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Characteristics and sources of framework data

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Framework data are those which underpin all GIS operations, providing the geographical context and structure within which spatially manifested processes operate and on which other data are assembled. This chapter describes the nature of the framework and its subset, the topographic template, as it has evolved to date and may evolve in future. It defines the desirable characteristics of a framework whilst recognising that resource constraints, historical legacies, changing user needs, and the impact of new technologies render the ideal unattainable and trade-offs inevitable. Reviewing the responsibilities for maintenance of the framework, the essential need for inter-organisational collaboration is highlighted. The likely impact of new high resolution satellite imagery is assessed and it is concluded that this will be very geographically specific and that, in itself, imagery is an inadequate framework for most applications though it may well form an important component of it. Finally, most frameworks to date have been nationally-specific: some of the growing needs for multi-national and even globally consistent frameworks are summarised, together with actions being taken to address these needs. The chapter concludes with an admonition to managers in GIS organisations to monitor and seek to influence those bodies maintaining the framework since most are under pressure to cut costs substantially and changes they may make could have substantial technical, operational, and financial consequences for users.

1 THE IMPORTANCE OF FRAMEWORK DATA

There are two main reasons why a spatial framework is essential in almost all GIS operations. The framework provides both spatial context and spatial structure. In dealing with a satellite image, for example, the incorporation of place names facilitates linkage to the real world; moreover, the framework may be used to rectify distortions in, or partition and re-orientate, the imagery. The second reason for the importance of the framework is that geographical or geospatial information is typically collected by many different agencies, usually within the boundaries of national territories and most of these agencies have historically collected data primarily to suit their own local purposes. Thus, if the benefits of added value are to be obtained from data integration within a GIS, there must be a mechanism (or spatial 'key') to register the different datasets together in their correct relative positions and, beyond this, to ensure that the component objects within each dataset are properly related. In general, only the framework can provide this ubiquitous key through the use of coordinates or implicit geographical coding (Seeger, Chapter 30).

2 THE NATURE OF THE FRAMEWORK

As in many other aspects of GIS, the terminology used to describe framework data differs amongst practitioners. Two apparently different but overlapping interpretations have been made of the term geospatial 'framework data'. The first, and more limited one, regards it simply as the topographic template, traditionally exemplified by topographic mapping. Much other information is typically referenced to this template, either because of historical factors (there was no nationwide alternative) or legal dictates. The template provides a context in which other data sit and a means by which geocoding and data linkage can take place. This type of framework exists in almost every nation: detailed parts of it may, however, be unavailable for reasons of state security or lack of investment (Bohme 1989; Brandenberger and Ghosh 1990) and the vast bulk of framework information is currently only available in paper map or coordinate list form. Its form, detail, currency, and availability also varies greatly from country to country: in Britain, for instance, the Ordnance Survey provides framework data which is used in conjunction with virtually all other geospatial data in the country, with applications ranging from recording the location of utility plant, through land registration and country-wide government planning, to defence, environmental monitoring, and recreational purposes. In some cases its use is statutory but in many other cases it is used because it has been in existence for 200 years, because there is no other detailed mapping (typically in uncommercial rural areas), or because the merits of a single consistent framework are recognised for data collection and subsequent use. Updating of major features takes place within six months of their construction. The form in which the framework is supplied is highly varied, including detailed house-by-house mapping, road centreline data, the national address database, and various generalisations and combinations of these data.

In other countries, different frameworks exist which are suited for different types of application and in response to different legal environments. Typically, only one or two public sector organisations are responsible for providing the overall national framework (as in Britain, France, the Nordic countries, India, Japan, and New Zealand). But, in countries with federal governments, local and more detailed versions of the framework are often produced by other (e.g. state or local) governments (as in Australia, Germany, and the USA). Rhind (1997) has assembled a set of examples of the different practices across the world. The private sector, so far, has been mainly involved in marketing some of this framework data or as contractors in its collection; however, firms like Etak and NavTech compile their own road centreline data from a variety of sources and surveys. The role of the private sector may expand with the advent of high resolution satellites (Estes and Loveland, Chapter 48; Calvert et al 1997).

The second and more general use of the term is to describe a core set of standard variables which are commonly used or needed and which ideally are available over the whole domain of interest (e.g. the nation state or even the entire world). These standard variables may include the topographic template, imagery, land use/land cover information, transport, and property and land ownership data. Some would argue that population density, hydrology, geology, and other variables should be included in the definition of the framework. Because governments have been the main source of these data and they are typically sub-divided on functional lines, many different bodies may be involved even within one country in the supply of such data, even in non-federal countries.

In practice, however, there may be only modest differences between these two definitions. The US Federal Geographic Data Committee (FGDC 1995), for instance, has defined the information content of the US framework as consisting of:

- geodetic control;
- digital orthoimagery;
- elevation data;
- transportation;
- hydrography;
- the geography of governmental units;
- public land cadastral information.

Many of the data listed above would be provided for under the topographic template definition as implemented in many countries.

In addition to the terms ‘framework’ and ‘template’, some use has been made of the terms ‘core data’ (which usually describes a wider range of data, including land use and population information: see Estes et al 1995 and below) and ‘foundation’ data. At present there is little general agreement on what constitutes the latter.

3 THE TANGIBLE AND INTANGIBLE BENEFITS OF FRAMEWORK DATA

Perhaps curiously, relatively few formal and analytical studies have been carried out on the benefits of framework data. In general, the answer has been taken to be self-evident: nations have needed topographic maps and (subsequently) data for defence or other contingency purposes. In many countries the studies have been funded on this basis. During the 1990s, however, a series of studies in different parts of the world examined some of the benefits which a good framework bestows. Coopers and Lybrand (1996) emphasised the difficulty of putting a realistic price on the value of such data, especially their intangible and externality effects (see Obermeyer, Chapter 42). They noted three types of external benefits arising from the use of a common framework:

- ensuring consistency in the collection of data (producer externalities);
- providing users with access to the same data (network externalities);
- promoting efficiency of decision-making (consumer externalities).

Other demonstrations of the value of framework data are found in many different, usually qualitative, studies. For instance, the US Geological Survey has published a defence of the benefits of collecting, holding, and disseminating geological data and many of these arguments hold also for framework data.

4 DESIRABLE CHARACTERISTICS OF FRAMEWORK DATA

A simple classification of framework data is shown in Figure 1. This demonstrates the complexity of features or entities which typically make up a dataset and some of the different properties they possess. From these elements a wide variety of different types of area may be created for different purposes (see Dale and McLaren, Chapter 61, for examples in the realm of land administration). In Britain, for instance, no less than 150 sets of geographical zones are used for different government purposes; this recognition has led to a move to create a much simpler and more universally used set of standard geographical units. Whilst statistical data are produced for many governmental/administrative units (e.g. communes, départements, and régions in France), many other statistical units exist which have no governmental or administrative purpose (e.g. city

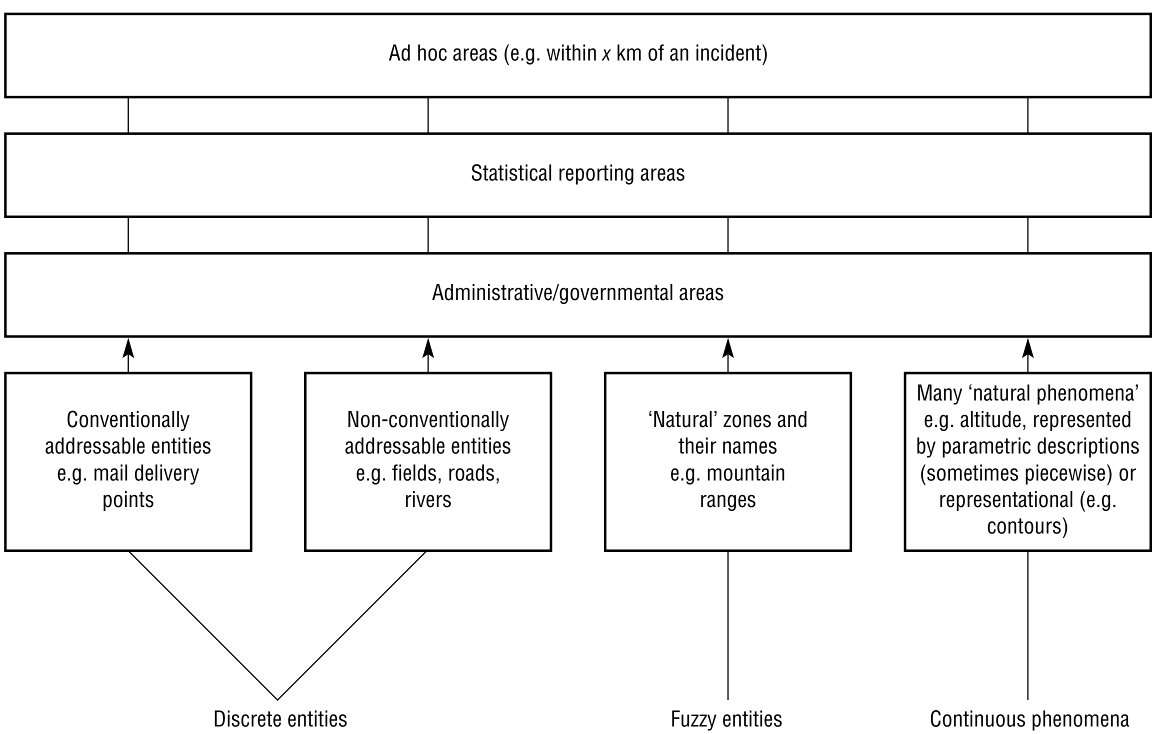

Fig 1. The components of the framework and their combination into different types of zones which may or may not nest geographically.

blocks in the USA or enumeration districts in the UK). It is self-evident that there is an infinite number of different ad hoc units which are possible (see Openshaw and Alvanides, Chapter 18).

Given its centrality to many different applications, including all those involving GIS, it follows that the framework should desirably have the following characteristics over the domain of interest:

- The measures of the phenomena to be collected should be formally defined and universally applied.
- The measurement, recording, and transformation techniques should be as consistent as possible but, at the very least, should be defined and made available through the provision of metadata.
- The organisation(s) involved in collecting and/or holding the data must define the standards of accuracy, consistency, resolution, etc., to which they are working; formal checks on these must be carried out and published and the organisation must have the confidence of the mass of users.
- It must be more 'fine grained' (or higher resolution) than any important application which seeks to use it.
- It must be updated as frequently as the most crucial applications of the framework require; the rules under which the updating will take place must be publicised and the organisations involved must have a longevity which gives users confidence that it will be available over the long term. Ideally, historical versions of the framework should be available.
- If one of the two primary roles of the framework is to permit linkage of other data, one other highly desirable characteristic is that only one such 'template' should be used in order to maximise the likelihood of all datasets being capable of being fitted together.

In practice, the last condition is sometimes violated. It is normally absurd, for instance, to use mapping at 1:1000 scale to match together two datasets, each pertaining to a whole country and whose use can be summarised on a single sheet of paper! In these circumstances, generalised versions of the framework are used (Weibel and Dutton, Chapter 10) but these are preferably derived by defined and automated rules from the high resolution data. More generally, it is obvious that some of these conditions result in variations in the desired characteristics of the framework over time, for example in the extent to which the needs are driven by important applications.

Finally, the framework is becoming increasingly something superior to digital versions of traditional paper maps. The early practice of encoding such maps in a fashion suited primarily to reproduction of facsimiles is highly constraining for any analytical uses of the framework. Thus, a good framework is founded on the recognition of 'real-world objects and phenomena' rather than cartographic representations of them. For example, the road network must continue under bridges. For some applications, the 3-dimensional topography of the built, as well as the natural, environment is required.

5 RESPONSIBILITY FOR THE FRAMEWORK

The responsibilities of the bodies charged with the creation and maintenance of the framework are obviously a function of how that framework is defined. However, using the US definition given earlier in the chapter, a comparison of the primary responsibilities for the different features in two very different countries is shown below in Table 1. Toponymy – the naming of features – has been extracted as a separate row. In principle it could form part of most other rows but toponymy is something of a special case. Who is actually responsible for naming geographical objects? Towns, streets, and administrative units are simple cases but other geographical features cause trouble because their extent may not be defined precisely – where, for example, is Salisbury Plain or are the Appalachians? (For a general discussion of entity definition problems, see Raper, Chapter 5; Martin, Chapter 6; for a discussion of the assignment of labels to cognitive categories of real-world phenomena, see Mark, Chapter 7.) Multi-lingualism provides another hurdle to be overcome and is a problem in many areas such as Wales (UK), Belgium, Switzerland, and Finland (in Finland four languages – Finnish, Swedish, and two Lapp ones – are used on some signs).

The summary in Table 1 is inevitably a simplification of reality and the situation differs greatly in other countries. In France and elsewhere, for instance, the cadastral framework is quite separate from the topographic one. The cadastral map and associated records have a basis in the need to ensure comprehensive and equitable taxation and the mapping was created as a separate operation under the auspices of the Finance Ministry (see also

Table 1 Responsibility for the framework in two different countries.

	Primary responsibility for definition, maintenance, and dissemination of the record of the framework *USA*	*Great Britain*
Geodetic framework: definition and use of national map projections and geodetic transformations	National Geodetic Survey, National Oceanic and Atmospheric Administration, Department of Commerce	Ordnance Survey
Digital orthoimagery	US Geological Survey National Mapping Division (in cooperation with other Federal agencies), individual states and local government, and private sector	No national jurisdiction (or provision) at present
Elevation data	US Geological Survey National Mapping Division some states	Ordnance Survey
Transportation	Department of Transportation, individual states and local governments plus US Geological Survey National Mapping Division	Department of the Environment, Transport, and the Regions, local governments, Ordnance Survey
Hydrography	US Geological Survey	Ordnance Survey
The geography of governmental units	State and local governments, US Bureau of Census, and US Geological Survey National Mapping Division	Office for National Statistics, Department of the Environment, Transport, and the Regions, Department of Health, etc., and Ordnance Survey
Toponymy	US Board on Geographic Names, Department of Transportation, states, and local governments. Collation of these names and dissemination by US Geological Survey Individual properties identified by street name and numbers: names often proposed by developers and approved by local government, with information assembled and disseminated nationally by the Bureau of Census and other parties	Branches of central and local government plus Ordnance Survey (on the basis of local usage). National collation of these names and dissemination by Ordnance Survey Individual properties identified by street name and numbers given by local government and information assembled and disseminated nationally by Royal Mail and Ordnance Survey
Cadastral information	Various federal agencies (public lands); individual states and local governments for other land parcels	HM Land Registry (England and Wales) and Registers of Scotland (both using Ordnance Survey maps/data)

Salgé, Chapter 50). Unsurprisingly, this has governed the content, form, and quality of the information collected. In Switzerland, cadastral maps show no more than the parcel boundaries with minimal details of the buildings and other landscape features. The cadastral framework and the topographic one may thus be entirely separate, in contrast to the British situation where everything is based on the same topographic map. In Australia, hitherto separate topographic and cadastral maps have been combined to form a new 'first pass' national spatial data infrastructure (Mooney and Grant 1997).

Irrespective of the detailed differences between countries and the fact that changes to the framework often originate in other organisations, it is the norm that the national mapping organisations (NMOs) – sometimes in parallel with bodies of a similar function in states or their equivalents (e.g. in Australia, Canada, Germany, and the USA) – play a major role in assembling, maintaining, and disseminating the record of the framework. The history of these organisations, their cultures, the resources available to them, their detailed policy remit (Rhind, Chapter 56), and the priorities set by their 'owners' all combine to produce different results. Many NMOs began as branches of the military and the characteristics of the framework still reflect this to some extent: examples of this include Great Britain, France, and Russia (but see Swann, Chapter 63, for a discussion of current battlefield demands for data and rapid data capture in multinational contexts). The national mapping organisations of Italy, the Netherlands, and some Latin American countries remain under military control. There are many instances where military influences still govern what geographical information can be made available, particularly (but not exclusively) in eastern Europe.

The processes by which that element of the framework for which one body is responsible is assembled and maintained, together with influences for change of the processes, are summarised in Figure 2. Any such diagram is prone to mislead because it implies essentially a linear process, albeit with some

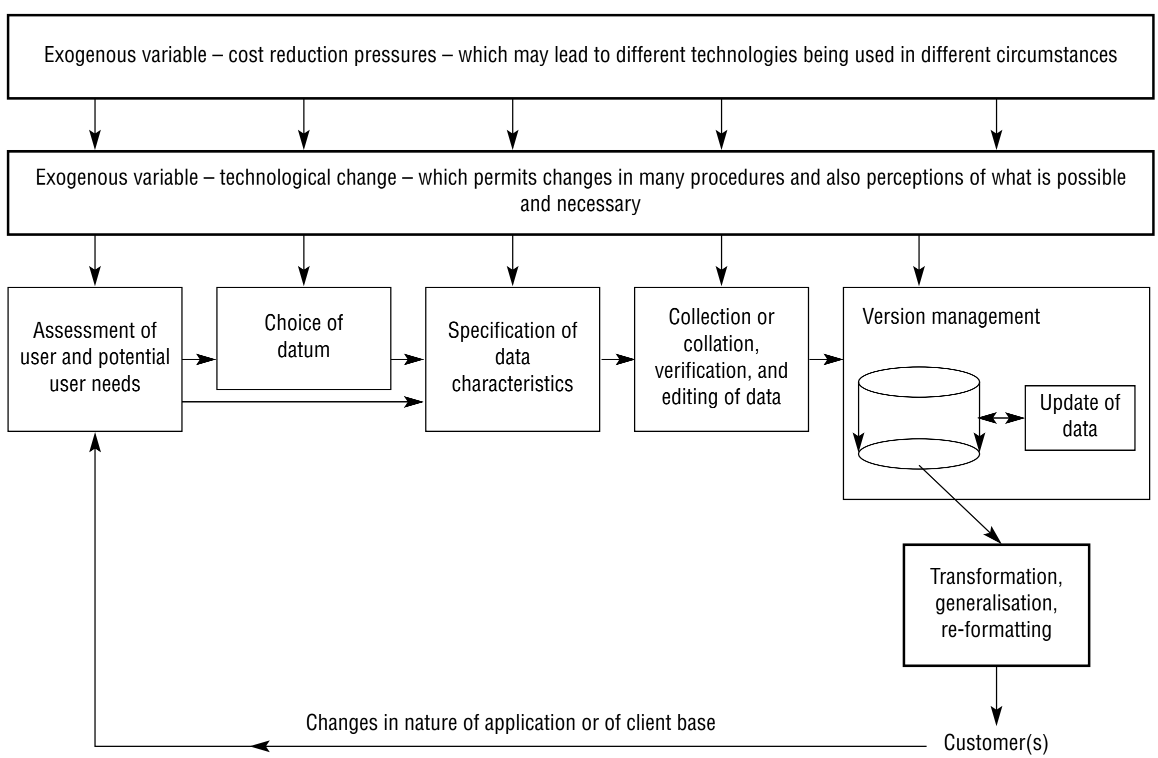

Fig 2. Processes in and influences on the creation of framework data.

with some feedback. It does not cope well with the historical legacy or with the constraints on change. Thus many frameworks have been assembled at huge cost over many years to a standard specification: in the 16 member states of the European Union, for instance, with about 350 million inhabitants, over US$1.5 billion is spent annually on maintaining or recreating topographic mapping and this process has been in operation often for decades. Similar or larger sums are expended annually by the cadastral organisations. It follows that any sudden change to the framework specification may well take years to be implemented across a whole country and cost vast sums.

An inevitable characteristic of the topographic template, let alone a comprehensive framework, is that information comes initially from multiple sources. Whilst the geometric survey will usually be done at the behest of the NMO, knowledge of change – and, in some cases, the manifestation of it – are uncovered from a variety of sources. Some of the sources used to update the topographic template are shown in Figure 3. The efficiency with which 'intelligence' is obtained strongly influences the performance of all organisations maintaining the framework except where that is produced by multiple automated data capture (e.g. by remote sensing – see Barnsley, Chapter 32; Estes and Loveland, Chapter 48). Such remote-sensing-based approaches suffer two great disadvantages – they are unable to detect many cultural features required for the framework (e.g. street names and access to land) and they cannot presently detect change in real-world features reliably on a feature-by-feature basis. Where change is slow yet important – and particularly where it relates mainly to human features – it is often much cheaper and more satisfactory to work locally to update the framework rather than re-fly and/or re-map an entire area.

6 SOURCES OF FRAMEWORK DATA

Despite the complexities cited above, the most obvious first sources for framework data are the NMOs. The addresses of many of these are given in Rhind (1997). In addition, links to the World Wide

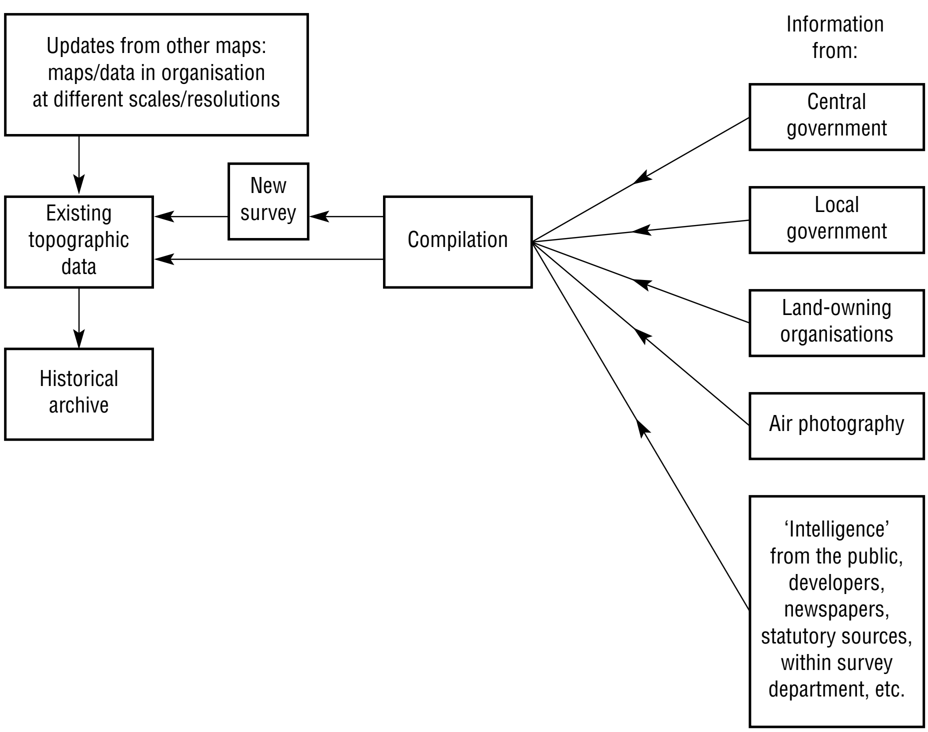

Fig 3. Sources of information for updating a topographic template.

Web sites operated by many of them can be obtained by accessing key sites such as:
http://www.auslig.gov.au (Australia);
http://mapping.usgs.gov (the USA);
http://www.ordsvy.gov.uk (Great Britain);
http://www.ign.fr (France).

7 THE INTERNATIONAL DIMENSION

As indicated earlier, most framework data are nation-specific at best. Greatest variation is at the level of the political jurisdiction and is attributable to cultural, social, and historical factors. The framework data of nations with strong federal government structures is also likely to exhibit sub-national variations, which can create considerable problems whenever pan-national studies are made. Before the widespread use of computers, the process of harmonising the framework across different map sheets in what was supposed to be a consistent global map series was particularly complex and error-prone: for example, Rhind and Clark (1988) illustrated different versions of the same area from two overlapping maps in the military ONC series from which the Digital Chart of the World (US Defense Mapping Agency 1992) was developed (see Figure 4). Some indication of the variations in characteristics of the national versions of one part of the framework can

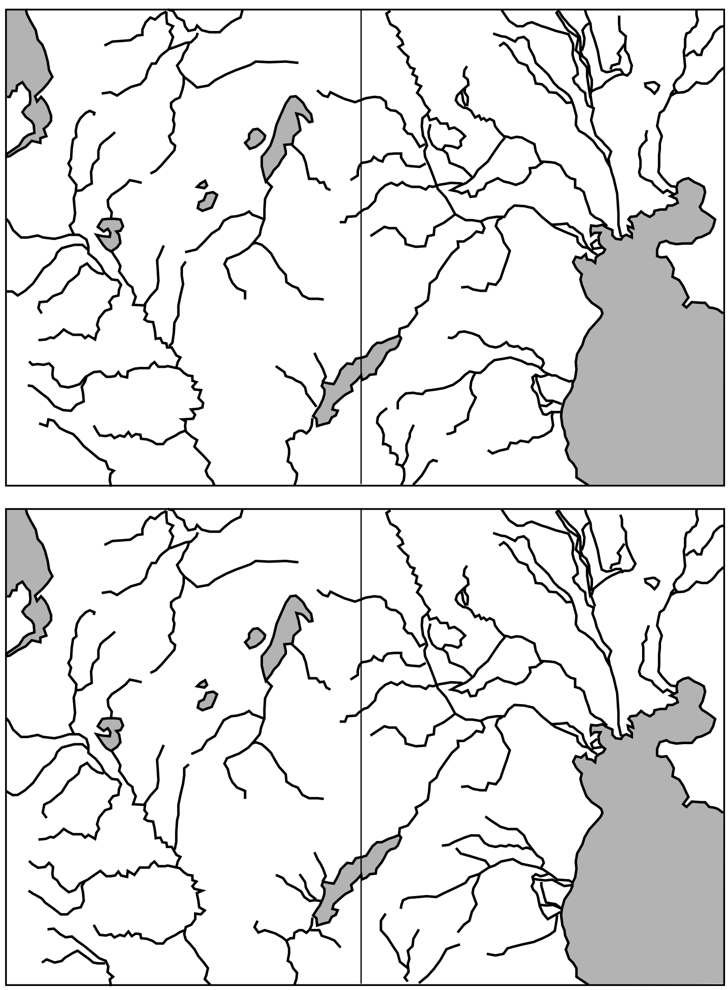

Fig 4. The same area on two different sheets in one map series, showing the effects of use of very small scale mapping for digital global databases (from Rhind and Clark 1988).

be seen in Table 2. This shows the variety of scales of source mapping and names of areas used to create the SABE dataset of pan-European administrative area boundaries made available by each NMO in the group of mapping agencies known as CERCO.

The need for multinational framework data is certainly growing. Htun (1997) has forcefully argued the need for greater coordination of data collection and supply on a regional and global basis:

'In any area of the world, a number of core data types is required to assess environmental conditions and develop strategies that can lead to long term sustainable human development. For many areas of the world, these data do not exist at the scales required to support these activities. Development of such datasets is labour intensive and costly and, although these datasets could support a wide variety of applications, no single use can generally justify the full cost of development.'

Whilst it is clear that his concerns go far beyond the content of the framework, the latter is a central part of his concern for he cites approvingly the findings on these ten 'core datasets' defined by a Bangkok meeting of experts as necessary to foster sustainable development (Estes et al 1995):

- topography;
- hydrology;
- infrastructure;
- climatology;
- demographics;
- land use/land cover;
- soils;
- air quality;
- water quality;
- economy.

Equally, Collins and Rhind (1997) have argued that there is a strong need for consistent, readily available framework data for scientific monitoring and modelling purposes. They summarise this by saying that 'the problems that face the World Conservation Monitoring Centre (WCMC) and other bodies are those of data availability, data cost, and the standardisation and harmonisation of base data layers. To enable WCMC and similar environmental and scientific organisations to continue to collect information on biodiversity and to support the building of in-country capacity to manage their own biodiversity information, changes in the information economy are required. Accurate, up-to-date [multi-national, preferably global] data, made available at costs which can be met by charities and without confining distribution restrictions are required.'

The pricing policies they criticise are a matter for other chapters in this book (see Curry, Chapter 55; Pickles, Chapter 4; Rhind, Chapter 56; and Sugarbaker, Chapter 43, for broader discussions of the social implications of spatial data pricing) and some developments have begun to occur in this area. All are facilitated by the growing adoption of the World Geodetic System WGS 84 (Seeger, Chapter 30); and some NMOs like that of Australia have adopted this as the basis of all their mapping. The other developments can be summarised as falling into four groups:

- 'bottom up' assembly of map-derived databases by groups of NMOs, such as MEGRIN;
- the Japanese-led plans for the development of a global map at 1:1 million scale (Warita and Nonomura 1997);
- 'bottom up' assembly of map-derived databases by the US military and its partners;
- the advent of new satellite systems which provide digital imagery data of resolutions comparable to some maps yet provide global consistency of datum and sensing tools (Barnsley, Chapter 32; Dowman, Chapter 31; Estes and Loveland, Chapter 48).

MEGRIN is a business offshoot of the NMOs of Europe. It has assembled a complete set of administrative and statistical areas, totalling about 100 000 polygons in all and reaching down to the Ward/Commune/Gemeinde/Termino Municipal level covering 25 countries of greater Europe and known as SABE. These form the boundaries of the standard set of EC statistical areas known as Nomenclature des Unités Territoriales Statistiques (or NUTS) level 5. The product is made available in the WGS 84 (or ETRF) reference system on the GRS 80 ellipsoid. The results are available at two resolutions of 30 m and 200 m, corresponding approximately to 1:100 000 and 1: 1 million scale mapping, and are updated regularly (see the MEGRIN web site at *http://www.ign.fr/megrin/megrin.html* which also gives access to details of all topographic mapping produced by European NMOs). Table 2 shows the complexity of source material and terminology involved in creating this one element of the framework on a multinational basis. In addition, MEGRIN is studying the best means of providing a pan-European framework database (PETIT) founded on 1:250 000 or similar scale mapping.

Lenczowski (1997) has described the overall objectives behind the third development as 'in the military domain . . . there is increasingly a need for a

Table 2 NUTS 5 areas and source mapping used to create the SABE dataset. Source: MEGRIN

Country	*Source data scale*	*Lowest level term(s)*
Austria	1:50 000	Politische Gemeinde
Belgium	1:10 000	Commune
Cyprus	1:100 000	Chorío
Czech Republic	1:350 000	Obec
Germany	1:5000 - 1:200 000	amtsfreie Gemeinde
		amtsfreie Gemeinde
		amtsangehörige Gemeinde
		Freie Hansestadt
		Freie und Hansestadt
		Gemeinde
		Gemeinde (verwaltungsgemeinschaftsfrei)
		gemeindefreies Gebiet
		große kreisangehörige Stadt
		große Kreisstadt
		große selbständige Stadt
		kreisangehörige Gemeinde
		kreisangehörige Stadt
		kreisfreie Stadt
		Land
		Landgemeinde (amtsangehörig)
		Landgemeinde (amtsfrei)
		Mitgliedsgemeinde
		Mitgliedsgemeinde in Verwaltungs gemeinschaft
		Ortsgemeinde
		Stadt
		Stadt (amtsangehörig)
		Stadt (kreisangehörig)
		Stadtkreis
		selbständige Gemeinde
		verbandsfreie Gemeinde
Denmark	1:25 000	Kommune
Finland	1:100 000	Kunta
France	1:100 000	Commune
Great Britain	1:100 000	Ward
		Isles of Scilly
Hungary	1:500 000	Kerület
		Település
Ireland	Unknown	District Electoral Division (DED)
		Ward
Iceland	1:750 000	Hreppur
		Condominium
Italy	1:250 000	Commune
Liechtenstein	1:25 000	Gemeinde
Luxembourg	1:100 000	Commune
Latvia	1:25 000	Republikas pilsèta
		Pagasts
		Rajona pilsèta
Northern Ireland	1:50 000	Ward
Netherlands	1:10 000	Gemeente
Norway	1:50 000	Kommune
Portugal	1:600 000	Freguesia
Sweden	1:250 000	Kommun
Slovenia	1:5000	Krajevna skupnost
Slovakia	1:400 000	Základná územná jednotka
Spain	1:25 000	Término Municipal
Switzerland	1:25 000	Gemeinde
		Kommunanz
		Munizipalgemeinde
		See (kantonal)
		Staatswald

world-wide capability to mount operations, whether these are to counter insurgency or support humanitarian operations. Many of these operations will involve partners and hence involve multiple sourcing and sharing of data . . . To help meet the growing need for data, the US National Imagery and Mapping Agency has embarked upon an initiative called Global Geospatial Information and Services (GGI&S). This effort follows upon the successful design, production, and distribution of the Digital Chart of the World (DCW) but extends it greatly' (see also Swann, Chapter 63). The most obvious part of relevance to the non-military community is the creation of V-Map, a conceptually integrated digital map framework for the whole world, compiled to a common specification. The DCW was assembled from the ONC maps at 1:1 million scale and was made available cheaply in 1994 (DCW has now been re-christened V-Map level 0). V-Map level 1, derived from other mapping at about 1:250 000 scale, is now in production. Plans for wide area coverage at more detailed levels also exist. In practice, then, this would seem to meet many of the expressed needs for large area, consistent framework data. But the general availability of these data is far from certain at the time of writing because of their likely commercial impact on, and possible infringement of, copyright of material made available by NMOs. A growing number of the latter are increasingly faced with the reality of paying their own way (Rhind, Chapter 56); and they are understandably nervous to see national data sold cheaply by a foreign agency. Moreover, despite the theoretically consistent specification of V-Map level 1, estimates by MEGRIN for the proposed PETIT project to provide a consistent, general purpose framework for Europe in a convenient form indicate that many person-years of effort will be required to harmonise the military product.

The final development relevant here is the launch of high resolution satellites by commercial suppliers. These are predicted to produce imagery at around 1 to 3 metres resolution (see Barnsley, Chapter 32; Dowman, Chapter 31; Estes and Loveland, Chapter 48; Calvert et al 1997) and the one metre data seem likely to be sold for around US\$20 per km^2. These may indeed provide global availability of high resolution data (except for areas not licensed by the US government) over a number of years but these data alone do not provide a global framework suitable for many purposes. For that, the data will need to be generalised for many wide area operations to a resolution comparable to SPOT imagery or LANDSAT (Barnsley, Chapter 32; Estes and Loveland, Chapter 48) and features will have to be recognised, annotated, and maintained if the data are to compete in many applications with traditional-type, highly interpreted maps. In other applications, of course, such as those in coastal environments, they may well be highly valuable.

8 THE FUTURE EVOLUTION OF FRAMEWORK DATA

Framework data are essential for all GIS applications. The assembly and maintenance of such data by their originators is non-trivial and costly though copying is increasingly a low cost operation. Operationally, the number of parties involved – even if there is a lead player such as the NMO – may be substantial and inter-organisational collaboration is essential.

The universal and low-priced availability of these data in a suitably up-to-date form cannot be taken for granted in countries in which public sector cost reduction and cost recovery have become major drivers of operations (Rhind 1997). In practice if those who created the framework data choose to revise them in some way, such as by change of datum or correction of some error, this may have major ramifications for GIS users since other data may hitherto have been 'fixed' to the previous version. It follows that all GIS-using organisations should have clear strategies for monitoring developments in the 'framework organisations', should understand the asset value of their databases and the costs and benefits of any externally induced changes, and should exert appropriate leverage on these 'framework organisations'. A primary characteristic of framework and other GIS data collation is that its benefits and disbenefits often fall on parties other than those collecting and maintaining the data!

By virtue of having been assembled traditionally on a nation-by-nation basis for nationally prioritised reasons and having been influenced strongly by historical factors, existing framework data differ significantly between different parts of the world. There are, however, a number of pressures and activities already underway which should diminish the problems that this leads to but the enormity of the harmonisation task is such that significant progress at global level is unlikely to be made for two or three decades.

By way of prediction, the key events with regard to the framework data in the next few years seem likely to be:

- growing competition in data supply, in some cases from new, private sector sources, which will undermine the principle of single framework use and cause complications for GIS users who import data from different sources. In addition, the 'bottom up, grass roots' approach to collecting data as advocated by Tosta (1997) may come to impact on the consistency and availability of framework information;
- a growing need for greater consistency between nation states (e.g. the incentive for the military V-Map project and the SABE and PETIT projects of MEGRIN);
- cumulative effects of changing technology, including heightened expectations of customers, a much larger number of 'small' customers, and the need for differentiated products (Elshaw Thrall and Thrall, Chapter 23);
- the consequences of changing rules under which government data suppliers operate, leading for example to the recording of more transient and more cultural features in framework databases;
- legal liability consequences of providing framework data.

The penultimate issue is addressed in more detail in the chapter by Rhind (Chapter 56), while Onsrud (Chapter 46) deals with the final issue.

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