UNITED NATIONS **E/CONF.97/6/IP. 23**

ECONOMIC AND SOCIAL COUNCIL

Seventeenth United Nations Regional Cartographic Conference for Asia and the Pacific
Bangkok, 18-22 September 2006
Item 7 of the provisional agenda*

INVITED PAPERS

THE DYNAMIC ROLE OF LOCATION INFORMATION AND TECHNOLOGY IN A FRAGILE WORLD

Submitted by Ordnance Survey and MapAction **

* **E/CONF.97/1**

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The dynamic role of location information and technology in a fragile world.

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Abstract

It is a truism to say that when a disaster happens, location information is important, but in a world where information and technology are coming together more and more, it is increasingly important to take steps to make sure our information is used in the most effective way before, during and after a disaster. This paper considers the information required in the various stages of the disaster management cycle, the roles of national mapping agencies and emergency mapping agencies, and some of the problems they face in bringing information together quickly and effectively, and looks ahead to a European research project called 'Orchestra' which is seeking to create an information architecture to support the risk management.

Introduction: The need for information and the role of national mapping organisations (NMOs)

Today, in the twenty first century, we live in an 'information society' in which the vital role of information is recognised and specific measures are put in place to ensure that, in our fast-paced world, information is passed around quickly and easily. In reality, of course, information has always been important. In the past it may have been information about sources of food, good hunting grounds, which lands flooded in the wet season, or who could be traded with in the vicinity. Good decisions were always based on information, not instinct or 'the way it has always been done'.

A country's land is a finite resource (with the possible exception of those who reclaim land!) and as such it is of crucial importance to the management of the country to know what is where on its territory and how it is changing. As a result almost every country in the world considers that the provision of basic mapping information is the role of the state, and puts in place an organisation to carry out this role. These are generically known as national mapping organisations (NMOs). The actual scope of the organisation varies from country to country. Some are tasked with land and hydrographic survey, some do cadastral (property) survey too, and some are essentially regulators and let contracts to the private sector to create the information, but all have a basic responsibility to record the essential features of the natural and man-made landscape.

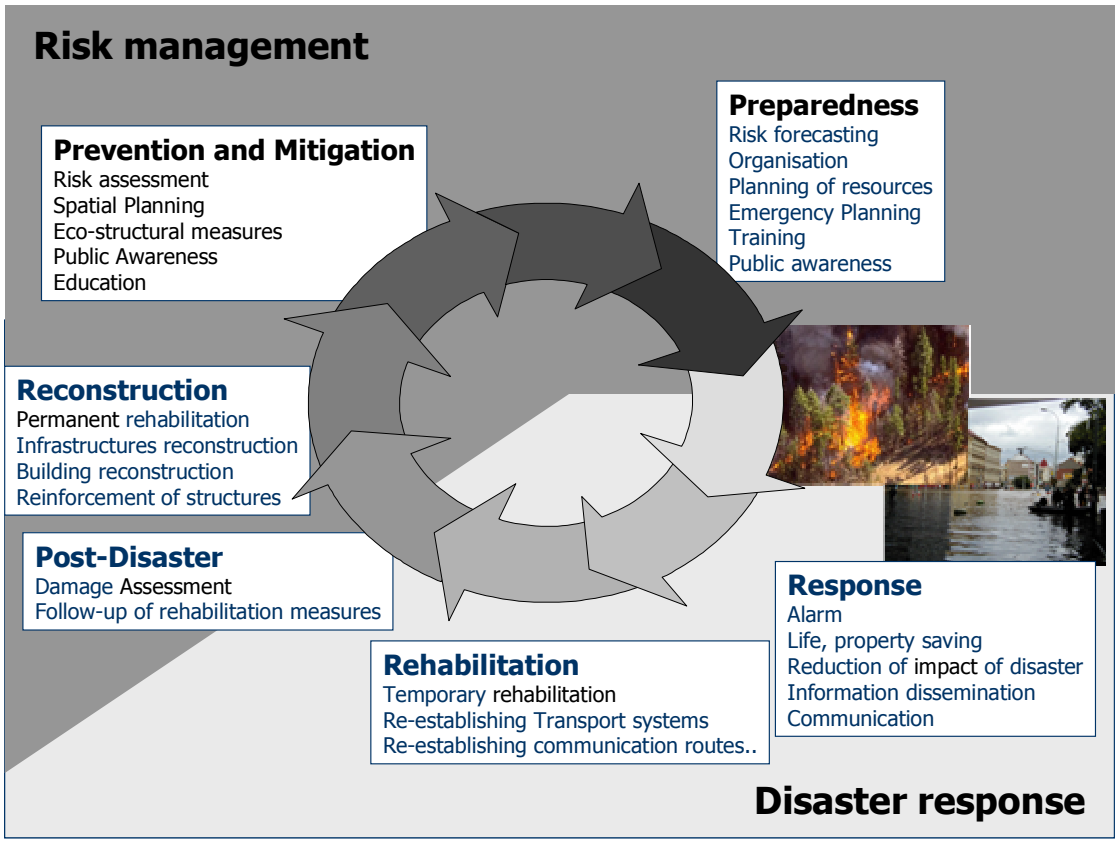
In Great Britain, the national mapping organisation is called Ordnance Survey. It's vision is to be, with its partners, the content provider of choice for location-based information in the new information economy. To do this it collects information and provides it to users in government and the private sector as a range of data and paper products. Although all the emergency services are already customers, it also operates

a ‘Mapping for Emergencies’ service which is available 24/7 and will provide data or maps to emergency services when requested in the event of an emergency. As a government department it also is aware that it can play a role in benefiting the wider society and so has developed a corporate social responsibility policy which covers environmental, economic and social aspects.

Disaster management cycle

Whether man-made or natural, the effect of disasters (often effecting thousands of lives and billions of dollars of economic activity) will largely be effected by the way we respond to it. Good management coordinated through each stage in the disaster cycle is critical to minimise the impacts (see Fig1).

Figure 1: The Disaster Cycle



Information needs

Good information is required at all stages of the cycle.

Before a disaster information is needed to

- Identify areas at risk
- Quantify the scale of the risk
- Identify and access the right sources of key information
- Set in place systems that will translate and integrate key combinations of data and information
- Draw up plans for dealing with a disaster

During a disaster information is needed to

- quickly locate affected areas and map damage
- gather information about the disaster and consolidate it to ensure an efficient response
- organise and optimise humanitarian aid missions

After a disaster information is needed to

- update disaster preparedness plans with newly identified hazard zones and emergency response plans
- improve disaster prediction and simulation models through lessons learned
- update the basic information so that is reflects the post-disaster landscape

The NMO will not necessarily be best placed to provide the appropriate information at all stages of the disaster cycle. This is where the emergency aid agencies can play a part and complement the information provision of the NMO.

Role of the NMO

The NMO's main role is in the before and after information collection. The preparedness of a country for a disaster will be greatly enhanced if the NMO has been able to create the basic information for the country and keep it up to date in a sustainable way (Hadley 2005). This then can form the basis for planning by other government agencies for potential disasters.

At the time of the disaster, the main role of the NMO will be to make its information available to relief agencies as quickly and smoothly as possible and offer what facilities it has to relief agencies. It is unlikely, though, that an NMO will be equipped or skilled to provide the information required during the disaster and its immediate aftermath – and why should it? – this is a specialist short term role and not the role of a government agency tasked with creating an information infrastructure.

However, after the event, the NMO role is clearly to take over from the relief agencies and take what they have done on for the longer term. The basic information may need to be updated and supplied to other parts of government concerned with revising plans and dealing with the longer term aftermath.

Data provision by emergency mapping agency – MapAction example

To better illustrate the role of an emergency mapping agency we will use the work of a UK charity which responds to rapid onset natural and man-made disasters. The role and responsibilities of various data providers is evident throughout, both in terms of data provision in the first instance and in terms of shared common standards for interoperability in the post-disaster and preparedness phases.

MapAction is a UK-based international Non-Governmental Organisation (NGO) that specialises in mapping disaster areas and supplying maps and geographical information for humanitarian relief operations. Using GIS technology, satellite imagery and GPS, MapAction produce instant, near real-time maps of a disaster - such as an earthquake or flood - and then provide the information to other NGOs and Government agencies in the field to help better co-ordinate the relief effort. Maps, where appropriate, are updated daily and distributed as paper copies in the field and electronically via the internet.

Funding comes from private charitable donations. MapAction have the support of sponsors, of whom Ordnance Survey is one as a part of its corporate social responsibility programme mentioned above. In this instance Ordnance Survey and MapAction share a common interest in the use, development and application of geographic information and GIS. In addition to supporting MapAction financially, Ordnance Survey also supports the charity in non-financial ways such as allowing staff leave to work for MapAction as volunteers and using its extensive network of contacts in other NMOs to provide MapAction with appropriate contacts in the event of an emergency.

All thirty members of the MapAction's "operational pool" are professionally qualified, unpaid volunteers employed in full-time jobs. This is through the goodwill of the individuals concerned and their employers. The team comprises experts in remote sensing, GIS, communications, logistics, computing, and medical skills who speak a number of different languages. MapAction deploy for one to two weeks, roughly akin to the rescue and early relief phases of a disaster so are solely concerned with short term emergency mapping i.e. the response part of the cycle in Figure 1.

Geographic Information readiness / data acquisition.
In their spare time however, MapAction team members are also responsible for developing their systems, equipment and procedures in readiness for a deployment, and all participate in a monthly training weekend.

Pre-deployment data collection
Following a sudden onset disaster, a MapAction "warning call" is triggered to assess volunteer availability. This call also initiates a process of data collection for the affected areas. MapAction have a series of "standby" datasets – VMAP (0/1), Landsat EMT+ and SRTM ready to use as saving a few half-hour downloads is critical at this stage, with the aim of being ready to leave within 24 hours. These reside on a high-capacity networked disc, ready to go. In addition, MapAction may invoke the 'International Charter' (e.g. for Hurricane Ivan). The leading space agencies have made their satellites available for humanitarian purposes by signing the 'International Charter on Space and Major Disasters'. The member agencies are ESA, CNES, CSA, ISRO, NOAA , CONAE , USGS , JAXA and DMCII . In the Charter they have committed themselves to pooling resources (RADARSAT, ERS, SPOT satellite images among others) in order to help lessen the impact of such disasters. As a member of RESPOND, ESA-funded, imagery may also be available to MapAction.

Much less predictable is the hunt for other specific geographical data of which that produced by the NMOs is one source which is where Ordnance Survey has been able to help them with contacts in other NMOs gained as as a result of its regular exchanges with other NMOs through the Cambridge Conference events (www.cambridgeconference.com) or NMOnetwork website (www.nmonetwork.org). MapAction's own network of contacts also often uncovers obscure sources – this has been effective in the Caribbean, India, Sri Lanka and Pakistan and of course the team turns to internet search engines. Much of this data searching work is done by team

members who are unable to deploy; they form a "UK base", continuing the data-hunt, image processing and staying in touch with the field team.

However time is still a limiting factor at this stage. In Pakistan, for example, all of the main suppliers of the Soviet topography maps of the area were closed for the weekend (MapAction had the warning call on a Saturday) and it turned out that despite paying and placing an order on the day of the quake, 1:100,000 topography data was not made available by FTP for another five days! This is a salutary lesson for NMOs and other data providers who do not have a process in place to provide their information at short notice in the event of an emergency!

Needless to say, much data located by MapAction is simply re-processed from public-domain datasets such as DCW and VMAP. As a result, MapAction often deploy without any good vector geodata at a scale larger than 1:1,000,000. This despite the fact that is exists at larger scales for many countries and is probably held by the NMO or a data distributor. MapAction have also found that a lack of metadata is a hindrance – so the creation and access to metadata should become a higher priority for countries seeking to be prepared for disasters. Beyond metadata, which is rarely consistently populated, is the concept of the Semantic Web. This extends the current Web by allowing a computer to automatically understand the meaning of web page content, or the content of databases accessed via web services. In the long term, Ordnance Survey's research in this area should facilitate the discovery not only of the data sets most relevant to a particular emergency situation, but also of the relevant data within individual data sets

Equipment ready to go

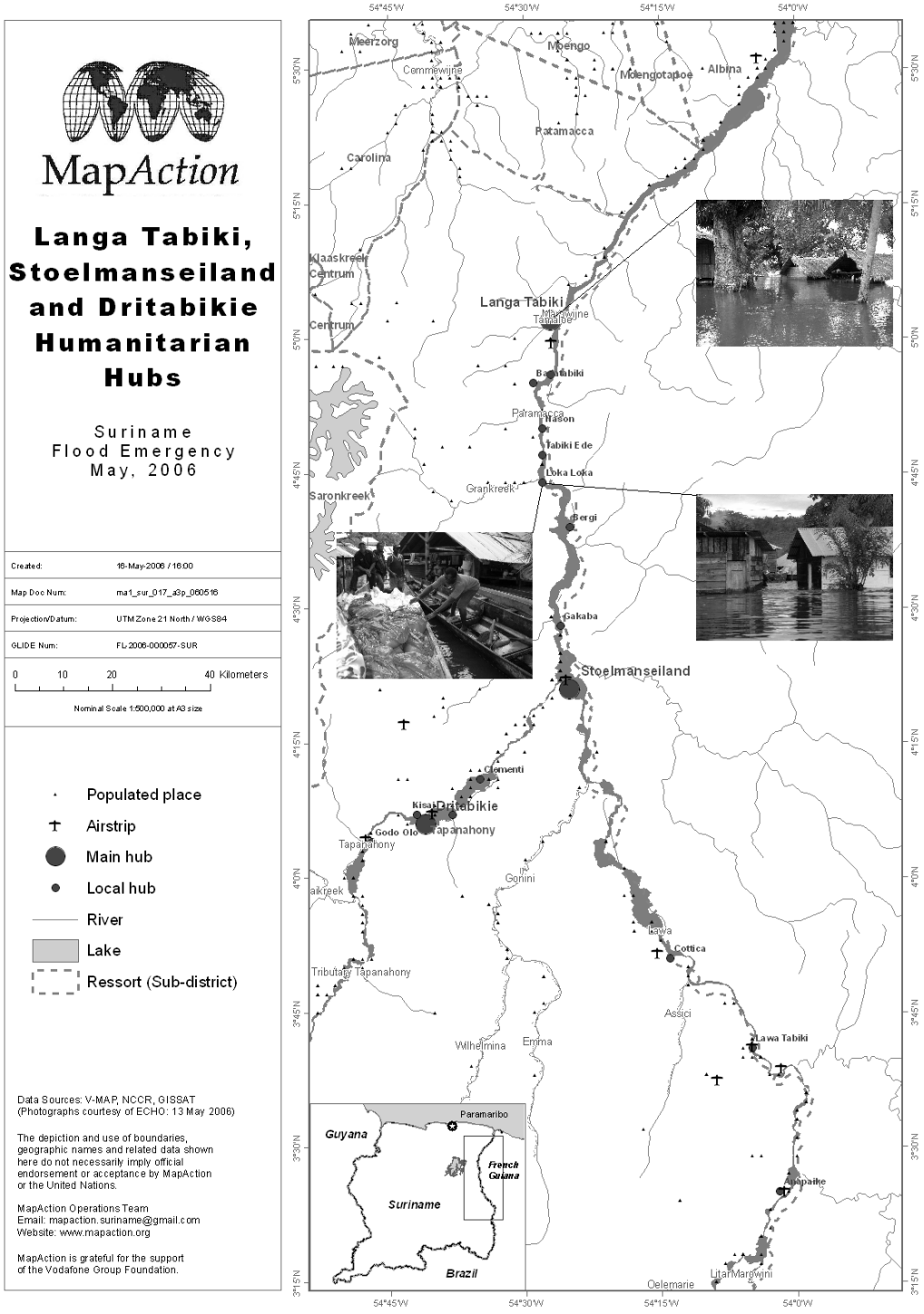
Whilst MapAction GIS team members have been collating data, uploading it to an FTP site (kindly hosted by Nigel Press Associates) at the MapAction stores, others have been preparing a small fleet of laptop computers, each with ESRI ArcEditor installed, plus a suite of other GI utility programmes. Also ready is equipment to network them, printers, two BGAN high-speed satellite communications systems and a generator. Everything is designed as far as possible to double-function or to have a back-up system should any component fail. If the main portable file server doesn't work, MapAction switch to a laptop; the printer has built-in networking *and* there is a print server in the network. Should the mains fail (as happened about 5 times a day in Pakistan and Niger), the system will run for about 30 minutes on batteries until the generator is ready. Meanwhile, other team members are concentrating on medical preparation, insurance, security, equipment, visas, flight tickets, communications etc.

In transit

In their recent mobilisations (Pakistan, October 2005 and Suriname May 2006), MapAction have sent an advance team to asses the situation. Whether the advance party or full team, transit time is useful as MapAction aim to have situation maps ready to distribute on arrival – thus they prepare maps whilst on the move. The first requirement for almost anybody new to a disaster situation is a simple geographical overview (geographical in the sense of integrating information about a place –

showing main towns, airports, roads, railways, mountains and rivers) so this is the first priority. Having access to good information at this stage can have large impact on the early work of the response teams.

Figure 2. A MapAction map from Suriname (May 2006).



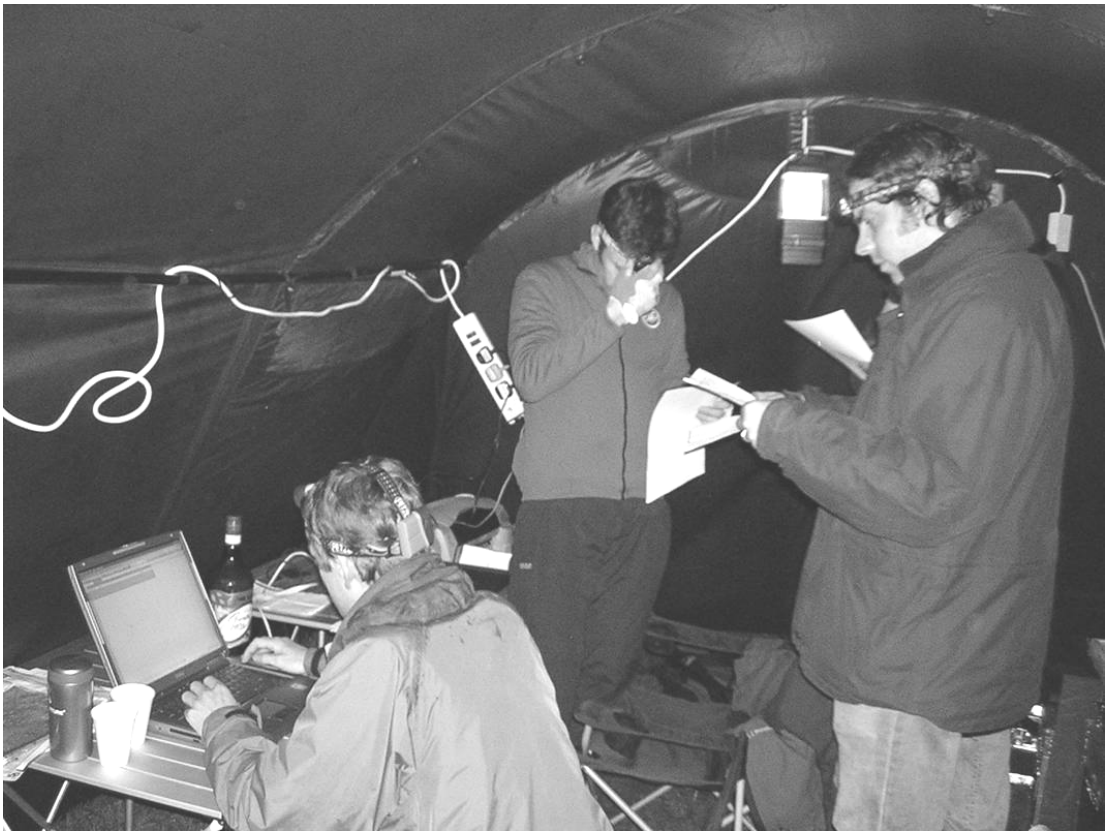
Once on site MapAction establish a field base, with a small network and communications devices (recent examples range from a tent to a presidential palace) *in situ* data collection can commence.

Advantages of being *in situ*:
The country's NMO may be many miles away in the capital city or regional centre. MapAction is unusual in being *in situ*. This has two significant advantages. They can:
1. deliver responsive products, maps to people on the ground.
2. gather data *in situ*.

It can be tempting to conclude that as soon as an Ikonos or Quickbird image (0.5 or 1 m spatial resolution) has been delivered, everything is known about what's on the ground. Undoubtedly such images are a huge help but numerous experiences in Sri Lanka and Pakistan, for example, have emphasised the essential requirement for direct observation; not remote, but local sensing.

Additional data requested from other agencies has the potential to provide vital supporting information. In particular the important, and elusive, geocoded *demographic* data.

Figure 3. A MapAction map from Suriname (May 2006).



Lessons learned and looking to the future
Rather than being "information purists", on a strict diet of high-quality, geo-referenced data, MapAction have found the need to be ready to be a lot more

"omnivorous". Pakistan is a good example. The most downloaded map from MapAction's on-line catalogue was taken, with permission, from a technical report written some years before on the flood hazard in Muzzafarabad (one of the worst-hit towns and which became a hub of humanitarian relief activity).

MapAction have seen the task of mapping in disaster areas as one for a team of GI specialists. Broadly that still holds true - other emergency relief agencies are not interested in how to symbolise roads in a GIS, or even in downloading a ready-made map, when they have 10,000 portable homes to deliver. They just want a road map, on paper, in their hands. So it makes sense to have people delivering on the ground. However, those people on the ground know more than others about populations, road conditions, even place names. Such actors are typically hugely keen to share such information, with their humanitarian motivation. In future, MapAction would like to be able to allow people to add their own data with a degree of automation to the geographic database. Ideally this information will also form a valuable source for the post-disaster stages of the cycle, so needs to be in a form which is interoperable with existing data.

The short-duration operational model of an agency such as MapAction makes it essential to find resources in country that can take over on-going GIS support and mapping requirements after the initial disaster phase. As noted above, the NMOs are usually the best placed to take on such activity and resume their role as the authoritative data collector and distributor in the country. They can also have a role in supporting emergency mapping agencies and ensuring that their data is available if required at short notice and in an interoperable form.

With the circumstances so variable (the place, the people, the problem) MapAction use a "tool kit" approach, with the right equipment, software and GIS techniques and adapt them "on the hoof" according to particular situations. Imposing a "template" solution invariably does not work. They are flexible and specialist and, as such, completely different from an NMO which is what makes them complementary in providing mapping services throughout the disaster cycle.

Mapping production and delivery during the response phases can rapidly become a rather complicated picture. There is a web of input, coming from different individuals and organisations, in different places, with different degrees of reliability and different agendas. Such a range of inputs also calls for interoperability in its widest sense - from data formats to the use of ontologies. An ontology, is one of the fundamental building blocks of the Semantic Web: it describes a domain by specifying the concepts in the domain, and the relationships between those concepts. A team Ordnance Survey's Research & Innovation is investigating the application of ontologies for interoperability at a semantic, or "meaningful" level. Ordnance Survey is developing a topographic ontology, to describe explicitly what it means by each of the terms in its database, and how they relate to each other. This makes it easier to combine the geographic data with other data sets also described by ontologies, as we know exactly what is meant by the terms each party is using. (Mizen et al 2005, Dolbear et al 2005). This is compounded by the wide range of circumstances that such

situations present - depending on the location, the nature of the disaster, the active agencies and to some extent the language and cultural understandings of the society. This is the real challenge for 'interoperability' in the future.

Judging by the high demand for MapAction maps following recent sudden onset disasters, daily situation mapping can be an asset to relief operations in the immediate aftermath of a major emergency. Producing a map is like producing a newspaper. Map production has to meet an unforgiving deadline each day.

Map production capability is not a trivial process. It is manpower intensive – adequate numbers of people are needed to put together a demanding 24 hour operation schedule of activities both technical and functional. Emergency map-making takes time, careful attention to detail, and requires sufficient human and technical means.

For MapAction to make the best contribution to emergency mapping requires the resolution of some abstract challenges and relates to our need to better define a framework for geographical information in disaster response, to allow multiple organisations to participate, to more efficiently collect data, share it, and depict it in the form of a map. One source of help in the future may be from the outputs of Project Orchestra.

Improving the way we deal with information – Project Orchestra

Disasters happen in many dimensions. Ordnance Survey has an active involvement in a project called "Orchestra" which deals with the risk management element in multi-risk, multi-lingual, cross border incidents, recognising that disaster is often created by a combination of different contributing factors.

The Orchestra Project (a 16 partied European Integrated Project) considers the Risk Management element and proposes an open architecture for risk management. The project will output free and open source software to create a backbone for services needed to assess risks and heighten the level of preparedness for all those associated with potential natural and man-made disasters.

Nearly two years into the three year project the core architecture is now created. Over the remaining year participants such as Ordnance Survey, Atos Origin and the Joint Research Council of the European Commission will be contributing to pilots to test the software and services over a range of different scenarios from water pollution to forest fires, from Pan-European to cross Alpine situations.

Ordnance Survey's interest in the project is in providing a robust platform where data, including our own geographic information, can be made accessible in the most effective way for these vital purposes. Specifically Ordnance Survey has led the project on the use of semantics for machine and human understandable interpretations of what the data means, bringing us a step closer to the automation of decision making. Ordnance Survey also contributes with the translation of geographic information schemas by hosting such a service in the pilots. And, to gain access to the right information, for the right purpose at the right time, Ordnance Survey are also investigating methods of automating the access rights to the data via a distributed system; a process know as Digital Rights Management (Vowles 2005).

Conclusion

This paper has demonstrated some of the many aspects of location information in a fragile world, with particular reference to the roles of key information providers within the disaster cycle, the problems facing both and some work which can help in future. Progress can be made on a number of fronts. An NMO can be aware of its responsibilities as both as the nation's provider of definitive information and also as a player on the world stage, with the ability to provide skills and information not just at times of emergency, but beforehand in creating the systems that will minimise the impacts of such disasters and support for complementary mapping agencies who provide the response service.

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www.eu-orchestra.org will link to all current papers relating to Project Orchestra