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DIGITAL SPATIAL DATA: PROBLEMS OF PROPERTY, ACCESS, PRICING AND QUALITY

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ABSTRACT: Spatial information data has become widely available in a variety of digital forms, and is of great interest to users and potential of Geographical Information Systems. Most of the data has come from the work in the cartographic and land information organisations, and the majority of these have been from the public sector. As a wider community of interested parties seek to apply the combination of spatial data and GIS, a series of practical problems arise which reduce the opportunities for the community to realise the potential productivity gains. These concern several different areas:

- Access to multiple sets of spatial data
- The terms and price of its usage
- The ownership of the information obtained and subsequently created
- The quality of the information obtained

Each of these are explored from the point of view of a secondary data user wishing to take advantage of the possibilities inherent in integrating multiple types of data with the spatial information now available. These include the legal aspects of databases, the issues of usage licensing and the mechanisms needed to ensure that the cumulative results can be effectively realised in spite of the often conflicting interests of the many parties involved.

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1. INTRODUCTION

Spatial data sets are frequently large and expensive to create, but increasingly have been brought together to provide greater administrative efficiency in public sector organisations, where the ability to determine the spatial distribution and character of particular types of locations or boundaries.

As these datasets grow, and in particular as commitments and arrangements to keep them up to date are put in place, interest in using the data is growing from other quarters.

There are many different types of digital data, ranging from terrain specifications to vector files of transport networks, with administrative boundaries a further essential form for many users to be able to make effective use of digital data.

While extensive terrain mapping and administrative boundary datasets have grown up for the water resource, physical, and environmental planning purposes, of the organisations devoting the effort to create the spatial databases, it is the combination of several of these with additional information (often from census or transport sources) where third parties gain a gleam in their eye.

Such users will typically come with three different types of spatial data requirement:

- Spatial location and differences and changes in locational characteristics at various spatial locations

- Network movement and characteristics monitoring

- Spatial analysis, forecasting and modelling

What they all have in common is no significant investment in the basic spatial data, and the intention to use what they can obtain in conjunction with others and their own information sources.

Any analyst reliant on secondary data sources will be immediately all too well aware that no two datasets will be quite the same in terms of coding, specifications, reliability and accuracy (Wigan, 1985). This is unsurprising, as the original data sets were set up for specific purposes, and the requirement of other users were not considered.

Many assumptions and convention become embodied in data sets from a single source, and many of these only become apparent once several data sets are compared in the course of an integration process. Questions of detailed documentation become very important, and anomalies tend to appear in unexpected places.

The reconciliation of such mismatches can be very substantial, and in one case at Monash for a small area of around 20 square km this correction and integration process led to a very significant improvement in quality of the data, but at the cost of several man-months of effort for a comparatively small area[1].

From this standpoint it is clear that the data supplier would not have been aware of many of the 'quality' factors encountered by the users, and would have exacted fees or imposed restrictions based on the supplier organisations views of the data. These can be based on the cost and effort required to create or maintain the data base (and the accounting conventions and assumptions used to determine such costs are far from transparent in many cases).

The integration of socioeconomic and spatial data bases also provides a potentially powerful means of location and identification of individuals, and therefore may be subject to privacy concerns that would not apply to either spatial or socioeconomic data base on its own.

This raises a further question of access to the data at an appropriate level of detail to take reasonable advantage of the spatial aspects of the combined dataset. This is not yet a great problem in Australia, due to the weak protection in law to privacy issues in the public sector, and the even weaker (or non-existent) coverage in the private (Wigan, 1992). The overall balance of the current issues is summarised in Fig. 1.

[1] In addition, the rights to this vastly improved dataset have probably been forfeited by the terms of access from the monoply supplier.

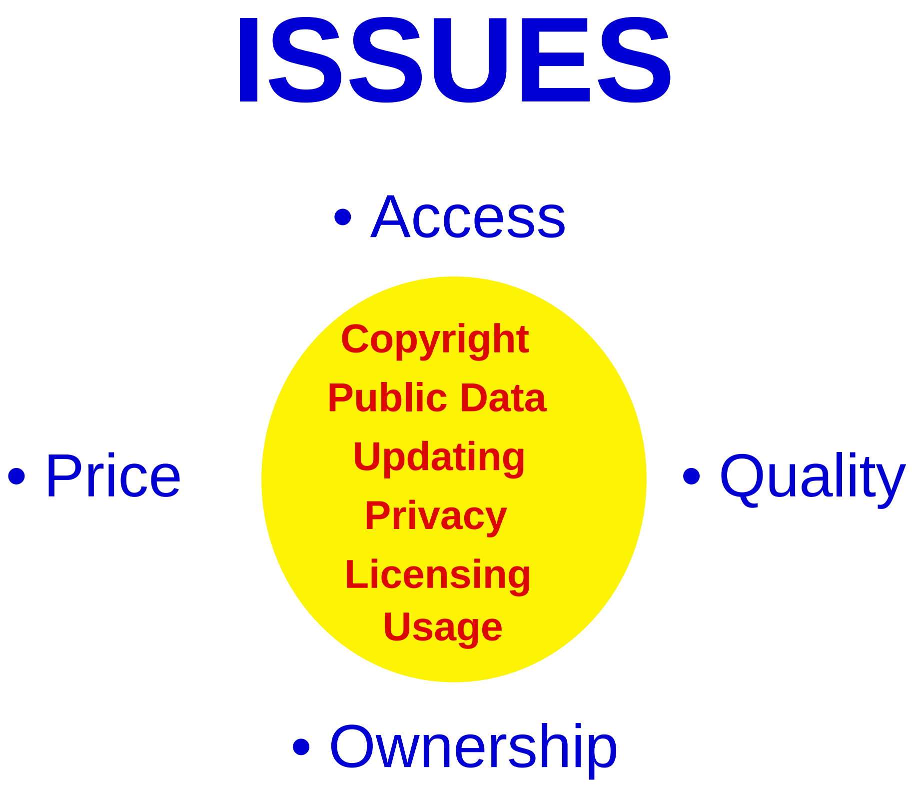

Fig. 1. The balance of the issues

TRANSPORT OPPORTUNITIES AND DATA LIMITATIONS

Small and large scale traffic and transport proposals can be handled in a more coherent manner by using Geographical Information Systems (GIS). GIS have a special importance for the management and monitoring of travel demand as they permit the spatial patterns of road and transport links to be handled on the same basis as the variables and administrative areas affecting demand, social and environmental impacts. Integrating land information and transport infrastructure enables better survey samples to be drawn, better transport data for monitoring, and less complex methods to integrate the use of different forms of traffic, land use, population and transport information.

Perhaps the most important need for linking up the land use, utility and travel information systems in a transport-oriented GIS framework is the pressing need to be able to assess long and short term responses to policies to condition, channel and manage travel demand. Few of these policies can be pursued without tracking the effects over time, and it is this need to work with a mutually updated land use and activity database that completes the case in favour of a GIS path to coordinate the land use, transport and travel data holdings of public authorities.

The ability to link models within a GIS framework provides a further valuable potential for improvement in communications, as the cartographic and environmental roots of GIS systems ensure effective graphical and mapping outputs become a **standard** method of providing the results of even exploratory analytical and forecasting investigations.

Many of the applied disciplines closely associated with geography and land information have major incentives to at least attempt to make use of the expertise and analytical capacity inherent in GIS systems, and for this spatial data sets are essential (Wigan, 1990). Transport is already making rapid moves in this area in several countries, with Pavement Management Systems in several US States operating as simple applications depending on the GIS framework.

There are two key factors that are important for most high level transport applications:

- The vector files need to be of very high quality, and;

- The GIS utilised requires the ability to add powerful route finding, spatial facility location, demand forecasting and other tools to be integrated smoothly and easily.

The US Transportation Systems Centre in Boston (now renamed the Volpe Centre) of the US DoT is using (and adding further analytical capacity to) Caliper Corporations' TransCAD system, which has precisely these characteristics added to the base GIS functions, and is one of the several specialised so-called GIS-T (GIS-Transportation) systems. Other GIS systems in wide use for transport or transport-related tasks include ESRI's ArcInfo and Intergraph's offerings. Most GIS systems have some form of extension capability or scripting language, but few are oriented towrads making the algorithmic process of transport and logistics the central feature of theiri design.

The ability to maintain a spatial database of the highway and transport networks, as well as linking to the land and terrain spatial information databases created by other public bodies provides a very substantial synergistic gain for the community.

This occurs from the lowering of the costs of continual updating and maintenance of each different type of database, and the powerful diagnostic and presentation and query facilities that a GIS can provide - and the considerably lower investment in time and effort required to make use of the combined spatial and transport information increases the relevance and response time to management, consultation and assessment requirement.

The very high cost in both time and effort in creating the spatial framework for transportation surveys and subsequent updating to monitor changes have become unsupportable in most administrations, and, although the overall planning and operational benefits are acknowledged, the rates of return for undertaking large scale surveys as well as the spatial information required to place travel demand in context can no longer undertaken by individual public agencies, and new techniques are needed.

These include substantial use of integrated GIS frameworks with multiply sourced spatial data sets, each of which can be maintained and updated efficiently, and a rolling survey technique to ensure that the monitoring aspects of the travel demand, movement and impacts can be tracked in a timely manner (Taylor, Young, Wigan & Ogden, 1992a).

The irony is that such data + analysis systems are now valued considerably more than they were in the past as contributors to better and more efficient management and development on a continuing - and often detailed - basis (Taylor, Young, Wigan & Ogden, 1992b).

It is in areas such as this that a badly needed public policy and management resource can be created from existing resources to yield higher quality public sector efficiencies.

Unfortunately, divided these all fall, and the pricing and data quality policies of many of the monopoly providers are severe barriers to this public benefit from already-sunk public investments.

The fact remains that if public data is not integrated and made accessible, that people and consultants are simply forced to guess - this was a consistent finding in studies of the utility and cost effectiveness of transport information in NSW (Wigan & Groenhout, 1990).

The lack of contestability in this market place, the limited numbers of fully operational land information + GIS + extended applications, and the need for broader understanding and education in gaining full benefits from the huge investments in spatial information all require more coherent and public debate.

One of the key problems is clarification of the property rights of the base data suppliers, and of those who add value to it.

DATA AS PROPERTY

It is not entirely clear that all spatial databases can be copyrighted in Australia. The law covering software and databases is still being clarified, and different countries have treated data and programs differently. The wide use of copyright (rather than patent) law has not helped.

Computers operate on a combination of data and programs to determine how the data held in the computer is manipulated. The legal position of programs and data have a fair amount in common, the first being the extension of copyright protection to either in an electronic form.

The impact of the Copyright Act 1968 (CAL.) on computer software was significantly affected by Apple Computer initiated the Computer Edge case in 1983 (*Computer Edge Pty Ltd v. Apple Computer (1986) 160 CLR 129*] when the High Court ruled on the decision of an earlier Court that copyright did not obtain in the machine readable forms of programs written by Apple to operate their machine. However, by that date in 1986, the Copyright Amendment Act had been passed in mid 1984, with the designation of software[2] as 'literary works' and thus unequivocally subject to the Copyright Act.

[2] 'literary work then included " a table, or compilation, expressed in words, figures or symbols (whether or not in a visible form)" and " computer program or compilation of computer programs":. The High Court decision on the *Autodesk Inc v Martin Dyason and Others* case then extended protection to programs in the forms of both source and object code

Just before the Australian High Court decision was handed down, Reed, J. in the Federal Court of Canada held that the Canadian Copyright Act (which was in effect the Copyright Act 1911 (UK) which was the precursor to the Australian Copyright Act), did indeed extend copyright to Apple's programs and endorsed the very reasoning of the Federal Court of Australia overturned by the Australian High Court. This illustrates the problems involved in dealing even with such constructs as software, which indubitably encompass skill and creativity in an expression. Data is even harder to define and pin down firmly in terms even of authorship, let alone originality.

In the US, ***patents*** are now being issued for software, in addition to protection under a series of copyright and trade secrets cases. This move to patents raises severe problems for the community on a world wide basis, and the full impact is only now beginning to be appreciated (Garfinkle & Stallman, 1992).

Recent Australian work on data bases (Monetti, 1990) suggests that minimal originality is required for a Court to grant copyright protection to a collection of facts, although (Ricketson, 1990) does not take such an extreme view.

A more recent finding (*Rural Telephone Company v. Feist (1991)* has placed a firm hold on this interpretation, and, at least for the US, has even placed Constitutional Law constraints on extending Copyright protection to data bases or collections of fact (Samuelson, 1992).

This case is only of persuasive authority in Australia, but as no Australian judicial decisions have yet been handed down on the copyright of databases, the question remains open. Databases as a specific example of collections of facts in a machine readable form are discussed in depth by (Hughes, 1991).

Machine readable formats as valid objects for copyright

s.22 (2) of the Copyright Act 1968 (CAL) specifically provides that 'For the purposes of this Act a '*literary, dramatic or musical work that exists in the form of sounds embodied in an article or thing shall be deemed to have been reduced to a material form and to have been so reduced at the time when these sounds were embodied in that article or thing*'.

The Copyright Act 1911 (UK) had been enacted specifically to give effect to the case that a pianola roll was a copy of a musical work, as it demonstrably provided the means to execute it.

The case that forced this issue (*Boosey and Hawke v. Whight [1901] Ch 122 E.C*) was a visual comparison-based decision - i.e. that this copy "could not be 'seen' to give the same idea to every person" (*West v. Francis (1882) 106 ER 1361*). The storage of a musical work in a database in the standard electronic MIDI format would fall into the same category if this principle was deemed to apply.

The ability and authorisation to copy computer programs (and *à fortiori* machine readable data) was the prime reason for the Computer Edge case, and the successor cases (*Ozi-Soft Pty Ltd and Ors v. Wong and Ors (1988) 10 IPR 520; Barson Computers Australasia Ltd v. Southern Technology Pty Ltd and Anor (1988) 10 IPR 597*).

The 1984 Copyright Amendment Act has a peculiar loophole [s 43a], where owners of the media on which computer programs are stored are permitted to make backup copies, and this would in general also apply to databases.

Economic importance of copyright of control of data and software

The impact of holding copyright is economically critical as the copyright holder of a work presently[3] has the right to prevent unauthorised importation or sale by other parties. This is not and unambiguous finding in the UK, but is firmly established in Australia (*Time-Life International (Netherlands) BV v, Interstate Parcel Express Co Pty Ltd (1977) 138 CLR 53; Ozi-Soft Pty Ltd op. cit.*), New Zealand and India (*Penguin Books Ltd v. India Book Distributors Etow (1985) FSR 120*). Even patents do not offer this protection against parallel imports (Knight, 1990]).

However, the 1984 Copyright Amendment Act contains provisions where the transmission of a computer program by delivery downline to an operable copy locally is a offence for distribution but is not debarred as a means for importation. Thus, if the blurring of data and program that has been asserted earlier is accepted as opening a basis for contention, then the operation of **and**

[3]The Prices Surveillance Authority has made recommendations to remove the parallel import prohibition from the Act subsequent to the 1992 PSA enquiry into software pricing.

the downloading of data from online data bases held overseas would not be debarred either. However the transmission of visual images and sounds are specifically covered- and other materials (in a narrow interpretation) are not (Ricketson, 1990).

This adds to the grounds to support (Knight, 1990) in his plea that 'reproduction' itself become the subject of a new amendment to the Copyright Act. Section 43A of the Copyright Amendment Act specifically allows backup copies to be made of a computer program, although such copies are stipulated to be usable only in the case that the original is 'lost, used or rendered unusable', and requires the express permission of the copyright holder.

Databases as a specific object of copyright

The question of database protection now requires a separate line of attack. The machine readability issues have already been addressed, but the application of Copyright Law to facts is now the issue. The basic legal question of this type remaining is the applicability or otherwise of a level of originality in the 'work'.

To this extent the machine readability and related matters are of lesser concern, and the independent argument of the nature of the facts and their arrangement is at issue. Ricketson (1990) argues that there are two types of question to be resolved: the storage, use and protection of works already Copyrighted which are stored in a database, and secondly the protection of the databases themselves (which may or may not contain material already subject to Copyright).

The 1985 Japanese Copyright Act (an amendment of the Japanese Law 48 of 1970) provides copyright protection to databases irrespective of their containing copyrighted material, and was based on a modification of existing Copyright law as a result of pressure from the EEC (Commission of the European Communities, 1988) not to create a special form of legal protection for software . The Australian Copyright Law Review Committee's June 1993 draft report on computer software protection points out both that the problems of complex authorship determinantion are not unique to databases, but alo that the European Community has been discussing the perceived need to give additional protection to the producers of databases.

Bibliographic data restricted to titles only presents no difficulties, indices of material of increasing content arguably can become copyrightable (Brown, 1985) but once an abstract is appended in the database then copyright clearly obtains for the author of each entry (*Valcarenghi v. Gramophone Company Ltd (1928-35) MacG Cop Cas 301]*, and could also apply to the total collection.

In electronic terms, the Australia Copyright Amendment Act of 1984 was an early and prompt entry into the efforts to clarify the law in this area, but it is necessary to repair to the speech by the Federal Attorney-General at the introduction of the Bill (Commonwealth of Australia Parliamentary Debates V s.10.4 2422 4.6.84) to clarify the intent that "*...a work can be made by simply depressing the keys required for entry into a computer*"

Authorship of databases

As a further problem in both current local and international copyright legislation, as s.32 of the Copyright Act 1968 (CAL.) requires that author of a work must be a natural person and thus excludes a computer program or the cumbrous handling of a continually updated data base. The French practice is to recognise the ownership of Copyright of *oeuvres collectives* such as dictionaries and encyclopaedias is the natural or legal person in whose name the work is made available to the public (Ulmer, 1976). However satisfactory this might be for the printed work, the question of electronic holdings clearly remains unresolved by this guidance. S.9(3) of the Copyright Act 1988 (UK) is a specific provision to overcome this by designating who should be deemed to be the author of a computer generated work.

The major issue addressed by the Courts to collections of data is the degree of effort or difficulty that has been applied to create the work - which may be interpreted by the Courts as "originality" enough even just for a layout of information (*Ladbroke (Football) Ltd v. William Hill (Football) Ltd [1964] All ER 485 (House of Lords)*). This does not necessarily suffice to establish Copyright, as Latham notes in (*Victoria Park Racing and Recreation Group Pty Ltd v. Taylor [1937] 58 CLR 479*) where it was established that : "*the law of copyright does not operate to give any person an exclusive right to state or describe particular facts*", given in the case of lists of horses and their running status in races.

This provides a lower limit to the level of copyright (if not ownership) of the simpler types of databases. Further, 10(1) of the Copyright Act 1968 (ACL.) expressly covers "*a table or compilation, expressed in words, figures or symbols whether or not in a visible form*" : see also Lahore (1977). However, the very recent Feist case in the US has placed much of the present case law on copyright applied to collations of facts (and *à fortiori* to databases) in doubt.

Copying and reproduction rights in databases

The last stage considered here is the usage, copying and reproduction: all critical aspects of the ownership aspects of copyright. The key problem identified in several Acts is the lack of a full treatment of the term 'reproduction' or 'copy'. The capture of significant amounts of information from a database would be permitted under copyright law, the reproduction of a machine readable database requires more careful definition than for literary works of a physical work.

The Australian Copyright Act is probably deficient in this area, but the UK 1988 Copyright Act confirms an exclusive reproduction right in any material (*Copyright Designs and Patent Act 1988 (36 Eliz II c48 s.16(1)(a) (1988)*), and the US 1976 Copyright Act (Anon, 1976) provides specifically for machine copying.

Until the Feist case in 1991 in the US, it could have been said that there was a growing consensus on copyright and reproduction rights on computer and other data and databases, in that a modicum of effort or originality would usually be sufficient to ensure that copyright could be secured for a database or compilation of facts. The EEC called for submissions in 1988 specifically on databases and copyright as an urgent issue (Commission of the European Communities, 1988). The outcome forms part of the basis for the currently emergent EEC policy. It is clear that there are many gaps as yet unresolved[4], yet there are already billion dollar industries based on database access.

The completion of the Uruguay Round of GATT iwill now help to resolve some of these ambiguities, as the TRIPS protocols (GATT Secretariat, 1992) specifically state that "*Compilations of data or other material, whether in machine readable or other form, which by reason of the selection or*

[4] There are a number of other technical and interpretive issues concerned with the meaning and operation of 'ownership' of databases.

arrangement of their contents constitute intellectual creations shall be protected as such. Such protection, which shall not extend to the data or material itself, shall be without prejudice to any copyright subsisting in the data or material itself" (Article 10.2).

The special roles of the public sector in the access and licensing of public sector data collections and statute law and regulation and the privacy aspects considered in each domain need to be reassessed in the light of the emerging legal position.

PRICING PROVISIONS

Where a contestable market for spatial data supply exists is where the information may be recreated by third parties and supplied in competition with other providers. There are two bases for such market entrants to compete:

- Price

- Quality

The monopoly position of some current providers is buttressed by the Government Copyright of public information (something that the US specifically abjures, to the great stimulation of added-value enterprise in America). Recent developments in NSW has at long last placed the text of the law in the public domain (McGuinness, 1993), but no such position has yet been mooted by public sector data holders who, in the main, hold both legal compulsion and monopoly supply as their basis for market power.

The pricing structures so far developed for spatial data vary widely, but there has as yet been (probably due to the protected position of suppliers such as the ABS) no stratified market for data as it ages, and only a limited segmentation of the market into educational and noneducational users.

The other major asset of spatial data sources is regular and reliable updating. This too has not yet been pricing into the market, and will probably have to await competition or at least real contestability.

It would be valuable to conduct the debate on the basis of the low marginal cost of data provision in bulk format (CD Rom costs are comparable to the stamps required to mail them and the plastic package in which they are mailed). Public sector data providers generally have major operational or statutory responsibilities which require them to collect data (and justify the legal compulsion applied) in the public interest to be able to undertake their own operations efficiently.

However, without a coherent policy for information ownership, public data copyright and marginal cost pricing for the release of public information to the broad community, this will tend to lead to both market and legal power being deployed in favour of a monopoly pricing philosophy with strong legal protection through restrictive contracts to override copyright issues. Any charging structure beyond marginal costing should therefore attract close examination for lack of competition or abuse of market power, and is also worth examining simply on the basis of the limitations in the effective and widespread use of public daata that could arise..

The massive - and still growing - impact of information technology and telecommunications on intellectual property is making the enforcement and maintenance of monopoly rents in computer-based information less and less easy to manage - and more and more important. Oniki (1992) points out that as information is a public good, the social and private benefits will be the greater the more widely it is copied and used. Oniki (*op. cit.*) provides an economic model of intellectual property information costs and benefits, and suggests that the economic balance is struck at recovery of the cost of production[5] of the information. This model corresponds well with the US Government approach to government funded information, where it is freely available at no charge or at the cost of distribution (as the information has been collected for Government purposes, and has thus is taken to have liquidated the production costs).

QUALITY FACTORS

Base data quality can be judged by cross-comparison between different sources of information for the specified region: for spatial information may be a

[5] As distribution costs have declined so precipitously, and with the application of online or CD Rom storage technology can be essentially negligible for any major source.

range of cartographic and remote sensing information sources, and for vectorised features may require the reconciliation of survey and organisation-specific permanent reference points. Administrative boundaries are in a special category, as there is a basic specification for each that is taken to define the boundaries, and reference back to this resource is necessary to confirm the accuracy of its creation in a machine readable format. Quality is therefore likely to be a different measure for each type of dataset.

For example, vectorised files permit transport and other networks to be handled in a GIS context rather than simply on a network connectivity basis (as most transportation models do). The levels of resolution offered sets defined limits on some of the applications, and the requirement of a land information system would not be expected to coincide with the needs of a road authority wishing to use dynamic segmentation to construct a Pavement Management System on the basis of their road network database.

Quality in one case would be the accuracy of the spatial data points, while in the second it would the accuracy and currency of the data associated with each segment of road, as the spatial accuracy (for this purpose) is not the central issue.

There are numerous applications for spatial information data and GIS in transportation. These range from improving the survey sampling frames to accelerating the development of models and network forecasts and the location of facilities in response to socio-demographic and marking analysis.

One of the key applications is for vehicle location. This requires only a low level of accuracy in terms of spatial precision (10m) but a high degree of accuracy in terms of timing. Increasingly the applications of spatial data sets will use a range of different 'quality' descriptors, and a tiered market will develop as entrants succeed in breaking into the market.

CONCLUSIONS

The role of the public bodies and GBEs in data holding, supply, costing and usage licensing requires more debate. The expectations of the different parties are unlikely to coincide, and the US precedent of placing public data in the public domain has not yet been seriously analysed or considered (Wigan, 1993). The availability of extensive datasets (in a fairly unprocessed format) is economic and cheaper than handling many queries. The example of the US Bureau of Transportation Statistics (1993) is a case in point, where this body was set up to improve the basis for policy assessment and information, and created a massive CD Rom of freely available data within a few weeks of the Bureau being created.

The legal aspects clearly need to be understood more widely. The constraints on usage, application and on-selling laid down by data providers may be necessary for privacy as well as commercial reasons. Where the data has been gathered by the public sector under legal compulsion there is a real question about the appropriateness of charging again for the public data, and the basis for any charges levied need wider debate.

The question over the applicability of copyright to databases must be applied to at least some the spatial datasets available, and the question of the degree of innovation applied to combinations of spatial data sources and other tools (such as vehicle location systems, and special marketing or other forms of algorithms) before copyright can be assured needs consideration.

Perhaps the largest issue is the one of barriers to many groups due to some of the pricing policies of some monopoly suppliers, and correct balance of rights and charges when data turns out to have been of poor quality and requires extensive reworking to be made effective. for the purpose for which hit was intended by the user when he/she purchased it.

It is clear that licenses for specific application may be necessary in some cases, but what rights do data suppliers have to know what other data sources are held or being obtained by their prospective client?

It is clear that coordinated and cooperative efforts between providers and potential users will be needed to realise the full benefits from the spatial information resources built up in Australia. Increased levels of practical interchange and cooperation between users and potential users will accelerate this process and should be actively encouraged between the interested parties in government, academic and business circles.

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