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Data Sharing

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Contents

Data Sharing

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Remit

The remit of this article as agreed with the Government Office for Science Foresight team is as follows:

- *'Clarify the use of the terms data, information and knowledge within the context of the study.*
- *Review the availability of existing data relevant to the area of hazard event forecasting, risk and vulnerability; create a high-level inventory of data-sets and data sources (to include biological, geophysical, hydrological, meteorological, climatological), identify major gaps in data relevant to the subject area, identify major new data-sets and data types that may become available over the next ten year period, assess whether relevant commercially restricted data may exist within the private sector, and assess whether changes in economic conditions and scenarios are likely to impact significantly upon data sharing.*
- *Identify current and future barriers to data sharing. These are expected to fall into:*
  - *a technical category (relating to infrastructure issues, availability of suitable data standards, 'discoverability' of data, analogue-only data, spatial and non-spatial, etc.)*
  - *the non-technical (relating to legal and licensing frameworks, intellectual property ownership issues, commercial considerations etc.), and*
  - *'cultural' issues that inhibit the sharing and integration of data between science disciplines, and between scientists and risk/vulnerability specialists.*
- *Identify best practice in sharing of spatial and non-spatial digital data-sets, the factors which have contributed to its development, and identify mechanisms and measures through which the adoption of such best practice can be increased to further the overall objectives of the project.*
- *Using specific examples, review how the real and potential gains of more effective use and sharing of existing data (and data which may be generated in the future) may improve anticipation of and resilience to disasters'.*

The Availability of Existing Data and Information Related to Disaster Anticipation and Resilience

The transformative effects during the past decade of the world-wide web have made it immeasurably easier for the data provider community to serve its outputs, and for the data user community to use those data to derive information and knowledge[1] for use in decision-support processes. Indeed, the comparative ease of serving spatial data in particular has resulted in a proliferation of web-based mapping portals, the phenomena of YAMPing ('yet another mapping portal') and information overload. These in turn have been recognised as a hindrance in situations such as the humanitarian response to the January 2010 Haiti earthquake disaster (United Nations Office for the Coordination of Humanitarian Affairs, 2010a).

Many data-sets, data models and data portals of direct relevance to disaster anticipation and resilience are now available through the web. These portals provide further links to a vast amount of additional relevant data managed and delivered by other organisations (see for example GeoPORTAL - www.geoportal.org. A table listing some of the key sources of data relevant to this study is provided in the Appendix.

[1] Data, information and knowledge have specific meanings in the field of information science. These terms will be used in line with the definitions below which are derived from several sources. However, it should be recognised that data, information and knowledge represent a continuum, and their boundaries can be fuzzy. In particular, the term 'data-set' is used commonly to describe aggregations of both data and information.

- Data are individual items or records (numeric or other) usually obtained by measurement or observation, which have not been processed in any way, *e.g.* barometric pressure value observed at a specific location.
- Information is created by interpreting and/or processing data so that their context and relationships are expressed and understood. In contrast to data, information has value in decision-making, *e.g.* regional barometric map.
- Knowledge emerges from the expert analysis and synthesis of multiple sources of information, and is used as a basis for decision-making, *e.g.* regional weather forecast.
- Technology involves the making, modification and/or application of tools, machines and systems to achieve a specific function, solve a problem, or to improve existing solutions to problems.

Factors affecting the availability of existing data

A feature common to many so-called ‘global’ data-sets is that the responsibility for the acquisition of the constituent data belongs to organisations and agencies operating at national levels. Consequently the availability and quality of such data is very variable, and is dependent upon diverse factors including the sophistication and resilience of local information systems and infrastructure, national data policies, and the existence of appropriate data and information standards. Conway and Waage (2010), for example, describe the paucity of data received by the World Meteorological Office from African reporting stations, which compares unfavourably with data supplied from other parts of the globe. Solutions to these issues are complex and frequently relate to the adequacy of funding of state institutions and the levels of knowledge and training of their human resource capacity. The consequent variations in quality and availability within some of global data-sets are therefore likely to persist for the foreseeable future.

In contrast, the financially well-resourced global earth observation community acquires and serves high resolution and consistently high quality global data of great value to hazard event forecasting, risk, exposure and resilience. In countries where national data policies permit there are few barriers to free and unrestricted use and re-use of such data-sets (e.g. in the USA with respect to Landsat Thematic Mapper data-sets).

The ‘International Charter’ (www.disasterscharter.org) aims to provide a unified system of satellite data acquisition and delivery to those affected by natural or man-made disasters through authorized users. Member agencies of the International Charter have committed resources to support the provisions of the Charter and to help to mitigate the effects of disasters on human life and property. It should be noted that the terms of the International Charter mean that the earth observation data-sets covered are made available to assist in disaster response situations, but not in hazard event forecasting.

The findings of the Rio+20 United Nations Conference on Sustainability Development, June 2012, stated the importance of supporting technology transfer to developing countries as agreed in the Johannesburg Plan of Implementation (UN 2012). Rio+20 noted that access by all countries to environmentally sound technologies, new knowledge, know-how and expertise and the importance of cooperative action on technology innovation, research and development as of value. Rio+20 also recognized the need for strengthened national, scientific and technological capacities for sustainable development using environmentally sound technologies, with the support of the international community for building science and technology capacity, including through collaboration among research institutions, universities, the private sector, governments, non-governmental organizations and scientists. It was acknowledged that there are factors affecting existing availability of research and technology assessment. In view of the rapid development and possible deployment of new technologies there may also be unintended negative impacts, in particular on biodiversity and health, or other unforeseen consequences.

What are the major gaps in existing data?

There is a huge potential benefit to be realised by collecting consistent, standards-based data on vulnerability and exposure before a hazard event or disaster. Case studies presented by Murray *et al.* (2012) show that a common factor in all case studies was the need for greater information on risks before events occurred.

In the Intergovernmental Panel on Climate Change Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation (SREX), a key ‘low regrets’ measure is access to early warning (IPCC 2012; Murray et al 2012). This measure has lead to a range of activities including the publication of the ‘Atlas of health and climate’ (World Health Organisation and World Meteorological Association 2012), a product of a unique collaboration between the meteorological and public health communities which provides scientific information and early warning recommendations on the connections between weather and climate and major health challenges which range from diseases of poverty to emergencies arising from extreme weather events and disease outbreaks and environmental degradation. Other reports have also identified early warning as a key activity includes the Global Framework for Climate Services (WMO 2012). To improve the development of early warning systems for disaster anticipation and resilience, by these approaches it is likely to require improved international cooperation and investment in forecasting particularly in developing countries, which has been started. The importance of topographic data to all aspects of this study cannot be overstated. Topographic data are the ‘connective tissue’ which link nearly all other data types, and without which these are of very limited use.

There is considerable variation in the resolution at which topographic data are published. They are generally available at higher resolution for populous areas than for rural areas, but there are considerable variations even between adjacent countries in the quality and ‘baseline’ resolution of publicly available data. The available resolution of topographic data is rarely good enough to meet the needs of the hazard prediction and response community. This is especially the case for less developed areas of the world (as evidenced for example by low quality topographic data available to disaster response organisations in the immediate aftermath of the Haiti earthquake; United Nations Office for the Coordination of Humanitarian Affairs, 2010b), and for spatially discrete perils such as flood, tornado, post-earthquake landslip and liquefaction.

There is a need for systematic collation of data, including standardised data-sets on physical and social aspects of hazards and disasters, and for knowledge syntheses to ensure the benefits of existing data are maximised (Few and Barclay, 2011; GRIP, 2008). The major gaps in biological and medical data collection are within the mental health and well-being fields, and there are difficulties in agreeing standards-based approaches to the collection of such data and a lack of baselines for comparisons. Areas which are significantly underfunded for research and therefore are or will become data poor in the long term are drought, extensive risk, urban risk, health dimensions, perspectives from the humanities (cultural and historical), poverty and vulnerability, governance and policy, and risk behaviour (Few and Barclay 2011). Attention tends to be placed on large-scale or high-magnitude hazard events and disasters, but the cumulative and cyclical impacts of smaller-scale hazard events such as landslides, flash floods or long-lived volcanic eruptions can be highly significant for a greater total number of people.

Few countries systematically account for disaster losses at national level, and a critical lack of data on such losses is exacerbated by inconsistent recording and documentation of events. A clearer indication of losses would allow for more analysis and modelling in order to reduce exposure. Fuller accounting of disaster losses will also encourage governments and the private sector to take ownership of strategic risks, and identify mitigation strategies and priorities when making risk-related decisions. If national public investment systems truly account for disaster risk, they can reduce losses at a scale impossible to achieve through stand-alone disaster risk management (United Nations International Strategy for Disaster Reduction, 2012). In a move to encourage more standardised reporting of disaster losses the

Global Risk Identification Programme (GRIP) has produced a set of recommendations for Disaster Loss Data Standards (GRIP, 2008).

The UNISDR provides support to in-country efforts in disaster loss accounting through a network of partners. In Asia, for example, national efforts have been supported through UNDP Country Offices, the UNDP Regional Centre Bangkok and other partners including the Asian Disaster Preparedness Centre and the National Society for Earthquake Technology, Nepal. In Latin America, regional and country level support has been provided by UNDP, the Inter-American Development Bank, and the Andean Community of Nations amongst others. The Arab Academy for Science Technology and Maritime Transport provides the regional anchor in the Arab States, while national level implementation has been supported by UNDP and the World Bank. In Africa, the Regional Centre for Mapping of Resources for Development, Nairobi is the hub.

Major gaps exist in the availability of exposure, vulnerability, historic damage data and critical building inventories. Currently the best such data exist in the catastrophe modelling communities such as RMS or EQECAT, but these data are commonly of variable granularity in terms of location and characteristics.

However, a significant amount of basic data on natural hazards is completely lacking because basic mapping and verification of remotely sensed interpretations by ground-based surveys (ground-truthing) has yet to be done, and the absence of long-term monitoring of some natural hazards remains a major issue. Many active volcanoes, for example, (especially those in the developing world) lack even basic monitoring programmes. Although there are efforts to collate monitoring data from all existing volcano observatories (WOVOdat – a database of the World Organisation of Volcanic Observatories; www.wovodat.org), there is a need for more effective ways of monitoring and data collection from more volcanoes before, during and after eruption.

Many events are a result of multiple hazards, for example landslides, mud-flows and flash-floods following volcanic eruptions. The close inter-relationships between such hazards highlight the need for standards-based, harmonised natural hazards databases. Although specialised hazards databases do exist, they are commonly developed as separate initiatives by different specialist communities which are often in the academic domain, and may therefore not be maintained or linked to exposure and vulnerability data. There is a strong need for a better-coordinated approach.

The lack of standardisation of observational data relating not only to physical phenomena but also to socio-demographic data is impeding progress in hazard research. Further, more systematic data-sets will enable the evaluation of data reliability and ultimately increase knowledge of the greatest sources of uncertainty in understanding the societal impacts of natural hazards (Few and Barclay 2011). Data standardisation will ensure future compatibility between approaches and disciplines.

More complete data collection and greater consistency in the reporting of findings is vitally important. This will enable comparison of research studies on medical response systems, both nationally and internationally. In 2003, for example, a World Association for Disaster and Emergency Medicine task force on disaster management quality control published guidelines for the evaluation and research on health disaster management, and recommended the development of a uniform data reporting tool (Sundnes and Birnbaum (eds), 2003). The time taken to encourage better data collection is of significant concern and may reflect that defining a disaster and how long it takes to recover from such events is a complex task for the health community. For example, should deaths on the day of the event be the only ones counted, excluding those who die from secondary infections in the month or so following?

If adopted by the international community these guidelines would facilitate the interpretation of results and comparisons between medical response systems, and improve the quality of disaster victim management. A template was produced by the Emergency Management and Disaster Medicine academy (*www.emdmacademy.org)* which provides a set of data elements for uniform reporting on the acute disaster medicine response (Debacker et al. 2012).

Does relevant commercially restricted data exist within the private sector?

Catastrophe modelling companies hold commercially valuable and sensitive exposure, vulnerability and damage data which are used in the creation of their models. These data are also provided by various insurance companies, but are not available to the disaster anticipation and response agencies. In some parts of the world (e.g. UK) private sector companies develop hazard models (e.g. flood prediction models) which are produced specifically for use by the insurance industry, and which are not available in the public domain.

Commercially restricted data also exist in the earth observation (EO) sector, where several charging models for satellite sensor data access exist. Some EO data are available entirely free of charge for unrestricted use. Landsat EO data, for example, are freely available for any use. In contrast, some satellite data are available only at full commercial cost (e.g. data from GeoEye, Ikonos, EADS Astrium N.V.). Between these two extremes are some earth observation data that might be available either free or for a nominal charge for certain non-commercial applications, but which attract a full commercial charge for commercial purposes. The current situation at the European Space Agency (ESA) exemplifies this situation: many ESA data-sets are available for a nominal charge for research purposes, but at full cost for commercial purposes. ESA is in the process of moving towards completely free access and all data from the upcoming Sentinel missions will be freely available for any use.

New datasets, data types and technologies – a forward look

Major investments are being made into the use of 'real-time' data for monitoring and probability forecasting particularly in the field of earth observation satellites and in-situ sensors. The European Union and European Space Agency initiative 'Global Monitoring for Environment and Security' (GMES) is developing six thematic areas, one of which is emergency management. The GMES programme aims to ensure access to data and information covering the six thematic areas, including spaceborne observations. Some GMES data are already available free of charge (see http://gmesdata.esa.int/web/gsc/data-access-portfolio), and more datasets will become available in the coming years. The Global Earthquake Model (GEM) project will produce global vulnerability and exposure data and earthquake forecast models. These real-time earth observation data, along with real-time ground data produced by sensor web arrays, have the potential to significantly improve hazard event prediction capability.

The importance of space-technology-based data, in situ monitoring and reliable geospatial information for sustainable development policymaking, programming and project operations was recognised at the Rio+20 United Nations Conference on Sustainability Development June 2012 (UN 2012). The authors of this report highlighted the relevance of global mapping and the efforts in developing global environmental observing systems, including by the Eye on Earth Network and through the Global Earth Observation System of Systems, adding that financial and technical support needs to be provided to developing countries in their efforts to collect environmental data.

Crowd-sourcing of data, especially through mobile devices, offers huge potential for rapid acquisition of valuable data-sets. It seems that the importance of crowd-sourced data in disaster resilience and response can only grow, especially so given the very rapid spread of mobile technologies and infrastructure across the globe. The role of new technologies and social media in catalysing the acquisition and sharing of data became evident in the response to the 2010 Haiti earthquake. The communities affected by the disaster issued pleas for help using social media and widely available mobile technologies. The result was that thousands of ordinary citizens were mobilized to aggregate, translate, and plot these pleas on maps so facilitating better-organized technical responses to the disaster situation. The organisation OpenStreetMap also played a very important role in quickly producing up to the minute topographic mapping of the Port au Prince area and environs using volunteer participation and web technologies (UNOCHA 2010a).

However it should be noted that responders did encounter problems with handling such new information sources. The UNOCHA report on the community response to the Haiti earthquake ‘Disaster relief 2.0 : the future of information sharing in humanitarian emergencies’ makes recommendations to improve coordination between the humanitarian, volunteer and technical communities in future emergency responses, including standards for data exchange and an innovation space where new tools can be explored (UNOCHA 2010a).

Ushahidi (www.ushahidi.com) is an example of an open source platform project which allows users to crowd-source crisis data and information, and to make them available via multiple channels including SMS, email and the web. Developed to show the locations of the inter-communal violence which occurred following the 2008 elections in Kenya, Ushahidi has since been used successfully as a crowd-source platform in the responses to both the Haiti earthquake and the Great Japan earthquake of 2011.

Enabled by the world-wide web, so-called ‘cloud’ technologies and services are challenging the more established, conventional paradigm of data acquisition, management and processing, which – with the notable exception of earth observation data – is mostly dominated by government and state agencies. Despite widespread concerns over data security and caution over the role of private sector companies in managing public sector data, the rate of adoption of cloud services is growing fast. Many governments and state agencies are already using cloud-based storage and processing services, and an example of the way in which cloud services are radically changing conventional wisdom and practise is provided by the decision of the US National Institutes of Health to use Amazon Web Services to store its 200 terabyte human genome dataset from the ‘1,000 Genomes Project’ (National Institutes of Health press release, March 29th 2012).

The business model behind this initiative is one in which digital storage is provided free of charge but high performance computer processing is charged for. One consequence of this model is to make the data and the processing services accessible at low cost to all-comers. Whereas in the past research on such large datasets would have been within the reach of only a few very well-financed research groups, use of cloud services has radically reduced the barriers to entry and made possible the participation of a very much larger community.

Applying such cloud-based models to hazard event, exposure and vulnerability data would significantly increase the efficacy of data sharing and will very likely encourage new and innovative approaches to disaster anticipation and response. However, opening up data to much wider use could in itself create new problems. Who, for example, has ownership of the intellectual property of models derived from ‘communal data’? How would the inherent uncertainty of such models be categorised and published? Notwithstanding such issues there is no doubt that new approaches and technologies such as crowd-sourcing of data, mobile platforms and cloud services are radically changing the norms of data acquisition, management, processing and delivery.

Data Sharing Issues

Barriers to data sharing

There are many technical barriers to data accessibility and sharing. At the most basic level the ability of national institutions to acquire and deliver data needed for hazard event forecasting will depend on their capacity, human resource skills, and basic information system infrastructure. Factors preventing sharing of data include legislative frameworks and funding. While some organisations in the developed world have to deal with unwelcome financial pressures, there is still no comparison between their plight and that of organisations in the developing world where even basic essentials such as a regular electricity and water supply cannot be taken for granted. It should also be recognised that the technologies and IT platforms that enable publication and sharing of data during times of 'normality' may not function in the aftermath of hazard events due to infrastructure damage and may mean that low band width technologies need to be used. The ability to download data during a disaster situation in an affected area depends on IT, electrical supply or even access to satellite communication.

The importance of standards within data and information workflows cannot be overstated. Standards enable the systematic collection of basic data to internationally agreed definitions and protocols and are essential for the derivation of reliable and consistent information and knowledge of use in decision-support. They also facilitate web delivery and interoperability of spatial data in particular. A study commissioned for the International Strategy for Disaster Reduction mid-term review on the use of databases for disaster risk reduction noted '*much of the existing operational research related to emergencies and disasters lacks consistency, is of poor reliability and validity and is of limited use for establishing baselines, defining standards, making comparisons or tracking trends.*' (UNISDR 2011). The Global Risk Identification Programme's 'Disaster Loss Data Standards' report is a major contribution to standards development and implementation in the field of disaster loss quantification. Further important work on data and information standards is undertaken under the auspices of domain-specific organisations such as the International Union of Geological Sciences and, more broadly, the valuable work of the Open Geospatial Consortium (OGC) in developing open standards that underpin the sharing of spatial data. The OGC's Emergency and Disaster Management Domain Working Group's role is to promote and support the establishment of requirements and best practices for web service interfaces and models to enable the discovery, access, sharing, analysis, visualization and processing of information related to the forecasting, prevention, response to and recovery from emergency and disaster situations (Open Geospatial Consortium 2012).

A huge amount of work on the development and implementation of standards remains across the entire spectrum of data types relevant to hazard event prediction, exposure and risk. However, there are some notable success stories where the adoption and implementation of standards-based approaches have facilitated the creation of interoperable, global data-sets. One example (OneGeology Global) is given in the Best Practice section (see page 9).

In addition to these technical barriers there are many non-technical barriers related to legal and licensing frameworks, intellectual property ownership issues, and commercial considerations. At one end of the spectrum are the commercial interests of data holders in the private sector, for whom revenues from selling of data are an essential income stream. Within this category are the insurance and re-insurance sector, and private companies operating in the earth observation sector. The spread of open data initiatives has resulted in improved access, and therefore sharing, of scientific data in particular. Most UK universities and research councils, for example, now make scientific outputs available free of charge through web-based, open access, research repositories (*e.g.* the Natural Environment Research Council Open Research Archive). The scholarly publishing industry has responded to this and related trends by introducing new publishing payment models including the ‘author pays’ principle. While the right of publishers to make profits is not in question, it needs to be recognised that new publishing models (such as the ‘author pays’ model in which there is a requirement on authors to pay to publish in some journals) are emerging which may impede accessibility and sharing of data.

Finally, there are cultural barriers to data sharing. Despite the best efforts of funding agencies and innovative knowledge transfer programmes, most scientists continue to operate within domain ‘silos’ (*e.g.* Rougier *et al.* 2010). A more holistic approach to risk analysis, to include risk and exposure specialists, humanitarian disaster response specialists, and scientists of all disciplines, is undoubtedly needed urgently.

Will changes in economic conditions and other scenarios impact significantly upon data sharing?

The availability of data collected at public expense and the conditions governing its use and re-use are generally governed by data policies and guidelines put in place by national governments, and by the business models of state agencies. In the USA most data collected at federal government expense (except military and security data) are available mostly without charge for generally unrestricted use and re-use. At the other end of the spectrum are governments that, generally through their agencies, attempt to recover at least part of the cost of data collection and delivery by charging the user.

In the last decade there have been increasing demands across the globe for improved public access to data collected at public expense. These demands have caused many governments, including the UK government, to launch ‘open data’ initiatives (see for example the UK government’s Open Data White Paper; Government of the United Kingdom 2012). Google now publishes a map showing the growth in nations adopting ‘open data’ strategies (its ‘World Map of Open Government Data Initiatives’). The open data movements have undoubtedly contributed to improved access to, and sharing of, publicly held data relevant to hazard forecasting, exposure and risk; UK Meteorological Office weather data, for example, are now publicly available for unrestricted use and re-use. Notwithstanding the financial pressures facing public organisations across the world caused by the global economic downturn, the continued growth and success of the open data movement seem likely to continue unabated.

Changes in public data policy at government levels have influenced significant policy shifts within influential global organisations. The World Bank, for example, changed its data and information policy in mid-2010, making data more freely available and making more transparent which data were excluded from open release (see http://data.worldbank.org/ for the vast range of available data). This was followed in 2012 by a new policy providing open access to World Bank funded research.

Within the European Union the key objective of the INSPIRE Directive (http://inspire.jrc.ec.europa.eu/) is to establish an infrastructure for spatial information in Europe to support Community environmental policies, and policies or activities which may have an impact on the environment. Under this directive, now transposed into national law across the European Union, member countries are required to make available spatial and other data relating to 34 themes (see http://inspire.jrc.ec.europa.eu/). Many of these data themes are very relevant to disaster anticipation and resilience, and they include topographic, hydrologic, geologic, land cover, elevation, earth observation, soil, land use, human health and safety, buildings, and natural risk zones. Data models and specifications for nine of these themes (including topographic and hydrographic data) have already been developed and published, while data specifications for the remainder are being drafted currently. Full implementation of the INSPIRE Directive will not be achieved until 2019, but it should make an enormously positive contribution to improving accessibility and sharing of public data across environmental, health and related themes.

It should be recognised that changes in security restrictions, which are very often unpredictable, can lead to significant changes in the availability of data for sharing. It is well known that governments may retain the right to restrict access to remotely sensed observations and navigation data, should continued release of these into the public domain be contrary to national security interests. In Haiti the United Nations Office for the Coordination of Humanitarian Affairs Rapid Initial Needs Assessment for Haiti report (UNOCHA 2010b) was delayed partly due to security restrictions imposed by UN regulations. The lateness of the report meant that much of the information contained in it was out of date and of less use.

In the United Nations International Strategy on post-2015 Framework for Disaster Reduction a key accountability measure identified is one to communities, where the extent to which a government is able to address the risks from poorly planned and managed urbanization, environmental degradation, and poverty (United Nations ISDR 2012). Improved access to data and information, particularly on disaster risks, can therefore also generate a social demand for disaster risk management measures, which in turn may increase data sharing between key responders.

The need for cost effective insurance coverage is also having a positive effect on data sharing. The Government of Turkey, for example, turned to the insurance industry and catastrophe modelling community for assistance in setting up a cost effective insurance scheme, so raising public awareness of the risks and encouraging active risk management within communities (Gurenko *et al. 2006*). Results of this initiative include improved risk mitigation procedures and a tripling of insurance policy coverage.

Best practice in sharing of data

The World Health Organisation's International Health Regulations (WHO 2005) provide a legislative framework for data sharing of public health risks. The IHR are an international legal instrument binding on 194 countries across the globe, including all the Member States of WHO, and require countries to report certain disease outbreaks and public health incidents to the WHO. The aim of the IHR is to help the international community prevent and respond to acute public health risks that have the potential to cross borders and threaten people worldwide, and to disrupt trade and travel. The IHR were developed and implemented to meet a common need to respond to risks posed by the exponential increase in international travel and trade, and the emergence and re-emergence of international disease threats and other health risks.

An outstanding example of best practice in the sharing of spatial data is the OneGeology project (www.onegeology.org). OneGeology's goals are to provide interoperable digital geological map data for the world through the web, make existing geological map data accessible in whatever digital format is available in each country, and to transfer know-how to those who need it recognising that different nations have differing abilities to participate. Currently 117 nations, states or provinces are serving geological map data through the OneGeology web portal. The success of the OneGeology initiative is heavily underpinned by many years of effort by the global geological survey community to develop and implement common data exchange and web service standards for geological map data. One such standard is the data exchange language GeoSciML (www.geosciml.org) which, although developed specifically for geological map data, can also be used to deliver features such as active fault distribution which is of course highly relevant to earthquake prediction and related shaking, liquefaction, tsunami and land-slip hazards.

A strong and effective programme of technical knowledge transfer and support from the more developed to the less developed geological surveys has also played an important role in the success of OneGeology. Extending these successes in delivering interoperable spatial data to other parts of the spatial data provider community would offer many immediate benefits to hazard event forecasting, risk and exposure prediction.

How Can More Effective Use and Sharing of Data Improve Anticipation of And Resilience to Disasters?

Recommendations

International agreements and legislation exist to encourage or mandate sharing of data and information relevant to this study. Three notable examples are the World Health Organisation's International Health Regulations, the International Charter covering earth observation data, and the European Union's INSPIRE Directive. The principles embedded within these initiatives offer templates which, if more widely adopted geographically and across more disciplines, could have a very positive impact on the availability and sharing of data across the globe to meet the challenges.

The United Nations International Strategy for Disaster Reduction's 'Hyogo Framework for Action 2005-2015' (UNISDR 2005) sets out a number of priorities for action in the field of information management and exchange (see also the UNISDR 'Post-2015 framework for disaster risk reduction' (UNISDR 2012)). Amongst the key recommendations are improving the supply and use of information and earth observations to reduce risks and build resilience, improving information-sharing systems and improving information standards.

A major factor behind the success of the WHO International Health Regulations is the legal obligation upon member states to report disease and public health incidents. Extending this principle of legally binding obligation to report other data and information types would improve the scientific community's ability to predict hazard events. Such data and information might include standards-based documentation and spatial information on losses from previous disasters, spatial information on known risk zones from seismic and related hazards.

The 'International Charter' provides a unified system of access to earth observation data to those affected by natural or man-made disasters. However, the terms of the International Charter mean that the data are made available to assist in disaster response situations and not in hazard event forecasting. Extending the terms of the charter to cover event prediction could have a very positive impact, particularly in developing countries, in facilitating better access to and sharing of relevant data for predictive purposes.

The EU INSPIRE Directive requires member states to make available through the web a vast range of public data and information of direct relevance to hazard event forecasting, exposure and risk within the EU. The implementation of INSPIRE is therefore making a very significant contribution to improving the accessibility and sharing of highly relevant data across the EU. Considering this legislation mandates member states to serve data on themes including topography, transport networks, human health and natural risk zones, it is clear that INSPIRE will radically improve access to disparate data-sets and so make a major contribution to the community's ability to predict, and build resilience to, hazard events and disasters. It is also clear that extending the principles and practical approaches adopted by INSPIRE to regions beyond the EU could radically improve our ability to forecast and build resilience to hazard events in those regions.

The UNOCHA report on the community response to the Haiti earthquake 'Disaster relief 2.0: the future of information sharing in humanitarian emergencies' presents an important analysis of the response to this major disaster event. Specifically it considers how new technologies such as mobile devices, social networks and web 2.0 tools changed radically the flow of requests for assistance from the affected communities and the responses from the humanitarian, volunteer and technical communities. It makes a number of important recommendations aimed at improving the coordination between these various groups in future emergency response situations.

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Appendix

Table of selected data sources of relevance to the IFDAR study.

Data provider or portal	Website
GEOPortal	www.geoportal.org
WORLD BANK	http://data.worldbank.org
World Health Organisation (WHO)	http://www.who.int/research/en
Food and Agriculture organisation of the United Nations (FAO)	http://www.fao.org/corp/statistics/en
United Nations	http://www.un.org/en/databases
The Centre for Research on the Epidemiology of Disasters (CRED) Emergency Events Database (EM-DAT)	http://www.em-dat.net/links/disasterdbs.html
Global Risk Identification Programme (GRIP)	http://www.gripweb.org/gripweb/?q=disaster-database
OneGeology	www.onegeology.org
United States Geological Survey (USGS)	http://earthquake.usgs.gov
National Oceanic Atmospheric Administration (NOAA)	www.noaa.gov
Global Geodetic Observing System (GGOS)	www.ggos.org
Global Disaster Alert and Co-ordination system (GDACS)	www.gdacs.org
Global Earthquake model (GEM)	www.globalquakemodel.org
Meteorological Office	www.metoffice.gov.uk
Intergovernmental Panel On Climate Change (IPCC)	www.ipcc.ch
Global Facility for Disaster Reduction and Recovery (GFDRR)	http://www.gfdrr.org/gfdrr/
Reliefweb	www.reliefweb.int
OneResponse (IASC)	www.oneresponse.info
Preventionweb	www.preventionweb.net

The Preview Global Risk Data Platform	http://preview.grid.unep.ch
Global Monitoring for Environment and Security (GMES)	www.gmes.info
World Organisation of Volcano Observatories (WOVO)	www.wovo.org
The International Charter	www.disasterscharter.org
PERILS	www.perils.org
United Nations Office For The Coordination Of Humanitarian Affairs (OCHA)	http://www.unocha.org

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