

Researchers collaborate on marine survey in Northern Australia

Geoscience Australia scientists recently teamed up with researchers from the Australian Institute of Marine Science (AIMS) to carry out a seabed mapping survey in the eastern Joseph Bonaparte Gulf off the coast of Australia's Northern Territory.

This survey was part of a three-year collaboration between the two organisations involving marine surveys off northern Australia using

Geoscience Australia's shallow water multibeam sonar system and AIMS' research vessel *RV Solander*.

The eastern Joseph Bonaparte Gulf was selected because its seabed environments are representative of the shallow banks and shoals and intervening channels common across the whole Gulf and, more broadly, the northern Australian shelf.

Environments spanning the outer to inner shelf in the gulf were mapped using the multibeam sonar system. This revealed a complex seabed characterised by shallow carbonate banks dominated by sponge gardens and deep channels (figure 1). There was

Table 1. Data and samples collected during the survey.

Data type	Total recovery
Geophysical data	
Square kilometres of multibeam sonar	1150
Line kilometres of sub-bottom profiler data	340
Samples	
Rock dredges	3
Surface grabs	118
Camera tows	45
Rotary cores	4
Vibrocore	16
Boxcores	2
Benthic sleds	45
Conductivity, turbidity and depth casts	23

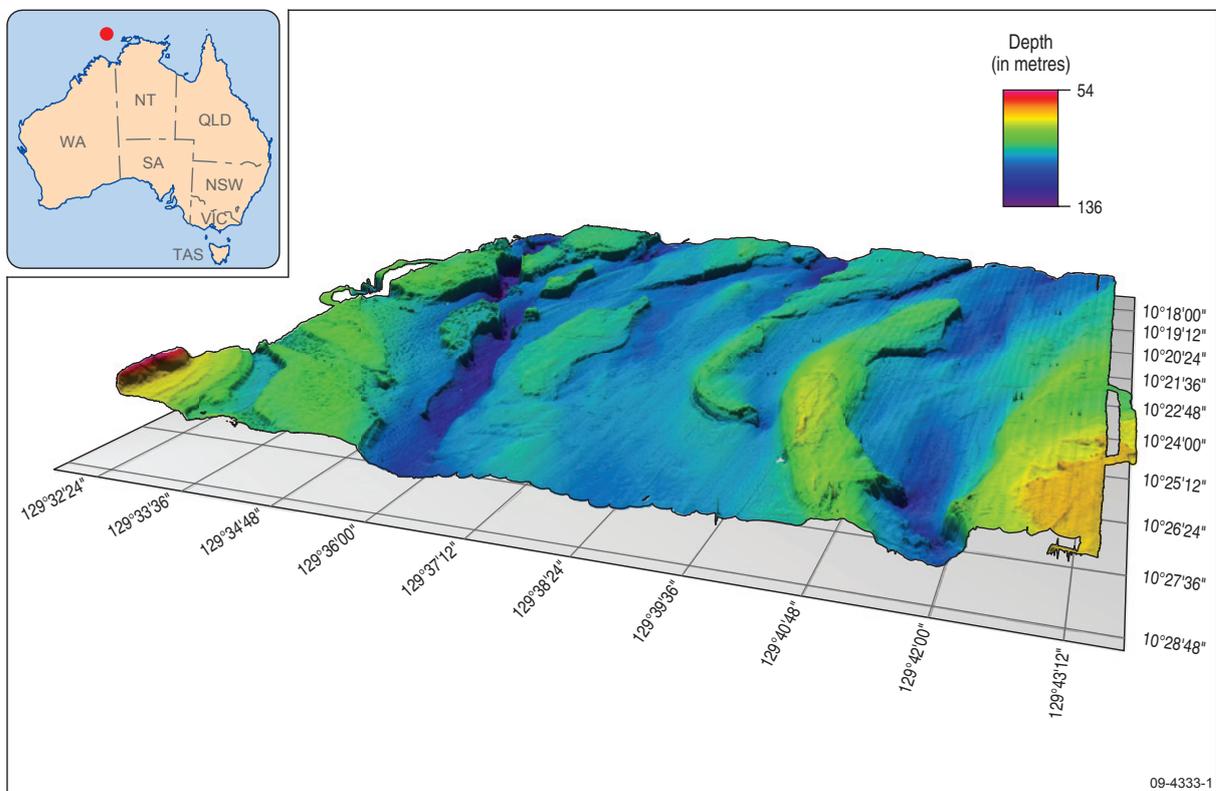


Figure 1. Perspective view of previously unmapped elongate banks and intervening channels on the eastern Joseph Bonaparte Gulf outer shelf.

also evidence of significant sediment transport across the banks. Seabed environments in a 200 metre deep channel were also mapped for the first time.

The survey also collected geological and biological samples as well as wave and tide current data and underwater video footage of seabed habitats. These data will help improve our understanding of seabed environments and habitats in the Joseph Bonaparte Gulf.

Information and data collected on the survey will be used to support the work programs of the Department of Resources, Energy and Tourism and Department of the Environment, Water, Heritage and the Arts. Data collected on the survey will be combined with existing data covering the whole Joseph Bonaparte Gulf to provide

a regional picture of seabed environments that can potentially be used to support resource development by industry and to characterise proposed marine protected areas.

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Mapping the shallow-water bathymetry of the Great Barrier Reef

Australia's Great Barrier Reef covers in excess of 340 000 square kilometres and stretches for 2 600 kilometres along the eastern coast of Queensland, making it the largest coral reef in the world. The reef provides a significant economic contribution at both the state and national levels, primarily through the tourism and fishing industries, whilst also being the focus of considerable conservation and environmental management efforts. One of the important fundamental datasets for stakeholders in all of these activities is bathymetry or water depth.

Mapping the variable bathymetry of such a large marine area presents a number of challenges, both in terms of cost and practicality. Traditional ship-based methods, such as multi-beam sonar, are restricted to depths below about 15 metres and the cost of conducting such surveys can be prohibitive, particularly in remote areas. Laser Airborne Depth Sounding (LADS) is often used as a high-resolution bathymetry mapping tool, particularly in shallow water (between zero and 20 metres depth), to complement ship-based survey data. However, the acquisition of this data is costly, and not suited to the widely dispersed shallow water reef areas that characterise many areas of the Great Barrier Reef.

One alternative is the use of satellite imagery from the Japanese Advanced Land Observing Satellite (ALOS) operated by the Japan Aerospace Exploration Agency (JAXA). Data from the Advanced Visible and Near Infrared Radiometer Type 2 (AVNIR-2) sensor, offers a cost-effective tool to develop broad-scale shallow water bathymetry mapping techniques. In particular, the AVNIR-2 data is characterised by a large spatial coverage (a 70 kilometre swath width) and a high ground pixel resolution of 10 metres. This means that most of the Great Barrier Reef could be covered in approximately 25 ALOS scenes, while still retaining the fine-scale reef features.

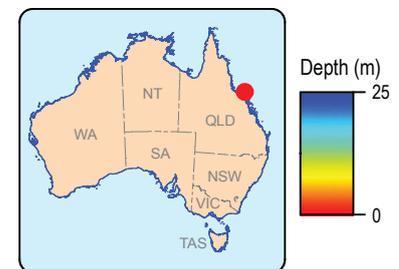
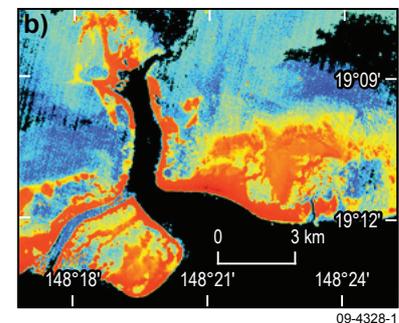
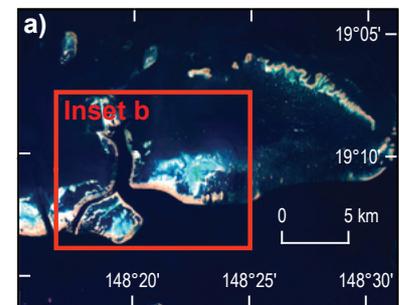


Figure 1. Bathymetry around Dingo Reef No. 1, Great Barrier Reef, derived from ALOS AVNIR-2 data.

The majority of available techniques using remote sensing to derive water depth have been based on empirical methodologies. These require known measurements over a range of depths in the study area to calibrate the algorithms being used. This becomes problematic in remote or extended areas, such as those in the Great Barrier Reef, where there is no available depth data for shallow areas.

To overcome this problem, researchers from Geoscience Australia are testing the use of a physics-based algorithm, which can derive bathymetry from the remote sensing signal without the need for known calibration depths. Assessment of the use of this technique with AVNIR-2 data has enabled the evaluation and development of mitigation solutions for problems such as excessive sun-glint, and the effect of reduced radiometric resolution with increasing depth.

Preliminary results have shown that this technique can derive shallow-water bathymetry to depths of approximately 20 metres,

which would deliver a valuable output to internal and external stakeholders engaged in environmental and economic research involving the Great Barrier Reef. This has the potential to develop into a broad-scale mapping capability across the agency.

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Smartline—mapping Australia’s coastal geomorphology

There is a growing need to identify those areas in Australia’s coastal zone which are potentially vulnerable to the impacts of climate change (Abuodha and Woodroffe 2006).

The Smartline, developed by the University of Tasmania and managed by Geoscience Australia, is a fundamental dataset commissioned by the Australian Government Department of Climate Change for their National Coastal Vulnerability Assessment (NCVA). The Smartline represents the first attempt to consistently map the coastal geomorphology and physical stability of the entire

Australian coastline. The mapping of coastal substrates and landforms which have varying sensitivity to the impacts of climate change and sea level rise (such as erosion, slumping, rock falls, and dune mobility hazard), is a key component of a coastal vulnerability assessment.

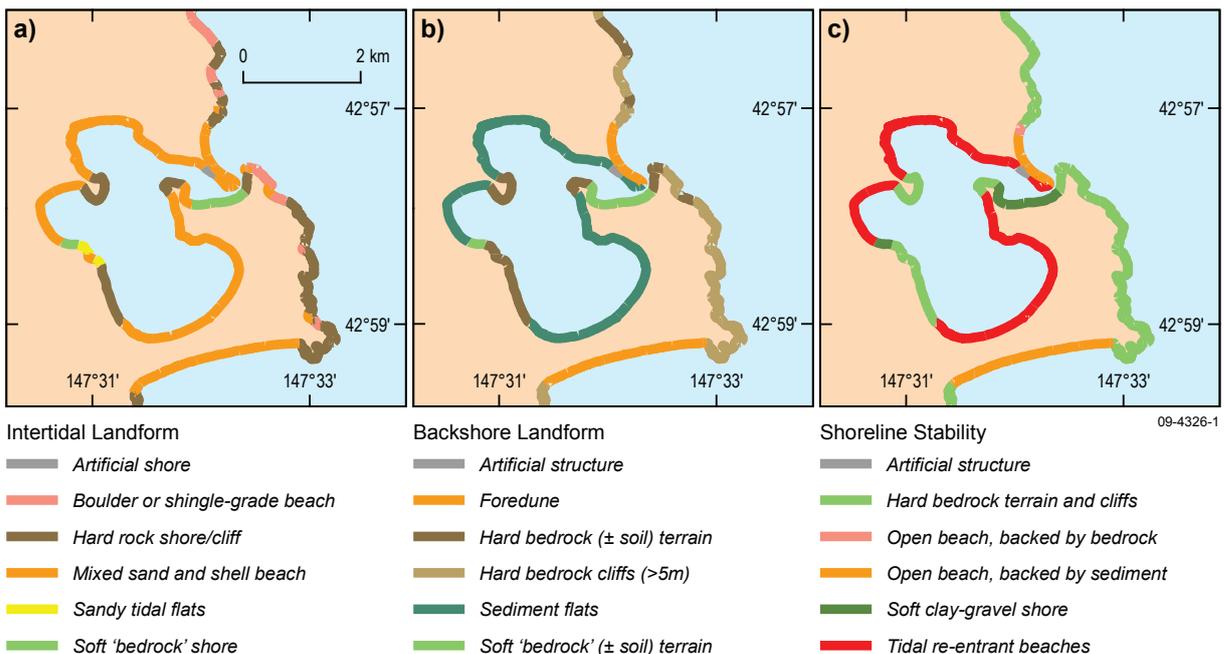


Figure 1. Simplified example of the Smartline intertidal landform, backshore landform and coastal stability classes.

Based on an approach developed by Sharples (2006) and expanded to incorporate the range of coastal landforms around Australia, the Smartline is a GIS format polyline that represents Australia's coastline at the mean high-water mark. The map was compiled by transferring information from over 200 pre-existing datasets (covering geology, habitat and geomorphology) onto a detailed coastline (figure 1). Using this information the Smartline is segmented each time a change in the geology, exposure, subtidal, intertidal, or backshore environment of the open coast occurs. By querying the landform and substrate information, sensitivity fields have been added to the dataset. These fields identify the potential susceptibility of each coastal segment to erosion and physical instability. By identifying soft (erosion-prone) coasts the Smartline has proved a useful tool for a first-pass coastal vulnerability assessment.

The Smartline has many uses for environmental planning, climate change adaptation and hazard assessment. The Smartline has made the first national identification of shorelines that are potentially susceptible to the impacts of climate change possible. It has also allowed for the identification of assets that are located within the vicinity of these potentially vulnerable shoreline types. Further, the Smartline has demonstrated the usefulness of geomorphology mapping to our understanding of how the coastal zone will respond to the impacts of global climate change such as sea level rise and an increased number of storms. Future development will focus on the addition of landform attributes for Australia's estuaries and coastal waterways.

Flood modelling tools reviewed

The average annual cost of floods to the community (excluding death and injury) over the period 1967 to 2005 has been estimated at \$377 million. When compared to the cost of severe storms, cyclones, earthquakes and bushfires they are Australia's most costly natural hazard (BITRE 2008). The development of tools, databases and models to support the identification and analysis of flood risk is therefore an important first step in reducing the cost of floods to the community. Two recent Geoscience Australia reports reviewed two flood modelling tools, the Australian Flood Studies Database and the inundation modelling tool ANUGA. The reviews were compiled following stakeholder consultation during 2008 and 2009 which sought feedback on the usefulness of these tools and explored options for their future development.

The Australian Flood Studies Database

Government and industry expend considerable resources to define flood areas in an effort to reduce the impacts of floods. This work usually includes the creation of reports detailing the methodology

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References

Abuodha PA & Woodroffe CD. 2006. International Assessments of the Vulnerability of the Coastal Zone to Climate Change, Including an Australian Perspective. Report to the Australian Greenhouse Office (now Department of Climate Change).
Sharples C. 2006. Indicative Mapping of Tasmanian Coastal Vulnerability to Climate Change and Sea-Level Rise: Explanatory Report 2nd Edition. Report to Department of Primary Industries & Water, Tasmania.

Related articles/websites

Smartline–National Coastal Landform and Stability Mapping Tool

www.climatechange.gov.au/en/publications/coastline/climate-change-risks-to-australias-coasts.aspx

OzCoasts website

www.ozcoasts.org.au



used, data sources and the results of the modelling. Though numerous reports are produced each year, there was

no centralised record of relevant studies undertaken in Australia at a state/territory or national level until 2004. The Australian Flood Studies Database was developed to address issues raised in the Council of Australian Governments' review of natural disasters, particularly the consistency of data collection and risk assessment. The database was made publically available through Geoscience Australia's website in 2006 following requests from local government.

Geoscience Australia reviewed the Australian Floods Studies Database in 2009 via an online questionnaire to determine if there was continued support from stakeholders. Three main recommendations were drawn from the survey responses and will be implemented with whole-of-government support. The major recommendations are that:

- the Australian Flood Studies Database is regularly updated and that the lead agency for floodplain management in each state or territory be responsible for updating at least annually
- the database's existing functionality and content is maintained and further enhanced (such as the addition of full reports)
- the database is further publicised.

The inundation modelling tool ANUGA

Geoscience Australia has also been leading the development of a software tool for modelling of two-dimensional water flows such as those arising from tsunami inundation. ANUGA is a collaborative effort of Geoscience Australia and the Australian National University and has gained increasing interest as a free and open source flood model. The development of ANUGA for flood modelling purposes has been guided and furthered through close consultation with a number of local government and consulting engineers.

The report highlights case studies where ANUGA has been used for flood modelling. This paper also makes two broad recommendations, including further:

- model validation and model comparison
- development of the ANUGA software to make it comparable with other two-dimensional flood models. The main priorities include the ability to model structures (culverts, pipe networks and bridges), the addition of a kinematic viscosity term and the inclusion of discharge as an inflow boundary condition.

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References

BITRE (Bureau of Infrastructure, Transport and Regional Economics). 2008.

About Australia's regions. Canberra. Available at:

www.bitre.gov.au/publications/38/Files/RegStats_2008.pdf

Related websites/articles

Review of the Australian Flood Studies database (Geoscience Australia Record 2009/34)

https://www.ga.gov.au/products/servlet/controller?event=GEOCAT_DETAILS&catno=69365

Investing in the development of an open source two-dimensional flood modelling capability (Geoscience Australia Record 2009/36)

www.ga.gov.au/products/servlet/controller?event=GEOCAT_DETAILS&catno=69370

National catalogue of flood studies

www.ga.gov.au/products/servlet/controller?event=GEOCAT_DETAILS&catno=61818

AusGeo News 82: New riverine flood hazard and risk studies available

www.ga.gov.au/ausgeonews/ausgeonews200606/productnews.jsp#product4