National Elevation Data Framework
REPORT OF OUTCOMES
from the National Workshop 'Preparing for the high-resolution future of digital elevation models in Australia' held 18 March 2008.

Preamble

The background to this national workshop, '*Preparing for the high-resolution future of digital elevation models in Australia*' has been previously identified.[1] The need largely resulted from inadequacies in, or the absence of, a national system of acquiring, distributing, and archiving data pertaining to elevation. This is particularly true of the land-sea interface. The drivers for the workshop arose from the Australian Greenhouse Office and ANZLIC – the Spatial Information Council[2] who responded to identified inadequacies in the present knowledge system that related to issues of coastal vulnerability, mapping of wetlands and other ecosystems.[3]

The two Academies, the Australian Academy of Science and the Australian Academy of Technological Sciences and Engineering were asked to review the draft science and business cases for the development of a National Elevation Data Framework (NEDF) and to organise a public workshop. The goal of the workshop was to 'facilitate exposure of the NEDF Science Case and Business Plan to public scrutiny in an independent environment so that the feedback received would be fairly treated in revised drafts. Because the Academies are involved before, during and after the national workshop, those making public comment will have a higher degree of confidence that their input would be given appropriate treatment'.[4] To achieve these purposes, a Joint-Academies Review Committee was established (Appendix 1).

The workshop itself was preceded by a nation-wide consultative process that largely involved the geospatial community. This was particularly useful for identifying the extent of interest in the proposal amongst the users of elevation data; for identifying the technological capabilities resident within Australia; and for identifying the need for developing an effective framework designed to meet the needs of today and the future. The documents prepared for the workshop included a Science Case[5] and a Business Plan[6] and the Joint-Academies Review Committee commented on

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[1] ANZLIC – the Spatial Information Council, 15 February 2008, 'Background Paper prepared for the National Workshop Canberra, 18 March 2008, National Elevation Data Framework, the Shared Digital Representation of Australia's Landform and Seabed'. Available at: http://www.anzlic.org.au/nedf.html

[2] Letter addressed to the President of the Australian Academy of Science – Kurt Lambeck from Ian Batley of ANZLIC, 11 July 2007. 'Development of the nationally coordinated DEM'.

[3] Council of Australian Governments, National Climate Change Adaptation Framework including the potential action 'develop a national digital elevation model (DEM) for the whole of Australia, with vulnerable regions being mapped using very high resolution images. This would involve linked topographic and bathymetric information at a resolution relevant to decision-making.' The Australian Greenhouse Office is developing this initiative as part of a broader programme of work on coastal vulnerability to climate change impacts under the auspices of the Natural Resource Management Ministerial Council.

[4] ANZLIC – the Spatial Information Council, 26 October 2007, Version 3, 'National Workshop Planning - National Elevation Data Framework, the Shared Digital Representation of Australia's Landform and Seabed'.

[5] ANZLIC – the Spatial Information Council, 20 February 2008, 'Revised Draft Science Case, National Elevation Data Framework, the Shared Digital Representation of Australia's Landform and Seabed'. Available at: http://www.anzlic.org.au/nedf.html

both these drafts. Without endorsing them specifically, the Committee then agreed that revised versions could go forward to provide the basis for discussion at the public workshop.

This report summarises the main outcomes of the workshop and recommendations from the Joint-Academies Review Committee.

Overview

There was broad agreement at the national workshop that the purpose of the NEDF was to develop a framework for quality elevation data[7] that would describe the landform and seabed of the Australian continent (including shelves and territories). The workshop was not about recommending a particular technology to perform a specific task at a specific point in time.

It was concluded that the framework must be comprehensive, effective and accessible. It must also be implemented at a level of accuracy and resolution that will meet: (i) local and national needs, including scientific requirements; and (ii) meet these needs now and well into the future. Another important feature was that it must be accessible to both the provider and user of elevation data.

The primary arguments for the NEDF, described in terms of meeting such needs for today and decades ahead, involve both scientific and applied components that in most instances cannot be separated. These include:

- The assessment of coastal vulnerability in a climate change environment;
- The modelling of tsunami and storm surge impacts on coastal environments;
- The mapping of drainage systems for water availability and distribution evaluation;
- Mapping of wetlands and other ecosystems;
- Landscape evolution and vegetation mapping, including carbon accounting; and
- Direct applications in engineering, communication, and transport industries.

It was further consistently emphasised at the workshop that any successful NEDF must consider the following:

- The Australian surface is not static and so the time dependence of the elevation data must be considered. This becomes particularly important in the coastal zone where erosion and accretion can be significant and rapid. This implies that it must be possible to resurvey areas with the assurance that all data can be connected back to a well-defined datum.

- The natural reference surface for elevation data is the gravitationally-defined geoid. Thus the definition of the geoid (noting its accuracy must be consistent with elevation measurement accuracy) is necessarily part of developing the NEDF. A related consideration is that the geoid is defined by models which are updated from time to time as more gravity data becomes available and, in addition, the geoid itself may be time-variant.

- The position of the ocean surface is an important element in the definition of the NEDF. This is not only because some elevation measurements are referenced to this surface and the mean sea surface is linked to the geoid, but because the temporal variations in this surface and its implications for the coastal zone are one of the rationales for

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[6] ANZLIC – the Spatial Information Council, 26 October 2007, 'Business Plan, National Elevation Data Framework, the Shared Digital Representation of Australia's Landform and Seabed' Version 3. Available at: http://www.anzlic.org.au/nedf.html

[7] Elevation throughout this document will include heights above sea level as well as positions below sea level. The NEDF will in most of the subsequent discussion include the framework and the actual elevation data along with all supporting information.

improving the NEDF in the first place. This requires knowledge of tides and other oceanographic perturbations of the ocean surface.

- The NEDF must include the offshore zone, in a way that is consistent and removes discontinuities at the land-ocean interface, all the way out to the edge of the continental shelf. Although this inclusion of onshore and offshore areas will present some special problems because measurement techniques are fundamentally different and these activities have often been carried out by different agencies, this cannot be any reason for ignoring the offshore zone.

Not all of these requirements need to be met at the same time as acquisition of elevation data; however, the framework established needs to be able to capture this information in such a way that the user of the data can introduce additional information a-posteriorly. This has implications for the metadata that needs to be collected and recorded along with the elevation data.

Issues of accuracy, repeatability, and long-term framework datum stability all need to be addressed such that the essential geometric measurements can be related to the physical quantities. Furthermore, the framework will need to be able to capture all forms of data – including provision for existing and future requirements and appropriate standards will have to be developed concurrently. It should be recognised that these may evolve as both demands on the system and technological developments evolve.

Specific observations, with which the Review Committee concur, include:

- In view of the vastness of the continent and its offshore zones of interest, and in view of different science and application priorities, it is inevitable that any NEDF will consist of a nested hierarchy of resolutions (e.g. from 10-20 cm in critical coastal zones and in major cities to 5-10m for much of the underpopulated interior) whose priorities will evolve in time. Thus seamless transitions at the edges of the different zones will be important.

- The assessment of precision <u>and</u> accuracy of all data must form an essential part of the NEDF data base. It must be able to capture data of different accuracies, but it is important that this data can be related to the underlying framework with at least comparable accuracy.

- It should be possible for data collected at one location at one point in time to be connected to data from a different location and epoch with the assurance that they both refer to the same reference frame. It is expected that the NEDF will be defined within the framework of the high precision national geodetic reference frame being established by the AuScope National Collaborative Research Infrastructure initiative.

- The framework will need to be able to capture all forms of data – existing and future, including metadata. Some specific information may be required (e.g. connection to an absolute datum) to transform the elevation information into different data forms or reference frames.

- Accessibility to the NEDF and availability of the data by users will be an important requirement, recognising that there will be proprietary and intellectual property issues to be addressed. The expectation would be that, as a minimum, all data collected with public funds or any form of government support will reside in the NEDF[8].

- Because of the national nature of the NEDF and because of the long-term commitments required, access and maintenance of the data base should be administered by a single national agency. Definition of the requirements is a matter of broader input with an expectation that there would be user community involvement,

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[8] A possible model is the Australian gravity data base of Geoscience Australia.

both from the applied and scientific user sectors. The data collection area is one for which there is a major industry role.

The workshop presentations and discussions explored the range of technologies available and raised computational and governance issues. There was a consensus that there are no barriers that would prevent implementation of the framework today even if there may be limitations today for providing some specific data-types in that framework. Technical issues that will require further development include:

- Improvements in automatic analysis algorithms for converting digital surface models (DSMs) to digital elevation models (DEMs)[9];
- Can more effective use be made of satellite imagery and other data types? These include INSAR[10] to measure temporal changes in elevation, including the use of permanent scatterers, and can resolution and accuracy be improved by 'stacking' successive images from repeat orbital passes; and
- Can a solution be found for efficient bathymetric surveys in the surf zone or zones of turbidity where present LIDAR techniques fail?

Conclusions

The workshop provided compelling evidence of the importance of developing a quality NEDF. It also demonstrated the capabilities that exist in Australia that may be directed towards bringing such a framework into existence in a way that will serve the nation well for decades to come. The national need for an urgent development of the framework has been clearly established and the demonstrated technological and scientific expertise in the geospatial industry, government agencies, and research sector means that an effective and efficient framework can be established. The need for a well-developed governance framework as an early step in the development of a NEDF was recognised and supported. In this context good examples of applications are important and necessary to demonstrate the value of high resolution DEMs to government.[11]
On the basis of the presentations and discussions of the workshop, and on the basis of the preceding discussion meetings with user groups, we conclude that:

- **There is a compelling and urgent case for the development of a NEDF across Australia and its offshore areas.**
- **There are no technological impediments to the establishment of a NEDF that will meet present demands, with the exception of information from shallow turbid waters, and one that is capable of evolving to meet future demands.**

To achieve a NEDF that will meet Australia's long-term demands it will be important that Government provides national leadership in initiating the actions required to meet the identified needs.

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[9] DEMs measure the earth's topography. DSMs include the effect of vegetation and buildings. Both are required for different purposes. Some techniques measure one or the other but they may also contain information on both.

[10] Interferometric synthetic aperture radar. See Massonet and Feigel, Revs. Geophys. Planet. Phys., 1998, *36*, 441-500; Hilley et al., Science, 2004, *304*, 1952-1955.

[11] There were a number of diagrams and examples from John Hudson's presentation at the national workshop that could fulfil this purpose.

Appendix 1.
Joint-Academies Review Committee Members

Professor Kurt Lambeck, PresAA, FRS (Chair of Committee)

Kurt Lambeck is President of the Australian Academy of Science and distinguished Professor of Geophysics at the Australian National University. His research interests range through the disciplines of geophysics, geodesy and geology with a focus on the deformations of the Earth on intermediate and long time scales and on the interactions between surface processes and the solid earth. His early research was in satellite geodesy and he participated in many of the early developments that have led to today's satellite geodesy capabilities. Past research areas have included the determination of the Earth's gravity field from satellite tracking data, the tidal deformations and rotational motion of the Earth, the evolution of the Earth-Moon orbital system, and lithospheric and crustal deformation processes. His recent work has focused on aspects of sea level change and the history of the Earth's ice sheets during past glacial cycles, including field and laboratory work and numerical modelling.

Professor Lambeck has been at the Australian National University since 1977, including ten years as Director of the Research School of Earth Sciences. He is currently also strategic science advisor to National Geospatial Reference System of Geoscience Australia. He was elected to the Australian Academy of Science in 1984 and to the Royal Society in 1994. He is a foreign member of the Royal Netherlands Academy of Arts and Sciences (1993), Norwegian Academy of Science and Letters (1994), Academia Europaea (1999), and the Académie des Sciences, Institut de France (2005). He has received a number of prestigious international prizes and awards.

Mr Robert Smith, FTSE

Bob Smith is currently Principal Consultant for Greenfields Geophysics and is widely recognised for fostering research, training and education through his activities in professional bodies such as AusIMM, Australian Society of Exploration Geophysicists and the Society of Exploration Geophysicists. He was elected to the Australian Academy of Technological Sciences and Engineering in 1994. Bob has provided national leadership that has transformed mineral exploration geophysics in Australia to a profession with a major impact upon world practice and upon Australian mineral reserves. In particular, he has stimulated research in many institutions such as the University of Melbourne, Monash University, and CSIRO greatly advancing the science and technology of exploration.

Bob was formerly Chief Geophysicist for CRA Exploration and Chief Consultant – Geophysicist for Rio Tinto. He has served as a member of advisory councils to CSIRO (Division of Mineral Physics), AGSO and CRCAMET. As a consultant, he has worked in many countries and with a range of clients including companies and government agencies.

Professor Bruce Thom, FIAG, FTSE

Bruce Thom is a well-recognised expert in coastal management, coastal land use planning, geomorphology, and coastal geology. He has held academic positions at the Australian National University, University of New South Wales at Duntroon, and the University of Sydney. He has also been a senior university administrator and President of the Institute of Australian Geographers. He is currently a member of the Wentworth Group of Concerned Scientists and an author of the Group's report *Blueprint for a Living Continent* published in July 2003 as well as the *Brigalow Declaration of November 2003* about land clearing in Queensland. He is Emeritus Professor at the University of Sydney and also visiting Professor at the Faculty of Built Environment of the University of New South Wales.

Professor Thom was Former Chair of the Australian State of the Environment Committee, and also Chair of the New South Wales Coastal Council. He served as Vice Chancellor at the University of New England and is a former Pro-Vice Chancellor of the University of Sydney. The Institute of Australian Geographers awarded him its Griffith Taylor Medal in 2004 for distinguished and sustained contributions to geography in Australia.

Dr John Zillman, AO, FAA, FAIP, FTSE

John Zillman was a former President of the Australian Academy of Technological Sciences and Engineering (2003-2006) and President of the World Meteorological Organization (1995-2003). He was President of the National Academies Forum (2005-2006) and President of the International Council of Academies of Engineering and Technological Sciences (CAETS) in 2005. He is a world leader in the science and management of meteorology. Dr Zillman is recognised for his distinguished service on a wide range of national and international panels and advisory bodies dealing with science policy. He served two terms as President of the World Meteorological Organisation, and was Principal Delegate of Australia to the Intergovernmental Panel on Climate Change from 1994 to 2005.

Dr. Zillman holds a Bachelor of Science (Honours) in Physics and a Bachelor of Arts (Political Science and Public Administration) from the University of Queensland; a Master of Science (Meteorology) from the University of Melbourne; and a Doctorate of Philosophy (Meteorology and Oceanography) from the University of Wisconsin-Madison (US).

He was Director of the Australian Bureau of Meteorology from 1978 to 2003 and Chairman of the Commonwealth Heads of Marine Agencies from 1994 to 2003. Dr. Zillman was also a member of the Prime Minister's Science, Engineering and Innovation Council (PMSEIC).