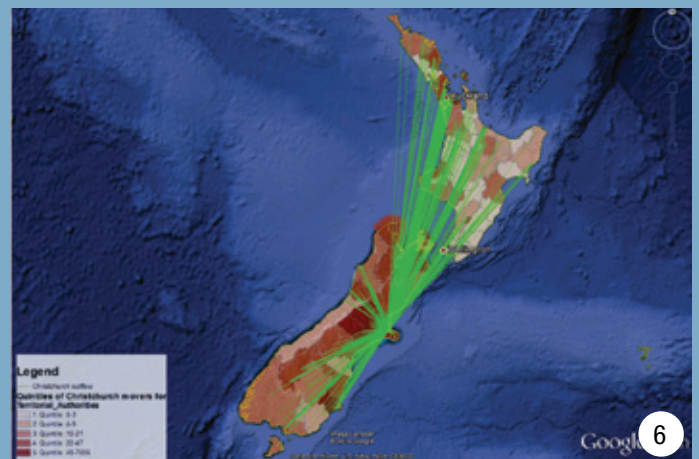
producers to increase total farm productivity by 11.1% (\$96 per hectare) for sheep enterprises and 9.6% (\$52 per hectare) for cattle production systems.

With the use of an Active Optical Sensor (AOS), spectral data from a large range of plant species from more than 70 sites across New South Wales, Victoria, Tasmania and Western Australia have been collected. Additionally, biomass data have been collected so that regional, seasonal and species-specific calibrations could be executed to infer the relationship between the Normalised Difference Vegetation Index (NDVI) and green dry biomass.

Modifications to the sensor device have been performed so that logging and more detailed self-calibration are possible. In addition, a mobile device application is continuing to be developed to support the AOS as a real-time biomass estimation tool, which allows for the management of paddocks and the containing biomass.

## 5. Creating Sustainable Suburbs

Just like Sim City but for the real world, the ENVISION software suite allows urban planners and developers to imagine the future using the data from today. With this imagining comes the ability to plan for sustainable buildings, walkable precincts, a sense of community, and a new place to live and work that delivers sustainable opportunities and better economic outcomes to our urban environment.

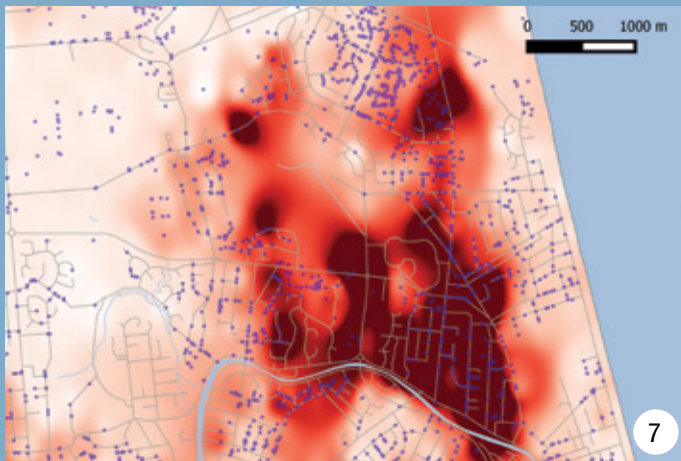


The WA Department of Housing, Curtin University, Swinburne University, AURIN, Landgate, Victoria Department of Environment, Water, Land and Planning, the Cities of Stirling and Canning (WA) and the City of Maroondah (VIC) are project partners along with the City of Christchurch (NZ) and the University of Canterbury. There are a further three councils in Victoria currently collaborating on software trials.

ENVISION, developed as a web based toolset in 2013, is a shared urban spatial information platform that brings together a wide range of planning related datasets for exploring the redevelopment potential of local government areas on a lot-by-lot bases. ENVISION provides the analysis of existing spatial information.

The tool draws on data sets related to property valuations, demolitions, zoning, transportation, demographics, water infrastructure, power infrastructure and the location of parks, schools and activity centres. The output of this information is the creation of indicators that can be combined and mapped in a single user-friendly environment.

ENVISION Scenario Planning (ESP) tools use the outputs of ENVISION analysis to develop a series of scenarios based on predetermined criteria. This criteria may include; low carbon living, green or shared community space, allocation for school development or growth,



Mark Judd, Arron Walker, Graeme Wright and James McIntosh

public housing and mid to high-rise development corridors.

Currently under development is the augmented reality software that will enable urban planners and developers to visualise the scenarios of ESP using mobile devices across existing infrastructure and land use.

## 6. Canterbury (NZ) Recovery

Although it is commonly understood that natural disasters can cause traumatic experiences in those affected, few studies have actually quantified and compared its influence in the population. The 'Christchurch earthquake' of 22 February 2011 killed 185 people, caused severe damage and impacted 340 000 people in the Canterbury Region. Research determined that people living in the widely affected central and eastern parts of Christchurch after the earthquake have a higher risk of developing a mood or anxiety disorder compared with people living in the rest of New Zealand. The results of this work allow health agencies to better target mental health care services to those most in need in future seismic events.

The New Zealand Ministry of Health provided anonymised daily mood and anxiety diagnoses and issuances of publicly funded drugs between 1 January 2009 and 30 June 2013. With the link to the National Health Index, demographic characteristics could be assigned to the mood and anxiety cases. This information was then used to

assess spatio-temporal occurrences of mood and anxiety disorders.

The study identified that the rate of mood and anxiety disorders per 100 000 people was generally higher in Christchurch compared to the rest of New Zealand. A steep increase in disorder rates was observed in Christchurch after the earthquake, while disorders in the rest of New Zealand followed its general trend. Statistically significant elevated risks were observed for females, the elderly, and for people of European ethnicity.

Generally, mood and anxiety-related disorders increased with closer proximity to damage from liquefaction and moderate to major lateral spreading, as well as areas that are more likely to suffer from damage in future earthquakes.

## 7. Earthquake Changes Land Boundaries

The Canterbury (NZ) region earthquake sequence of 2010 and 2011 resulted in the horizontal movement of several metres creating and introducing errors to existing mapping. This movement led to difficulty in determining precise property boundaries as described on land titles.

Research partners University of New South Wales (UNSW) and Land and Information New Zealand (LINZ) undertook the analysis of over 7000 cadastral (property boundaries) and geodetic survey markers both before and after the earthquakes.



Existing deformation models for the earthquakes were first enhanced to better reflect the observed tectonic movement in the Christchurch area. This meant that the overall tectonic signal could be removed so that the analysis could focus on the shallower, more localised movements which were of particular interest for this research due to the greater impact on property boundary location.

A number of filters and corrections were applied to the cadastral coordinates to account for various anomalies in those coordinates. For example, the cadastral data was corrected to account for the fact that post-earthquake surveys carried out before the geodetic control was updated were still using pre-earthquake control coordinates. Once coordinate changes at survey marks had been determined, these were interpolated onto a grid from which shallow surface movement across the city could be visualised.

The geodetic modelling technique is a world first in application to cadastral data over large areas.

#### AWARDS RECEIVED

The CRCSI staff, collaborators, projects and commercialised intellectual property received a number of awards in 2014-15. These awards represent the breadth of the work we do and the robust user-led research we conduct. Table 3 highlights this recognition.

#### CRCSI AWARDS

The first CRCSI awards dinner was hosted during the Annual Conference 2014 in November, an event that celebrated the achievements of Student Excellence, Research Excellence and leading 43pl Industry Contribution. A special Chair's Award was also granted to an individual who contributed outstandingly to the CRCSI.

The award winners for 2014 were:

**The CRCSI Student Excellence Award** went to Dr James McIntosh for his outstanding research effort and contribution to a CRCSI project outcome. James was recognised for his ability to engage with industry and project partners to provide tangible outcomes for rail development projects in Perth and Melbourne. He submitted an exceptional thesis based on seven academic publications in top rated journals.

**The CRCSI Research Excellence Award** went posthumously to Professor Rod Walker formally of QUT for the outstanding contributions to the CRCSI research and innovation which have delivered high impact outcomes from an end user perspective. Rod was instrumental in conceiving the research that led to the development of the autonomous aircraft guidance system (FAS) that is now saving Ergon Energy \$14M a year in remote asset inspection costs.

**The 43pl Company Award** went to Mr Mark Judd as a champion for the 43pl cause from the very start of the CRCSI. He had a vital hands-on role encouraging the 43 foundation companies to understand and embrace this new industry initiative. Mark's leadership inspired his peers to invest in 43pl and left a long-standing legacy of industry unity.

**The CRCSI Chair's Award** went to Professor Graeme Wright for his sustained and exemplary contribution to the governance, research and academic leadership of the CRCSI since inception in 2003. Graeme has always been and remains a source of wise, impartial and unbiased counsel for the CRCSI, without which we all would have been much the poorer.

This inaugural awards event will continue in 2015 and beyond.

Table 3: Awards 2014-15

Project	Recipient	Organisation	Award
Spatial-temporal modelling of cancer incidence, survival and mortality	Prof Kerrie Mengersen	Queensland University of Technology	Awarded Australian Laureate Fellowship by the Australian Research Council  Elected Fellow of International Society of Bayesian Analysis
New carrier phase processing strategies for achieving precise and reliable multi-satellite, multi-frequency GNSS/RNSS positioning in Australia	GNSS Research Centre	Curtin University	European Space Agency award for the successful and early Galileo positioning analyses; awarded to the worldwide first 50 users of the Galileo System
New carrier phase processing strategies for achieving precise and reliable multi-satellite, multi-frequency GNSS/RNSS positioning in Australia	Lei Wang (PhD Student)	Queensland University of Technology	Paper presented at the China Satellite Navigation Conference won the third prize of "outstanding youth paper"
Greening the Greyfields: Precinct visualisation and community engagement	Prof Peter Newton	Swinburne University	Nominated as a fellow of the Australian Academy of Social Sciences
New carrier phase processing strategies for achieving precise and reliable multi-satellite, multi-frequency GNSS/RNSS positioning in Australia	Prof Peter Teunissen	Curtin University	Awarded Honorary Doctorate (Honoris Causa) from the Institute of Geodesy and Geophysics, Chinese Academy of Sciences
CRCSI Staff	Dr Peter Woodgate	CRCSI	APSEA 2015 Award – SIBA Chairman's Award for an exceptional contribution to growing the spatial industry
CRCSI Staff	Phillip Delaney	CRCSI	APSEA 2015 Award – 2014 Young Professional of the Year Award
Capacity Building of GIS and Spatial Data Skills for Pacific Island Countries	Dr Nathan Quadros, AAM & NGIS	CRCSI & 43pl	VSEA 2014 Award – People and Community Award ~ for Pacific Island coastal inundation capacity building and planning  VSEA 2014 Award – Spatial Excellence Award for AAM, NGIS Australia & CRC for Spatial Information for Pacific Island Coastal Inundation Capacity Building & Planning
Capacity Building of GIS and Spatial Data Skills for Pacific Island Countries	Dr Nathan Quadros, AAM & NGIS	CRCSI & 43pl	APSEA 2015 Award – People and Community Award for Pacific Island coastal inundation capacity building and planning  APSEA 2015 Award – JK Barrie Award for AAM, NGIS Australia & CRC for Spatial Information for Pacific Island Coastal Inundation Capacity Building & Planning

# Education

The Education Program provides scholarships to PhD and Masters Students through our university partners.

The students work across projects in all program areas and engage with the private sector through 43pl.

This year 12 students completed their studies. Table 4 provides student and thesis details.

## STUDENT ALUMNI

Since 2003, the CRC SI has supported 71 PhD and nine Masters Students through the Education Program. Sixty-two percent of the students came to Australia and New Zealand on a foreign passport.

Of the 53 alumni students 89% have found employment in Australia after completing their studies with most being employed in research and the private sector.

Table 4: Completed PhD and Masters Students 2014-15

Name	Title of Thesis	Graduating University
Grant Hausler	National Positioning Infrastructure: Technical, Organisational and Economic Requirements	UNSW
Jonathan Kok	Robust and Efficient Hardware based Evolutionary Technique for Multi-objective Optimisation in Aerospace	QUT
Xiaoying Wu	Schema Evolution in a Federated Database Environment	Curtin
Mark Broomhall	A Method for the Remote Sensing of Aerosols based on MODIS Time Series Data within an Operational System for Near Real-time Atmospheric Correction	Curtin
Yuxiang He	Automated Building Reconstruction from Aerial and LiDAR Data	Melbourne
Cole Hendrigan	Building on Spatial Relationships in the Urban Fabric to Inform Higher-order Transport and Land Use Policy and Planning	Curtin
Su Yun Kang	Comparison of Spatial Modelling using Point-process Data and Aerial Data	QUT
James McIntosh	Funding Sustainable Transport through an Integrated Land Use and Transport Planning Framework Utilising Value Capture	Curtin
Abdul Nurunnabi	Mobile Mapping of Transport Corridors and the Extraction of Assets from Video and Range Data	Curtin
Robert Odolinski	GPS and Galileo Integer Ambiguity Resolution Enabled PPP (PPP-RTK)	Curtin
Jessica Roberts	Spatially Enabled Livestock Management: Improving Biomass Utilisation in Rotational Systems	UNE
James Head-Meares*	Human Interface Technology: Accurate wide area tracking	Canterbury

\*Masters



## Governance and Management

The CRCSI is an unincorporated joint venture and is governed, managed and operated by a single unlisted public company limited by guarantee – Spatial Information Systems Research Limited (SISR) – that acts as trustee of the CRCSI intellectual property, employs the management staff, undertakes contract research work and manages the CRCSI operations.

For stakeholder engagement and communication, the CRCSI participants and partners are formed into three Colleges:

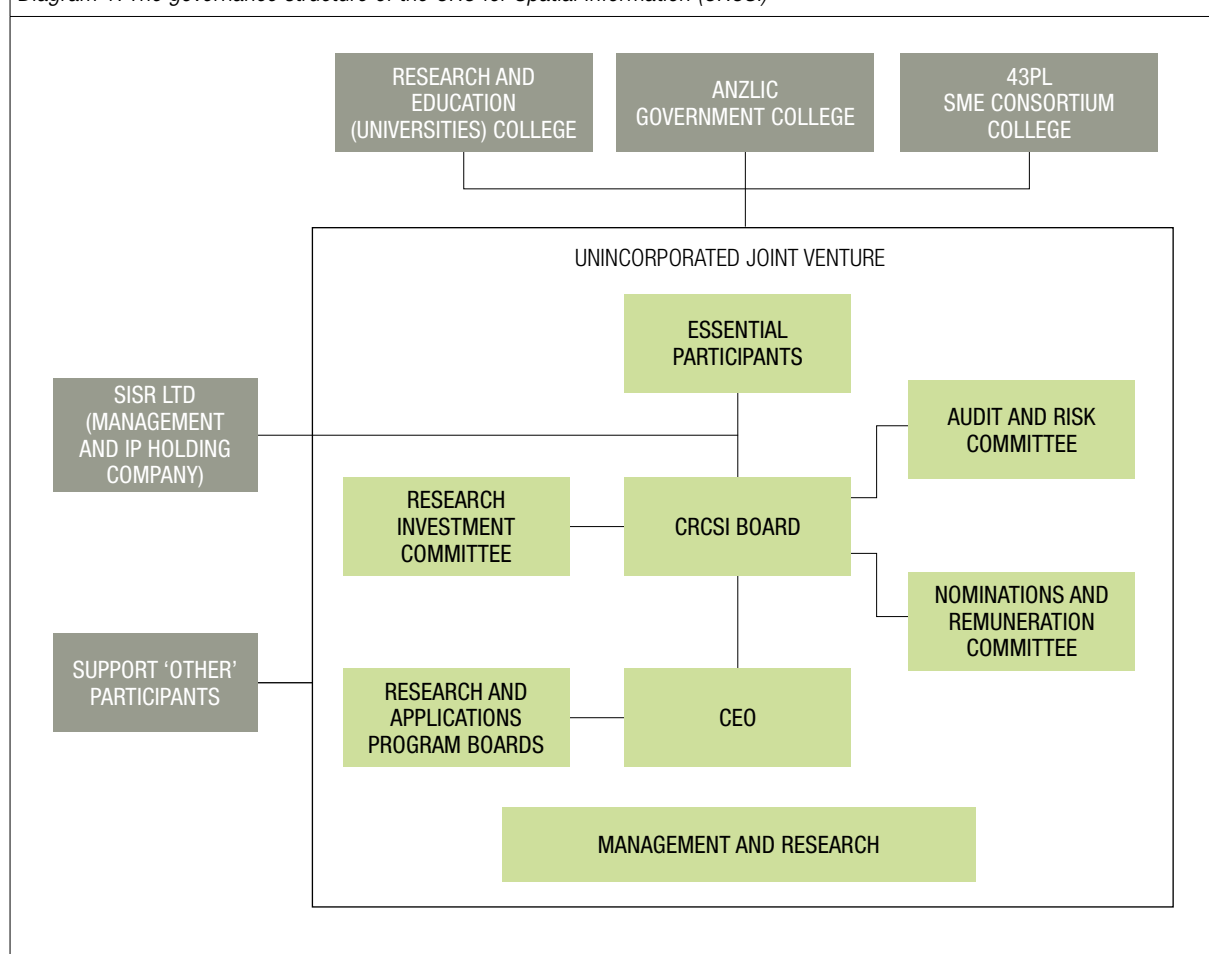
- Government Agencies College managed by ANZLIC (the Spatial Council of the Governments of Australia made up of agencies at federal, state and territory levels)

- the Research and Education College (primarily universities)
- 43pl (the private sector).

The Colleges operate independently of each other and help represent the views of the respective members especially in the policy formation, strategy development, nominations of candidate directors to the CRCSI Board and the admittance of new participants. This structure also provides a vital mechanism for feedback and communication.

The CRCSI has a management structure that supports the research and business development activities of the organisation.

Diagram 1: The governance structure of the CRC for Spatial Information (CRCSI)



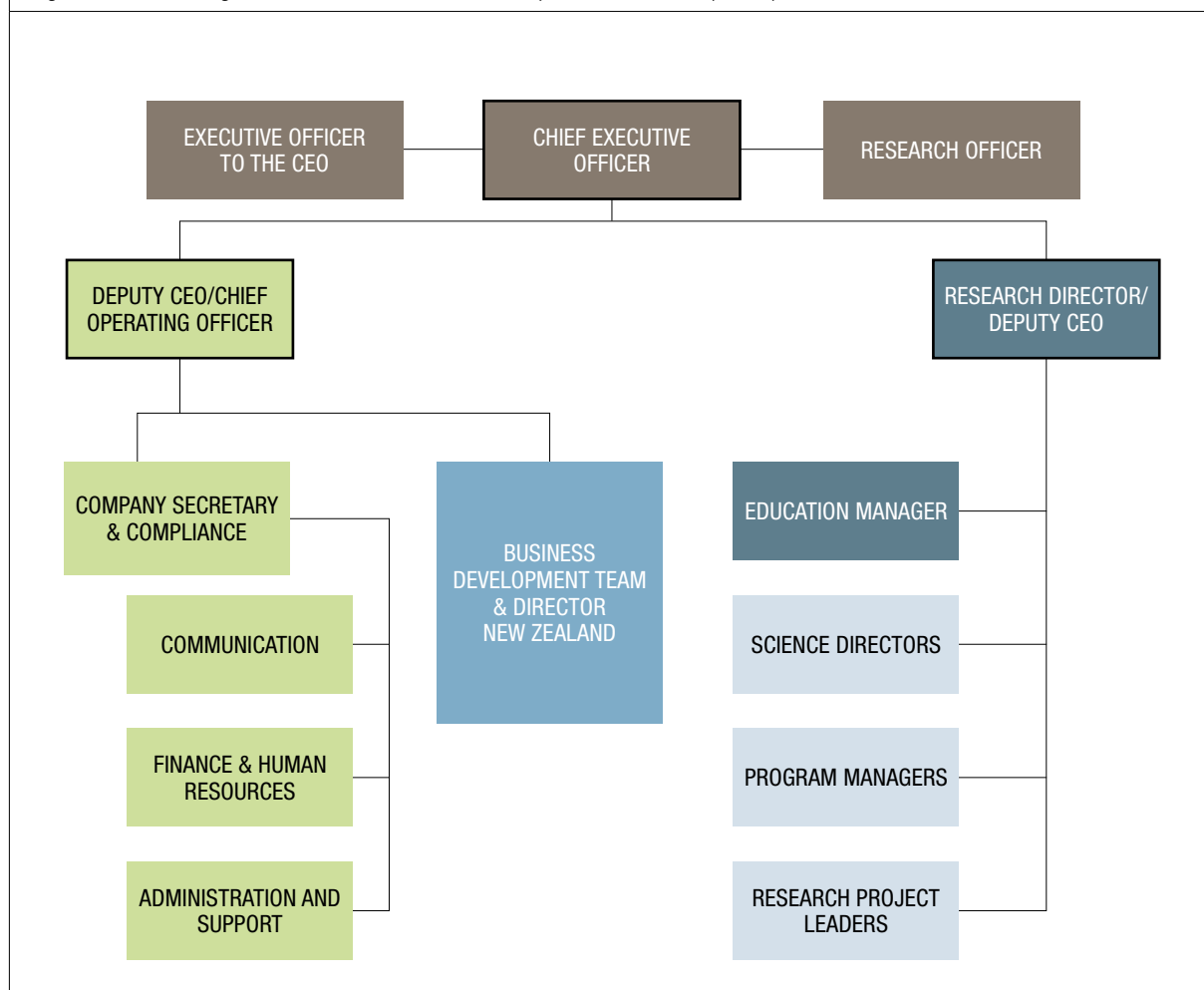
The Research Director is supported by Science Directors, Program Managers and Research Project Leaders. The Education Program also operates under the guidance of the Research Director.

The Chief Operating Officer is supported by compliance, finance, human resources and communication, and seven Business Development Managers, including the New Zealand Director.

In total the CRCSI works with over 500 individuals from across Australia, New Zealand, Japan, China and the Netherlands.

A full list of staff and locations across the CRCSI network can be found on the CRCSI website [www.crcsi.com.au](http://www.crcsi.com.au)

Diagram 2: The management structure of the CRC for Spatial Information (CRCSI)



## Finance Summary

The CRCSI received \$12M in cash contributions in 2014-15, 59% higher than the target in the Commonwealth Agreement. By 2018, the estimated cash contributions to the CRCSI will be around \$88M.

The CRC Programme contributed \$3.7M, Essential Participants \$4.3M, Other Participants \$645K, and commissioned research \$3M.

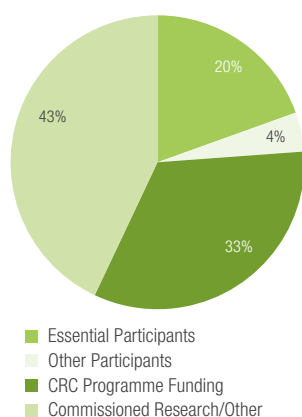
The biggest change over the last 12 months has been an increase of nearly \$1M in commissioned research receipts, totalling 27% of cash contributions. This trend is expected to continue with commissioned research receipts budgeted at 43% of total cash receipts in 2015-16.

In kind contributions from participants were slightly lower this year by 20% at 38.4 FTE. This has not impacted the CRCSI's ability to deliver research and utilisation milestones. In kind contributions from non-participants was 20% higher at \$5M, which aligns with the growing trend for the CRCSI to undertake commissioned research.

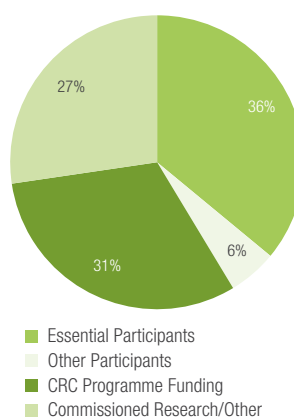
Seventy-three percent of CRCSI expenditure was directed to the research program, with the remainder allocated to business development, communication and education, and governance and administration.

At the end of the year the cash balance was \$12M of which 98% was tied to agreements.

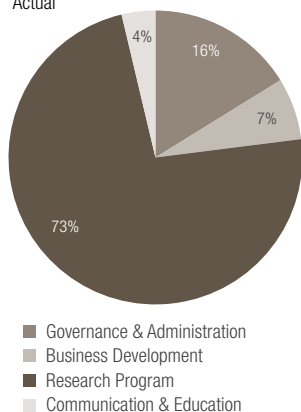
2015-16 Funding Budget



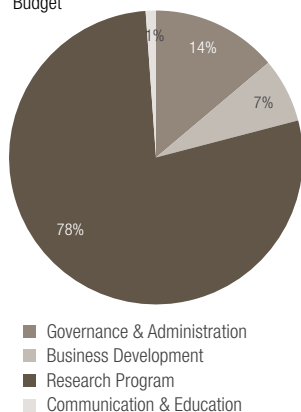
2014-15 Funding by Source



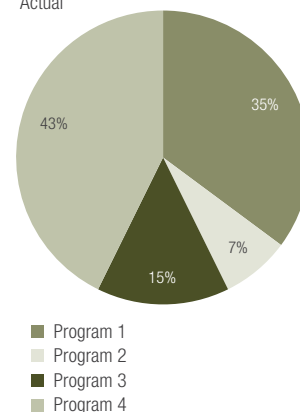
2014-15 Expenditure by Department Actual



2015-16 Budget Expenditure Budget



2014-15 Staff (FTE) In Kind Actual



## Collaboration

During 2014-15 the CRCSI collaborated with 124 organisations across all three sectors; government, private and research (university) sectors. These partners contributed either cash or in kind support to the organisation during the year.

There are 52 equity partners in the CRCSI (11 Essential and 41 43pl) holding beneficial ownership rights in intellectual property in proportion to cash contributions to the CRCSI. The remaining 72 organisations either entered into support participant agreements, specific project agreements or participated via memoranda of understanding or letter agreements.

Key relationships continue to flourish with non-equity holding partners including all of Australia's leading spatial peak bodies; Australia New Zealand Land Information Council (ANZLIC) representing the government interests, Spatial Industries Business Association (SIBA) representing the private sector interests and Surveying and Spatial Sciences Institute (SSSI) representing the spatial profession. All these organisations are involved in the CRCSI programs.

*Table 5: CRCSI Partners 2014-15*

Participant's Name
<strong>1. Essential Participants</strong>
43 Version 2 Pty Ltd
Curtin University of Technology
Department of Natural Resources and Mines, QLD
Ergon Energy Corporation Limited
Geoscience Australia
Department of Finance and Services, Land and Property Information, NSW
Landgate, WA
Queensland University of Technology
The University of New England
University of Canterbury
Department of Environment, Land, Water & Planning, VIC
<strong>2. 43pl Members</strong>
AAM Pty Ltd
Alexander Symonds Pty Ltd
Amristar Solutions Pty Ltd
BioMedware Incorporated
Business Aspect Pty Ltd
Brazier Motti

Participant's Name
Brown & Pluthero Pty Ltd
C R Kennedy & Co Pty Ltd
Eco Logical Australia Pty Ltd
e-Spatial Ltd
ESRI Australia
EOMAP GmbH & Co.KG
Fugro LADS Corporation Pty Ltd
Fugro Spatial Solutions Pty Ltd
Gaia Resources
GHD Pty Ltd
GPSat Systems Australia Pty Ltd
Insight GIS
Land Equity International Pty Ltd
Leica Geosystems Pty Ltd
Lester Franks Survey & Geographic Pty Ltd
Mercury Project Solutions Pty Ltd
Milne Agricultural Group
NGIS Australia Pty Ltd
Omnilink Pty Ltd
Fugro Satellite Positioning Pty Ltd
FARMpos Pty Ltd (Precision Agriculture)
Photomapping Services
PSMA Australia Ltd
Position Partners Pty Ltd
RPS Australia East Pty Ltd
Jacobs Group (Australia) Pty Ltd
Spatial Information Technology Enterprises Ltd
Spatial Vision Innovations Pty Ltd
Sundown Pastoral Co Pty Ltd
Superair
Think Spatial
Trimble Navigation Australia Pty Ltd
Twynam Agricultural Group Pty Limited
VPAC Ltd
Whelans (WA) Pty Ltd
Semantic Sciences Pty Ltd

Participant's Name
<b>3. Support Partners</b>
Australian Geospatial Organisation
Department of Health, WA
Land Information New Zealand
Office of Environment and Heritage, NSW
Delft University of Technology
Energex Limited
Open Geospatial Consortium Inc
Murray-Darling Basin Authority
Royal Melbourne Institute of Technology University
Swinburne University of Technology
Telethon Kids Institute, WA
The University of New South Wales
University of Melbourne
Western Australian Agricultural Authority
Wuhan University



## Resources

To learn more about the CRCSI and its work, please visit [www.crcsi.com.au](http://www.crcsi.com.au) – the website is a rich resource for the spatial information industry in its content and hosts a range of publications and reports.

### KEY CONTACTS

The following team members are key contacts for the CRCSI. Additional contacts across the organisation can be found at [www.crcsi.com.au/about/our-people](http://www.crcsi.com.au/about/our-people)

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#### RESEARCH DIRECTOR

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Cooperative Research  
Centres Programme

