

IUGS' Secretary General's report to AGC meeting 4 February 2013

The first five months of the new IUGS Executive Committee (EC) have proved to be interesting and productive. The fact that the EC is largely new, made it quite difficult to get across everything. To help all members of the EC come to grips with how the Union operates and the issues it has to deal with, I have spent considerable time preparing a comprehensive Reference Manual (extracts from an early draft were tabled at October AGC meeting).

China's increased involvement in IUGS, in providing the Treasurer and Secretariat is working out well.

Amongst the actions to date are:

1. The first meeting of the Bureau (President Roland Oberhaensli, Treasurer Dong Shuwen and Secretary General Ian Lambert) was held in Beijing, in association with opening the new Secretariat;
2. A submission was made concerning TOR for the International Council for Science (ICSU) review;
3. Reviews were conducted of the joint IUGS-UNESCO programs, International Geoscience Program (IGCP) and Geoscience Applications of Remote Sensing (GARS);
4. Discussions with UNESCO on future collaboration, including on Global Geoparks;
5. The new Publications Committee was appointed, chaired by Brian Marker;
6. Initial scoping was conducted for a new initiative on mineral resources for future generations (ATTACHMENT 1);
7. Initial planning was conducted for a joint IUGS-Geological Society of Japan international workshop on tsunami in September 2013;
8. Approval was given for the International Commission for Stratigraphy's recommended the type section for the Santonian Stage;
9. IUGS renewed its agreement with OneGeology;
10. Organised annual meeting of the new EC, Paris, February 2013
11. Planning commenced for a significant IUGS presence at the GSA Annual Assembly in Denver in late October, including potential keynote address to launch IUGS' proposed new initiative Resourcing Future Generations, interactions with Affiliate Members and holding of a Bureau meeting;
12. Paper (ATTACHMENT 2) on *Scientific Advice Underpinning Decisions on Major Challenges* accepted for publication in Episodes; to be discussed at ICSU's Unions meeting in April in the context of the Council's major new initiative: Future Earth.
13. Interacted with the new IUGS Task Group on Global Geoscience Professionalism on geoethics. [AGC members should consider involvement in the activities of TGGGP, which covers professional accreditation, resource reporting, etc.]

Aside from my IUGS duties, Carillon and I have been working on the major task of completing the 34 IGC Proceedings. I am in the process of integrating material I have prepared into the basic framework. The objective is to finish the report and circulate it to the Organising Committee meeting ahead of our final meeting (possibly the week before Easter). Costs involved are already in the 34 IGC budget.

Dr Ian Lambert: ian.lambert7@gmail.com

ATTACHMENT 1: A proposed new IUGS' Initiative – Resourcing Future Generations

DRAFT CONCEPTUAL OUTLINE, WITHOUT PREJUDICE

There is a lot of activity internationally aimed at discovering new mineral and energy resources in the short and medium term, but less focus on what needs to be done now to address the challenges faced in finding the vast resources mineral resources that will be required to meet the needs of future generations given the burgeoning global population and the aspirations of emerging nations.

By drawing on its strengths and membership, the International Union of Geological Sciences (IUGS) is planning an initiative aimed at guiding mineral exploration in the longer term = a high proportion of which will be in developing nations, which currently have limited geoscience capacity. Evaluations by USGS and others of the potential for undiscovered mineral resources have concluded that there are many underexplored regions which have good mineral potential, as far as can be assessed from the generally limited information available.

The IUGS has very broad international membership and strengths in running international collaborative projects, geology, maps, education/training, data management, remote sensing and geoscience professionalism. These mean it is ideally placed to enhance relevant geoscience capacities where needed.

Further, the formative Global Geoscience Initiative (GGI) includes a resources component, which has a medium term perspective, and there have been recent in principle discussions about collaboration between IUGS and GGI in the Resourcing Future Generations initiative. Further, the GSA, SEG, SGA, IAGOD and other societies affiliated with IUGS have been invited to consider involvement in detailed scoping of this Initiative.

A presentation, being prepared to introduce this Initiative, will set the scene by considering demand and supply scenarios beyond 2030 and summarising some constraints which will need to be overcome to secure adequate supplies. It will discuss how these constraints can be addressed, including through: (i) building geoscience capacity as a means to get better geological information and enhanced assessments of mineral resource potential in many "promising" regions of the world; (ii) pursuing enhanced applications of satellites for exploration and assessments of environmental conditions through influencing specifications and research on data acquired (particularly through GEO/GEOSS). A "Future Resources Summit", in 2014 in China, will bring together international experts from government agencies, academia and industry. This will involve detailed discussions with a view to maximising interest and involvement, reaching agreement on priority activities and funding arrangements.

ATTACHMENT 2: Article accepted for publication in *Episodes*

Scientific Advice Underpinning Decisions on Major Challenges

Dr Ian Lambert, Secretary General International Union of Geological Sciences and Senior Advisor to Australian Geoscience Council: ian.lambert7@gmail.com

Dr Phil McFadden, Scientific Strategy Consultant: mcfadden@grapevine.com.au

Abstract

It is important that scientific advice is taken into account in making decisions directed at meeting the needs of the rapidly increasing global population and the aspirations of developing nations, while sustaining Earth systems. However, this has not commonly been the case - it is an all too frequent complaint of scientists, particularly geoscientists, that their advice has not been sought, or ignored.

Better community education and ubiquitous rapid communication are resulting in increasing questioning of what are perceived as poor decisions and policies. As a consequence, many governments and other key decision makers are now more amenable to supporting constructive proposals for provision of authoritative scientific and technical advice to guide their responses to major challenges.

This paper discusses how effective mechanisms can be developed for provision of authoritative scientific and technical advice to decision and policy makers and illustrates this in relation to Australia where scientific inputs are now routine. It also emphasizes the need to ensure that all of the information and monitoring required for authoritative advice is available.

The International Council of Sciences' (ICSU's) new program, Future Earth, will provide an excellent platform for international coordination and action to drive consideration of scientific advice, tempered by social and economic considerations, in addressing major challenges.

Introduction

Addressing some of the major challenges facing humankind requires geoscience inputs. For example, geoscience and geospatial information underpins the solutions to challenges associated with finding mineral and energy supplies to sustain a growing population; understanding and managing groundwater systems; minimizing soil degradation and loss; decisions on competing land uses; pollution and environmental health; addressing the impacts of climate change/variability; building megacities and major infrastructure; mitigating the impacts of geohazards and better emergency management.

The opportunities for scientists to influence important policies and decisions have been limited and fraught with difficulties. They have been brought into the international spotlight in the last few years as some serious questions have been asked, such as:

- Why was the existence of major paleo-tsunami deposits along the east coast of northeastern Honshu not factored into risk scenarios in this region, with disastrous consequences for the Fukushima nuclear power plant and coastal communities in the region more broadly?
- What are the ramifications of the conviction of Italian scientists and engineers for manslaughter, stemming from public statements preceding the L'Aquila earthquake?

There are at least two principal requirements for achieving routine consideration of scientific and technical inputs before decisions and policies are made on major contemporary and emerging issues:

1. Establishing effective lines of communication for providing advice into government and other decision makers, including flexible, interactive approaches and an economic and social basis for the acceptance of advice.
2. Enhancing the information base for decision-making through international coordination and support for approaches using high-quality multidisciplinary systems-science that takes advantage of ongoing advances in computing power and in data management and access;

This paper succinctly discusses how these requirements can be achieved. It covers in order government funding and expectations of research, developing effective mechanisms for advising governments, and enhancing the information base to underpin advice. Three Appendices provide more examples and further information: Appendix 1 provides an example of economic and social considerations; Appendix 2 provides an example, from Australia, of effective arrangements in place for routine provision of geoscientific and technical advice to guide important decisions; and Appendix 3 illustrates the value of looking into what needs more attention in current international initiatives to underpin good decision-making, based on mitigating the impacts of tsunamis.

Scientific research and governments

Scientific research is, to a large extent, government-funded. Governments provide this funding because they have the expectation that this investment in knowledge generation will enrich the social and economic fabric of the nation. Yet it is a persistent and frequent complaint from scientists, particularly those in the Earth and Earth-Systems sciences, that their advice is ignored by government.

Clearly there is a clash of cultures and expectations. Scientists tend to see their hard-won knowledge as an absolute because it is knowledge about how the natural system works and that system cannot be changed by opinion polls or political ideologies. Consequently, many scientists feel that their advice should be accepted as given and that it should be paramount in any decision-making process. Conversely, governments consider the (often short-term) economic, legal and social impacts of their policies and the scientific advice, if considered at all, becomes merely one of a mélange of factors contributing to the decision-making process. This is not unreasonable, because the electorate expects their government to make decisions that the electorate considers to be economically and socially responsible. This means it is commonly necessary for scientists to work with economists and social scientists to develop messages that can be appreciated by decision-makers.

For contentious, recurring issues, governments appreciate formally agreed guidelines developed by experts in consultation with interested parties, which can be used in responding promptly when such issues arise.

Establishing effective mechanisms for providing advice

China is unique in having a strong geoscience profile in government. The Geological Society of China is well organized and many senior government officials are members – from Wen Jiabao to various Ministers – because they were trained in the geosciences.

In other countries, the geosciences have variably lower visibility. It is common at scientific meetings to hear leading scientists calling for governments to heed their advice and to provide more funding for research. But more proactive approaches are needed. Putting effective lines of communication in place for evidence-based decisions takes strategic planning, high-level networking, good powers of persuasion, persistence and demonstration projects. In many cases, the mechanisms developed will involve groups of broadly-based scientists working in government who are willing to focus on

practical applications of scientific data and research, can see “the big picture”, are good communicators, are attuned to the work of academic and other research groups across all relevant disciplines.

Advisory groups need to keep abreast of all relevant research, data and issues; be aware of any limitations in data or knowledge; prepare authoritative papers on trends, options and opportunities; organize projects to demonstrate capabilities; and communicate regularly in appropriate ways with key decision makers. They should be prepared to have their advice subjected to peer review. Where appropriate they should be leading participants in formal processes to develop national approaches, guidelines and standards.

Economic and social basis for acceptance of the advice.

Scientists typically deal with developing the knowledge necessary to understand how natural (usually complex rather than just complicated) systems operate. Governments typically deal with developing policy to achieve appropriate economic and social outcomes.

For there to be an effective communication it is usually necessary for the consequences of actions, as elucidated by scientific endeavour, to be articulated in terms of economic and social impact so that governments have an understanding of the actual social and financial commitments that they might be making by putting in place policies that respond to the scientific advice. This is discussed further in Appendix 1.

Flexible, interactive approaches to provision of advice

Because of the pervasive influence of politics, decisions are more often than not about careful compromise rather than bold, decisive policy action. The science community has to recognise that decision-makers take into account a wide range of issues and interests and that the scientific advice is, unfortunately, often in competition with these other issues and interests.

Hence, even when there is a suitable platform for supporting decisions, it is necessary to avoid providing advice in an absolute way. This makes it difficult to find a suitable compromise and so the scientific advice often gets left out entirely, leading scientists to complain bitterly. It is often a better outcome to get a scientific foot in the door through initial compromise and then gradually grow the influence of the scientific advice.

In order to get their knowledge to have an impact on high-level decisions, scientists should strive to acknowledge any shortfalls in information and provide the knowledge system that will allow a decision-maker to ask questions of the form “What will be the consequences if I make such and such a decision?” and “What would be the likely consequences if I make the decision with these compromises?” The answers to such questions can allow all the knowledge, different competing interests and the consequences to be taken into account in reaching an effective decision.

The costs of engaging governments

Putting the above into place does not come for free; there is a cost in time, resources and actual financial commitment. Not surprisingly, governments are often more willing to fund areas of knowledge generation where there is evident social impact. Experience shows that if scientists put in the effort and resource to build effective communication with government then their advice has a far higher likelihood of being accepted, then being manifest in policy and then in having positive social impact. Governments then tend to look positively at providing more funding into that area of scientific endeavour.

Hence, scientists should recognise the building of effective communication channels as a strategic investment in their own future. They should also be arguing for funding to help build those channels.

Australia has been unusually successful in achieving an effective system for injecting science into major decisions and policies. This example is described in Appendix 2.

Enhancing the information base for decision-making through international coordination

As many of the challenges and approaches are global, it is important that there be authoritative international coordination and support for enhancing the information base for decision-making, through comprehensive approaches employing high-quality multidisciplinary systems-science which takes advantage of ongoing advances in computing power and in data management and access.

The International Council for Science (ICSU; <http://www.icsu.org>) acts as the main representative and facilitator of international science, across disciplinary boundaries in order to encourage research and scholarship in those areas that require a multidisciplinary approach. Further it issues positions on topics that are controversial to some, but in which scientists have a firm opinion.

Accordingly, ICSU and its Unions are well positioned to play pivotal roles in ensuring that: (i) holistic approaches are applied increasingly to achieve real progress in addressing major challenges; (ii) all important data are being collected and are available; and (iii) there are up-to-date authoritative statements available in relation to dealing with global challenges. Cross-disciplinary collaboration is important - the expertise and research needed generally require geoscientists working with mathematicians, computer scientists, chemists, physicists, environmental and social scientists, and economists. Further, data and infrastructure for managing, modeling and simulation must be readily available to those who need them.

ICSU's major new initiative, Future Earth (<http://www.icsu.org/future-earth>) offers an ideal opportunity to for the Council to entrench its role in international facilitation and coordination roles in enhancing knowledge and understanding to underpin important decisions in relation to meeting societal needs while maintaining Earth systems.

The importance of taking stock of what is happening globally and identifying important gaps in information which are limiting the effectiveness of advice is illustrated with regard to tsunami in Appendix 3.

Concluding remarks

Earth scientists often complain that governments are adverse to accepting their advice. This does not have to be the case. When a sensible, coordinated approach is developed, governments will take account of advice that is presented in a way that is understandable and useful for policy creation, and willing to fund the scientific work necessary to create that advice. This will normally involve advisory groups working with government, comprising broadly-based scientists, who consult with social scientists and economists.

There should be international coordination and support for multidisciplinary systems-science addressing major global issues. ICSU is uniquely well-placed to achieve this through its Unions and member states, particularly in developing and implementing its Future Earth program. This would minimize duplication, set priorities, ensure that the information base for decision making is comprehensive and facilitate authoritative position statements. The time is right, given increasing public concern about poor decisions, and the advances in computing power, data management and access which make it possible to use and integrate data in ways that were not previously possible.

Appendices: Additional Information and Examples

Appendix 1: Exemplifying the economic and social basis for acceptance of advice

As scientists we have to accept that there are many instances - for example, the location of radioactive waste stores - where governments have accepted and acted upon scientific advice only

to have those actions become electorally toxic because the public-at-large had not accepted the scientific advice. Politicians often respond quickly to this kind of negative feedback and rapidly learn to treat such scientific advice with caution.

Another example of the need for the consequences of actions, as elucidated by scientific endeavour, to be articulated in terms of economic and social impact, is afforded by the influence that the Stern Review on the Economics of Climate Change (Britain; http://webarhive.nationalarchives.gov.uk/+http://www.hm-treasury.gov.uk/sternreview_index.htm) and the Garnaut Climate Change Review (Australia; <http://www.garnautreview.org.au/update-2011/garnaut-review-2011.html>) had on the acceptance of the science of climate change and on the responses of governments to that science.

Further, the consequences of social impact are starkly illustrated by the differential response to scientific advice about the ozone hole and about climate change. Addressing the ozone hole issue seemed to require that a relatively small number of industries (dominantly refrigeration and air-conditioning) change the chemicals they used with little flow-on social impact; hence it was relatively easy to get global action through the Montreal Protocol (http://ozone.unep.org/new_site/en/montreal_protocol.php) to ban the production of halocarbon refrigerants.

Addressing the climate change issue effectively means moving away from carbon-based energy sources, requiring large changes to lifestyle and quality of life for most in the developed world and threatening the aspirations of most in the developing world for much higher quality of life. For the ozone hole issue it was relatively easy to sell the message that the social impact of not taking action would be substantially worse than the social impact of taking action. For climate change it has been much harder to articulate this message in such a way that it is genuinely accepted by the community-at-large. Hence it has been much harder to get effective global policy action on climate change than it was on the ozone hole.

Appendix 2: Example of effective mechanisms for scientific advice - Geoscience underpinning approaches to major challenges in Australia

The Australian Academy of Science's National Committee for Earth Sciences produced a *National Strategy for Earth Sciences* in 2003 (<http://www.science.org.au/natcoms/nc-es/documents/nc-es-strategic.pdf>), which emphasized the key underpinning role of the geosciences in approaches to a wide range of major issues. In many cases decision-making processes require: (i) information on surface features, including through remote sensing; (ii) information on subsurface materials and processes, including through collation of information from direct sampling and integration of geological and geophysical data; (iii) systematic monitoring as required to track important trends and events; and (iv) strategic analyses involving integrated consideration and modeling of all relevant data and information. It also identified the need for integration of the efforts of academic researchers and government agencies and collaborative approaches to sharing expertise and infrastructure needed for major research programs. This national strategy was influential in achieving wider appreciation of, and increased funding for, the vital underpinning roles of the Earth Sciences, as well as in developing important new roles for the national geological and geospatial agency, Geoscience Australia (GA: <http://www.ga.gov.au/>).

GA is currently a vibrant government agency with a strong public profile. It is a primary source of scientific and technical advice in support of policy development and major decisions on a wide range of issues. But this was not always the case. Two decades ago its predecessor organization, the Bureau of Mineral Resources was underfunded, much-reviewed and under pressure - struggling to be seen as relevant to the government that was funding it. This motivated the agency to transform

in an effort to reverse this perception, involving it contributing to and implementing the national strategy.

In changing its attitude and culture, GA transformed from an introverted agency with poor communication channels into the main body of government to a vibrant agency with a culture that said its job is “to apply geoscience to Australia's most important challenges” and with effective communication channels to ensure that its work is recognised, relevant, and used.

The success of the transformation from the beleaguered Bureau of Mineral Resources to the present-day GA is evidenced by a 2010 review by the Department of Finance and the Department of Resources and Energy (http://www.finance.gov.au/publications/strategic-reviews/docs/strategic_review_ga.pdf). That review recognized the importance of the agency’s work to many major issues the nation and recommended that its funding be increased to (i) strengthen capabilities for collection of regional-scale data and for monitoring, (ii) invest in custodianship of Australia’s exponentially increasing geoscientific and geospatial data, and (iii) enable continuation of fundamental capabilities in areas such as groundwater, natural hazards, and clean energy. This was a unique outcome for a review involving the Department of Finance, particularly at a time when the focus is on reducing government expenditure.

Australia is a major supplier of a wide range of mineral and energy commodities to world markets. The strength of its economy is linked to its considerable mineral endowment. In 2010, recognising the falling success rate of mineral exploration in Australia as a consequence of deep cover across about 80% of the continent, the Australian Academy of Science ran a Think Tank for young scientists to try to develop a fresh approach. The Academy then drew together a representative group, now known as the UNCOVER group, from across the spectrum of academia, government agencies, and industry to develop from this Think Tank an appropriate research and data-acquisition vision and to improve collaboration and coordination across the sector. In 2012, UNCOVER released the document *Searching the Deep Earth: A Vision for Exploration Geoscience in Australia* (<http://www.science.org.au/policy/uncover.html/>). This vision, which includes enhanced information on the subsurface through comprehensive integration and modeling of geological information and a range of geophysical datasets, has now informed strategic planning for the state geological surveys and for Geoscience Australia.

Amongst the numerous other important geoscience contributions to high profile government policies and decisions are

- Improved water management through better knowledge of groundwater systems and their links with surface waters.
- Addressing community concerns about the rapidly growing coal seam gas sector, particularly centred on potential impacts on ground and surface waters.
- National guidelines to facilitate decisions on proposed uranium mines.
- Enhanced monitoring environmental health and vegetation cover through developing improved remote sensing approaches.
- Establishing links between geology and bioregions.
- Reinforcing Australia’s leadership role in mitigating the impacts of geohazards in its region by building a fit-for-purpose tsunami warning systems, and developing a web application for non-experts to conduct inundation modeling to assess their own tsunami risk.

Appendix 3: Example of ensuring everything needed to facilitate decisions is being done - Mega-earthquakes and tsunami

Given increasing acceptance that it is not possible to rule out any subduction zone hosting a magnitude 9 or greater earthquake, it is important that there is considerable activity aimed at

providing relevant information as to where major tsunamigenic earthquakes are most likely to occur and as to what the societal impacts are most likely to be. Geologists, seismologists, oceanographers, and geodesists are working together to understand the physics of the processes and complexity of the lithosphere that lead to catastrophic events. This has been a “hot” topic since the disastrous Boxing Day tsunami of 2004 and it is widely believed that enough is presently being done on this topic to achieve this aim – but we should critically appraise whether everything that is needed is in fact being covered adequately. Also, it is important to finesse how these different bits of information should be marshalled to get government to listen to and act upon the scientific knowledge – an important component of this may well be easily understood decision support systems to display data, analyses and options on a laptop. This link to decision makers was clearly not strong enough in Japan.

There has been huge investment in tsunami warning systems, which many see as a quick technological fix. Unfortunately, one of the best warning systems in the world didn't save the many Japanese who died in Tohoku. Does this mean that the scientific advice to develop such warning systems was flawed? The answer is no, but having made significant investments governments will require assurance on this and carefully reasoned and supported advice on what else should be done to protect their peoples.

A lot of scientific activity is underway, as outlined in the next section. Clearly, future advice will have to be developed from these activities and a substantial effort should be put in to prepare governments for the advice and to ensure that it is appropriately articulated and packaged.

Major current and recent activities directed at mega-earthquakes and tsunami

The following summary of activities has been compiled with assistance of Alik Ismail-Sadeh (IUGG), and Phil Cummins and John Schneider (both of Geoscience Australia)

- There is ongoing compilation and analyses of historical records of earthquakes and tsunamis. Japan has by far the best historical records in the world, but this wasn't enough to expect a magnitude 9. The basic problem is that historical records are very short in geological timescales.
- An Intergovernmental Oceanographic Commission (IOC, UNESCO) committee is tasked with identifying the subduction zones around the world that can produce giant earthquakes and tsunamis, as well as tsunami earthquakes (events that are dangerous because their slow ruptures can be misread by warning systems and coastal populations). Understandably, the IOC is very much dominated by oceanographers and meteorologists and yet the bulk of the evidence for past events is geologic in nature.
- The Global Earthquake Model (GEM) is developing a global databases and global scientific consensus on the state of knowledge. This work is being done through a series of Global Components studies which will be underpinned by a computational modelling framework and tools: <http://www.globalquakemodel.org/global-components>. In particular, it is intended that the Global Active Faults and Seismic Source Database will represent the authoritative source for information on active earthquake sources, including the world's subduction zones. However, GEM is not directly addressing tsunamis and is certainly not doing paleo-seismic or paleo-tsunami studies to increase the knowledge base. GEM's work will, however, provide an excellent baseline from which to identify knowledge gaps and to expose the risks associated with them. GEM is trying to develop a global scientific consensus on Mmax for earthquake hazard calculations. This will at least help establish the state of play from a hazard/risk assessment perspective.
- The Extreme Natural Hazards and Societal Implications Project (ENHANS; <http://www.iugg.org/programmes/enhans.php>) of the International Union of Geodesy and

Geophysics (IUGG) launched in 2010 is supported by several ICSU bodies including the ICSU Regional Office for Asia and the Pacific. It aims (i) to improve understanding of critical phenomena associated with extreme natural events and to analyse impacts of the natural hazards on sustainable development of society; (ii) to promote studies on prediction of extreme events reducing predictive uncertainty and on natural hazards mitigation; to bring the issues into the political and economic policies; (iii) to disseminate knowledge and data on natural hazards for the advancement of research and education in general and especially in developing countries.

- Paleo-tsunami research (including trenching etc.) is one of the essential tools in tsunami research and covered under umbrella of ICSU, which established a new 10-year program dedicated to disaster risk research, Integrated Research on Disaster Risk (IRD, <http://www.irdinternational.org/>). IRDR tries to bridge natural and social sciences, engineers and policy makers etc. to mitigate, if not fully prevent, disasters. IUGG was a very supportive of this initiative from beginning and hope that other Unions of ICSU will promote this scientific program of ICSU-ISSC-UNISDR.
- In 2011, the Geological Survey of Japan (GSJ) initiated a project related to Asia-Pacific region global earthquake and volcanic eruption risk management (G-EVER, <http://gever.org/index.html>). The first workshop was held in Tsukuba in Feb. 2012 (<http://gever.org/en/gever1/index.html>) and co-sponsored by IUGG and two IUGG associations dealing with seismology (IASPEI) and volcanology (IAVCEI). One of the major topic was earthquake- and volcano-generated tsunamis.
- The first bilateral symposium on geohazards and disaster risk under the US–Russian Presidential Commission on Science and Technology was held in Moscow in July 2012. One of the important topics was joint paleo-tsunami studies. Further two Natural Hazards sessions at the AGU Fall meeting in San Francisco December 2012 were dedicated to two new initiatives: NH13B. Asia-Pacific Region Global Earthquake and Volcanic Eruption Risk Management (G-EVER); and NH14A. Geohazards and Disaster Risks in the North Pacific Region.
- In a good example of harnessing advances in information and computing power, Geoscience Australia has developed and rolled out TSUDat, which is a web application for increasing the capacity of non-experts to conduct inundation modeling to assess their own tsunami risk (<http://eresearchau.files.wordpress.com/2011/11/jeff-johnson.pdf>). The web-server and tsunami simulations are hosted in the Cloud giving scalable computing resources. The application is underpinned by, and provides access to, pre-computed data base of 70,000 tsunami events from all sources in Pacific and Indian oceans. All data is Open Geospatial Consortium compliant and all software is open-source. For each event a 24 hour time series of the tsunami was saved to a database, allowing the TsuDAT application to draw on a database of offshore waveforms which means that only the inundation component needs to be modelled.

What is important but not happening systematically?

The above list of the considerable number major earthquake and tsunami activities under way begs the question as to whether there are other important things that are not happening systematically.

It is submitted that there is scope for better links between various activities already in place and to fill important gaps. It is suggested that the main needs are for:

- More coordination of research, analyses and modeling of data.
- Improving coverage and coordination of geodetic and seismic monitoring networks.
- Integrated systematic geological inputs, particularly **identifying paleo-tsunami deposits in the recent geological records** to establish the occurrence, magnitude and frequency of tsunami **in all regions with significant populations at risk**. This needs an internationally coordinated.

- Systems analysis to understand concatenated events, e.g., mega-thrust earthquake - tsunami - flooding - technological accidents or volcanic eruption - lava flooding - volcanic ash clouds - health issue - aviation problems.
- Finally, and of crucial importance, is the need to develop formal mechanisms for gathering and communicating authoritative scientific and technical advice to governments and other decision makers, as exemplified in Appendix 2.

Many Governments and some international funding agencies would likely be interested in supporting internationally agreed priorities for filling knowledge gaps and achieving more effective communication of advice to guide decisions and policies. The sort of message that they can appreciate is: "This region has had three major tsunami events over the last 2.2 million years. The last was approximately 650,000 years ago. This means that, in terms of the proposed major new infrastructure" Such information resonates more with decision makers than something like "Geologists, seismologists, oceanographers, geodesists are working together to understand the physics of the processes and complexity of the lithosphere which lead to catastrophic events. Major meetings will be held to discuss the current status."

Firstly, there is a need to have broad agreement on:

- (i) additional activities and programs that are most important for increasing our capability to predict and mitigate tsunami;
- (ii) appropriate mechanisms for managing and communicating authoritative information to underpin short to longer term decision making at international and national levels; and (iii) funding opportunities.

Addressing gaps

With this in mind, the International Union of Geological Sciences (IUGS) has agreed to support a workshop in conjunction with the Geological Society of Japan meeting in September 2013, in Sendai – which suffered so much devastation from the tragic tsunami of March 2011. This will have the objective of achieving widespread collaboration and support by bringing together leading tsunami researchers, appropriate government and international funding agency representatives, and ICSU and its Unions.

IUGS plans provide funding to support the participation by key experts, who will be central in workshopping what is needed for (i) effective mechanisms for advice into decision makers in different circumstances; (ii) collaboration between academic and government scientists to fill important gaps in knowledge; (ii) international coordination; and (iv) securing funding for the most crucial activities.