National Mapping Agencies – A new model for the 21st Century

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ABSTRACT

Many countries cannot afford to run a modern capital intensive national mapping agency (NMA). This paper proposes a new model for NMAs as Centres for Geographic Information, supported where appropriate, by International Mapping Agencies (IMAs). Traditionally, NMAs have been responsible for topographic mapping (based on 19th Century military requirements) and cadastral mapping (concentrating on property boundary beacons). Much of the mapping is out of date or covers only parts of a country. The data, though necessary, is insufficient for the needs of a modern society.

Two proposals are put forward. The first is to develop local data gatherers operating with simple equipment but feeding up-to-date and relevant information into the national spatial data network. These new-model surveyors will collect much more data than that currently gathered by cadastral surveyors. The second is to help the less developed countries in their basic geodetic, topographic and database management work through franchises, in the way that national airlines are run by international carriers.

The paper considers such a model from an organisational perspective and suggests its strengths, weaknesses, opportunities and threats. It identifies the costs and benefits and considers a possible role for the International Federation of Surveyors (FIG) in facilitating the re-engineering of national mapping agencies.

NMAs must change if they are to survive. This paper suggests a way forward.

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1. INTRODUCTION

Over the last decade the trend towards computerisation and the use of high technology in surveying and mapping has accelerated. Data input requires Global Positioning Systems, electronic 'total stations' and portable electronic notebooks. Data processing requires powerful computers and sophisticated software, as do data presentation and distribution. This move towards high technology has happened at a time when national mapping agencies (NMAs) have come under increasing pressure to recover more if not all of their operational costs. Those at the leading edge of the technology have been struggling to keep up with the developments. Those in the less developed nations are simply unable to cope, many still having to operate with equipment purchased 30 or more years ago. Even where international aid agencies have offered some support the gap between the rich and the poor amongst NMAs is steadily growing wider. The data rich are getting richer while the data poor are becoming poorer. In a number of poorer countries the quality of topographic mapping that is held by foreign powers (for instance by military mapping and charting agencies) far exceeds that available within the countries concerned.

The problems are not however restricted to topographic or hydrographic mapping. In many countries cadastral surveyors are unable to cope with the volume of work that is needed if the growing numbers of informal settlements are to be regularised. There is growing evidence that spatially related data are a resource that can reduce risk in decision-making and have a potential to help in creating national wealth. Unfortunately many NMAs in their present form have become anachronistic, offering no more than 19th Century solutions to 21st Century problems. Many are already being marginalised and are in danger of becoming totally irrelevant. Something therefore needs to be done to overcome these difficulties.

2. THE CHANGING SCENE

Most National Mapping Agencies have failed to grasp the far-reaching consequences of the change from Measurement Science into Information Science, from a method-oriented approach in surveying and mapping to a problem based set of solutions. They may discuss Land Information and Geographic Information Systems but they still focus on maps and charts and on manual skills rather than information management skills. Topographic mapping is all too often locked into a 19th Century paradigm and military thinking in which only those features that can be hit with a mortar bomb are shown on the map. Where are the comprehensive records of underground services or large-scale land use data? Where are the maps showing building heights, the quality of building construction or property values? All too often, urban mapping is out of date and incomplete because cadastral surveyors seek too high technical standards and show too little concern for user requirements. Cadastral mapping is often a producer driven commodity seeking to meet imagined though unrealistic needs.

The far-reaching changes to which NMAs must respond include moves from:

Labour intensive systems	into	Capital intensive systems
Cheap/old technology		Expensive/new technology
A specialised/narrow role		A multi-disciplinary service
Government driven		Market oriented
Government funded		Full cost recovery
Monopolistic		Competitive with private sector
Traditional products		New products and services
Casualness about time scales		Time and cost focused
Quality Controlled		Quality assured/risk managed
A Benevolent NMA		An uncertain future

Some agencies are meeting these challenges. Others have yet to begin.

3. DEVELOPING A NEW AWARENESS

The traditional roles of National Mapping Agencies were clear. Their functions were to:

1. establish geodetic control points and a spatial data framework,
2. provide complete national topographic map cover at a variety of scales,
3. produce maps for national security,
4. guarantee national cadastral map coverage,
5. implement quality control over the private sector, especially with regard to cadastral surveys,
6. undertake research and development; and in some cases
7. carry out large scale mapping projects.

Today these seven activities have changed, and in particular:

1. Given Global Positioning Systems (GPS) and agreement on the national spatial referencing system there is little need for triangulation networks and trig points. The scientific community including universities and consultants can usually offer good advice on geodetic datums and map transformations. It is important that NMAs provide a forum for debate and decision-making on all issues concerning surveying and mapping and ensure that national interests are addressed. But they no longer need to carry out all the work themselves and increasingly are unable to do so.
2. Topographic mapping can often be produced more cost-effectively by the private sector or by foreign contractors. The key issue is the frequency with which revision takes place. Many NMAs fail to undertake continuous revision and have provided the public with out-of-date maps – even at the date of publication. In any re-engineering of NMAs there must be mechanisms for frequent updating of all spatially related data.
3. NMAs still need to ensure the maintenance of complete basic topographic map cover. The collection and maintenance of data required for national security should be the responsibility of the military or the police or a separate unit within the NMA. If NMAs are to be market driven then access to their fundamental data sets must be open to all at an appropriate price.

4. Even though, in many countries, much cadastral surveying is undertaken by the private sector, the quality of the cadastre is still controlled by central government. Although some cadastral mapping may be based on mass production methods using photogrammetric techniques, there are always data that can only be collected on the ground at large (i.e. detailed) scale. Most central government mapping agencies are no longer able to meet the demand for more comprehensive data sets, especially since the nature of the cadastre is changing and continuous monitoring of what happens on the ground is an imperative. As a result, the data that are held are normally restricted either in the area that is mapped, the variety of data types that are recorded or the currency of the data.
5. Whereas quality control is essential, the present systems of monitoring the private sector are often unacceptably slow and expensive. In many countries the national economy suffers from the delays and costs in checking cadastral surveys.
6. Research and development (R & D) is now almost always carried out either by manufacturers or is sub-contracted to universities or research establishments. Few NMAs now have the expertise to undertake R & D on their own.
7. NMAs in less developed countries do not in general have the expertise or the equipment to carry out major projects such as engineering surveys or scientific investigations.

4. TOWARDS A NEW MODEL NMA

In refocusing the aims and objectives of National Mapping Agencies there must be greater awareness of the needs of the potential user community. There has been an assumption that the government agency knows what is best, leading for example to unnecessary high standards of cadastral survey or the mapping of features that interest the military with the omission of many other data types. There is a need to rethink what data are needed and by whom and in what time scale. All too often there has been an assumption that the public can wait until the agency has completed its work. One consequence of modern communication systems is that time scales are shortening and delays in delivering products and services are no longer acceptable. If maps, for example, cannot be delivered on time and up to date then clients will find alternative ways for solving their problems, either by using satellite imagery or by taking risks that could be avoided if appropriate spatial data were available.

Given the difficulties that all mapping agencies face, especially in the developing world, a new paradigm needs to be developed. The first challenge is to refocus NMAs on a wider range of customers and on the needs for a wider range of spatial data. In this context the government is an important customer but only one of many. Each NMA needs to become a comprehensive Centre for Geographic Information (CGI). The data should not be restricted to topographic features or cadastral boundary information. Some of the data that the agencies should collect – such as census data – may be gathered through sampling techniques; others will need to be surveyed more precisely.

As the variety of data gathered becomes greater it will become increasingly important to keep all the data items up-to-date. In reality few nations live in a genuinely data rich society since neither are there enough data sets available to satisfy modern land management nor are the

data items being kept sufficiently up to date. It would be unacceptable for telecommunications companies were to produce out of date telephone directories hence every year or two they publish new directories. NMAs should follow the same practice.

The solution in both developed and developing nations is to employ a series of Local Land Information Managers (LLIMs) who will monitor and report on all changes to spatial data. Working predominantly in the private sector, they will be the eyes and ears of the local community, gathering all the local data and keeping it up to date at all times. Each community should have its local surveyor whose tasks should include the recording of every house extension or alteration to a building facade, every new underground pipeline or cable that is laid, and every change to urban and rural land use. For each property there should be an accurate record of the building, containing all the data necessary for the assessment of its value. The LLIMs would monitor and record changes so that the local records are kept up-to-date at all times and would contractually be required to guarantee the quality of the data. The information would be fed electronically into the national land information service, which in turn would be co-ordinated by the National Mapping Agency. The resulting information would provide support for central government services and many local government activities.

In Europe the LLIMs would also provide data for the Integrated Administration and Control System (IACS) that supports the Common Agricultural Policy (CAP).

Although working within the private sector, the LLIMs should operate under government licence. Their work would need to be co-ordinated at the national level to ensure uniform cover and an adequate supply of data. This should be the responsibility of the NMA who would let contracts to ensure that all areas of the country are covered. In some regions the responsibility might be given to an individual while in more complex areas the contract might go to a survey company. The contractor would be the licensed data gatherer for the local area and custodian of the local land information database, feeding data to the local government authority and to the national archive.

The responsibility of the NMA would be to:

- co-ordinate the work of the LLIMs;
- use public sector surveyors to gather data in areas where no private sector LLIMs are available or where there is specially sensitive data to collect (e.g. military sites);
- quality control the data collection and processing;
- manage the national land and property information services and databases;
- supervise data distribution (e.g. restricting public access to some sensitive data); and
- maintain the data for posterity as a national historical archive.

5. THE COSTS AND BENEFITS

Turning National Mapping Agencies into centres for geographic information implies an expansion rather than a contraction of their roles. As NMAs in less developed countries, especially in Africa, cannot even afford to keep their topographic data up to date, how can they possibly afford to provide the spatial data infrastructure that is needed to underpin

economic and social development? How can they fund a series of local land information managers? They have no hard currency to buy the new technologies for data acquisition, processing and display and cannot afford to maintain their existing data let alone to expand. Yet they can least afford to waste or abuse their limited resources. The more wealthy nations at least have the luxury of being able to pay for wastage.

Looked at over the longer term, the benefits of improving access to land and property related information are considerable. Hernando de Soto, the Peruvian economist, has argued in his book 'The Mystery of Capital' that the reason why there are so many poor people in the world is that they do not have formal access to land and property. They work every bit as hard as people in the more affluent West, they are every bit as intelligent even though many lack a good education, and many have manual and craft skills that those in the more affluent countries cannot be bothered to learn. De Soto argues that many of the poor are potentially enormously wealthy, but at present their capital is dead.

Part of the process of bringing that dead capital to life and creating a more equitable distribution of wealth is through the provision of safe, open and cheap access to land and property markets. The stakes are high when it comes to improving spatial data infrastructures. There is a very significant cost but there are very great potential benefits.

The main costs would be in the initial creation of the data and then in their maintenance. The latter will not require very high technology although access to the Internet will be desirable. Once the basic mapping is in place the revision and update of the data will be possible with little more than a linen tape and a notebook. Preliminary investigations in the UK suggest that there is enough work that needs to be done to provide a reasonable income for the LLIMs as well as meeting the fundamental needs of society for up to date and reliable property-related information. If this is true in the UK where labour rates are relatively high it must also be true where labour is cheap. Hence the key challenge is how to build the data sets in the first place.

6. MANAGING THE TRANSITION

Unfortunately there is little at present that many NMAs are able to do to meet their present terms of reference, let alone expand on their activities. In a number of countries bilateral and multilateral aid in surveying and mapping has been provided but in general it has met with limited success. Recipients of aid in geomatics often do not match the gift of technical assistance with the necessary commitment to maintenance and recurrent expenditure. In many countries, civil service salaries are so low that those who receive additional training through support programmes move to the private sector at the earliest opportunity. Giving hardware and software and even technical assistance is not sufficient to create an effective solution. It makes no sense (other than for the instrument manufacturers) to give every country GPS receivers, digital photogrammetric and other computerised mapping systems and database technology if their use cannot be sustained.

Attempts at establishing regional centres to provide support for mapping, especially in Africa, have likewise met with little success mainly because each country jealously guards its own

independence. As in Europe, each NMA has a remit that discourages innovation hence it cannot easily take initiatives in areas that are currently outside its terms of reference.

So why not try the national airlines model? Countries want the prestige of having their own national airline but cannot afford to operate it without the help of some of the major international carriers. Third World country airlines carry the colours of their nation but are operated and maintained by foreigners without threat to national sovereignty. Why not handle mapping in a similar way? The routine work would be done at the local level (through local land information managers) but the hardware, software and management would be provided by a major internationally recognised surveying and mapping organisation.

One difficulty of course is that there are hardly any global mapping agencies that are the equivalents to the multinational airlines. The American military have been mapping many countries and are dominating the development of the Global Spatial Data Infrastructure for commercial and security reasons. Within Europe EUROGI (European Geographic Information umbrella group) is a public and private sector partnership that has been looking at greater European integration. It is essentially a lobbying group, not a mapping agency. Eurogeographics, the organisation that provides a forum for European NMAs, could possibly become the European Mapping Agency.

What is needed is an International Mapping Agency (IMA) that can offer a truly global service that addresses the many spatial information problems in the Third World. The IMA would articulate spatial infrastructure opportunities and lobby the international community for funds. It would not be a production unit but would sub-contract work to the private sector or to those existing NMAs that are adequately resourced. Its function would be to help the Third World by advising on contracts for the delivery of national spatial data infrastructures (NSDIs) in countries that cannot at present manage to pay for them. It could go further and act as a multinational quasi-governmental organisation running local NSDIs in partnership with local agencies. Local people would act as the local land information managers while the IMA through its contracted operator would provide the central core of management expertise and access to modern technology, just as certain multinational carriers help local airlines. Thus each country would be able to have its own national Centre for Geographic Information under its own political control even though the base mapping and data processing would be carried out by those who can afford the technology. Donors would work in partnership with the IMA so that quality was ensured in the delivery of a modern land information service.

7. THE OPPORTUNITY FOR FIG

It is not in the remit for FIG to become an international mapping agency. FIG is neither resourced nor mandated to carry out such work. It should however be the catalyst for the creation of an IMA. It has access to a wealth of knowledge and experience on which it can draw. It should use the expertise that it has available to lobby international agencies, promoting the ideas and providing advice as appropriate.

In its Bathurst Declaration FIG committed itself to ***'Halving*** **the number of people around the world who do not have effective access to secure property rights in land by the Year**

2010'. This can only be achieved through a radical and far-reaching initiative. The challenge is to re-engineer the way in which national mapping agencies operate. They need to become agencies for wealth creation by becoming comprehensive centres for geographic information.

BIOGRAPHICAL NOTES

Peter Dale is an Honorary President of FIG having served as President from 1995-1999. He was a practising land surveyor before entering academia. When he retired from University College London in 2001 he was made an Emeritus Professor.