Keeping up with remote sensing and GI advances—Policy and legal perspectives [15]

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Abstract

Technological advances in remote sensing capabilities, wider participation of commercial firms and the possibilities of 'processing' data to create value-added information have given rise to a range of policy and legal issues in the geographic information (GI) field. How far satellite images can still be considered a 'public good' conflicts between commercial and national interests, especially where security is concerned, sovereignty and the rights of sensed states, shutter control vs. transparency, data access, IPR and infringement of privacy are all discussed. A multilateral debate to formulate a GI policy that will take account of these while ensuring that the full benefits of remote sensing are available to society is called for.

1. Introduction

One of the important information sets that is emerging to play a dominant role in informatics is spatial data—data that pertain to a geographic location or have a "reference coordinate" connotation. Spatial data constitute images from satellites and aircraft; maps derived from the images and from other ground surveys, information from GPS and positioning systems, and data from specialized instrumentation surveys (many new instruments are in use today— Airborne Laser Terrain Mapping instruments, Ground Profiling Radars, etc.). Spatial data have had a substantial impact on the government and business throughout the world. Increasingly, they constitute the core of the information management systems of both private companies and public agencies. The spatial data and processing capabilities supplied by the technology also constitute a significant component of the emerging global spatial data infrastructure (GSDI).

Technological advances in remote sensing capabilities, wider participation of commercial firms and the possibilities of 'processing' data to create value-added information have given rise to a range of policy and legal issues in this geographic information (GI) field, issues which were not anticipated when legal regulation was first introduced. This article enumerates recent developments in GI and surveys the legal and policy problems they can create. It argues that a new international policy on the conduct of remote sensing is needed and highlights key points that will need to be taken into account in its formulation—which should be done on a multilateral basis.

1.1. Growth of transparency

With the information revolution well underway, by means of which huge masses of information now flow widely around the world, there is a growing acceptance of transparency, which has led to the relaxation of long-held political restrictions on the gathering and dissemination of information.

One of the major elements that has changed the information scenario is the availability of high-resolution satellite imagery in the commercial domain. Although satellites have been observing the Earth for nearly 40 years, those that could provide highly detailed imagery were operated by secret military intelligence programs. The USA made satellite imagery available for sale from 1972, followed by the French SPOT system and the Indian IRS systems. But all this imagery showed broad panoramas, not fine detail. While the Indian IRS opened the civilian domain of high-resolution images (i.e. anything better than 5m resolution) with 5.8m resolution in 1995 and later Cartosat-1 with 2.5m resolution, today Ikonos, Digital Globe and Orbview provide images at 1m (and better) resolution and there are missions planned that will achieve 30 cm resolution from satellite platforms shortly.

The public availability of timely high-resolution imagery represents a notable break with the past. With the availability of the 1m data (later maybe even sub-meter resolutions) in the commercial domain, the divide between the "free access" civilian image requirements for supporting developmental activities and the "restricted" defense requirements for national security and image intelligence applications has vanished [1].

Such images considerably enhance the scope of applications for developmental activities and open up vistas for a number of newer applications—specifically spatial databases for urban infrastructure, cadastral and rural mapping, geo-engineering, micro-watershed development, disaster management support, business geographics, retailing and marketing. Satellite imagery has become a crucial component of an ongoing shift towards greater transparency. The relevant question, therefore, is whether this era of transparency has adequately equipped itself to meet the current and perceived future challenges in terms of appropriate international legal and policy frameworks.

With the availability of images of any part of the globe, the outlook of any nation on their dissemination and use will have to adjust to these technological and market driven developments. We have moved from an era in which only a handful of governments had access to high resolution imagery to one in which every government and business, non-governmental organizations and public groups will have such access. The new transparency could offer enormous benefits for nations and people around the world and yet governments throughout the world are woefully unprepared for the coming era of global transparency.

1.2. GIS and positioning

Another major technology that has changed the scenario is the geographic information system (GIS)—which allows for handling maps in the digital domain and allows powerful integration of various map data sets to create new visualization of information and the simulation of patterns that enhance knowledge. Thus, GIS have come to handle GI and may include images, maps, positioning data, etc. Increasingly GIS constitute the core of the information management systems of nations and their entities. The data and processing capabilities offered by the technology also constitute a significant component of the emerging national information infrastructure in many nations. The use of spatial data promises generally greater efficiency in commerce, improvements in the environment, health, and safety, increased convenience for consumers, more citizen participation in governance, and improved public and private decision making [2].

A third major technology that is emerging is the precise positioning and navigation data sets compiled using satellites that use radio ranging to fix the precise position of an object. The precision of position is so high and so easy to obtain that the data set is a major GI input for a variety of aviation, navigation and personalized navigation systems.

Policy and legal regimes for managing the varieties of spatial data, their usage, access to them and their commercial potential, however, are underdeveloped and unclear. Ownership of digital spatial data, protection of privacy, access rights to spatial data compiled and held by governments, and information liability are still developing in the context of images and GIS. Moreover, it is spatial data products and services, as opposed to other forms of electronic data, that agencies at a variety of levels are attempting to sell, thus prompting legislative and other efforts by owners to restrict access to spatial information in digital form. In short, because of the great value of GIS, of its potential for altering a government's relationships with its citizens and for intrusiveness, concerns over the handling of digital spatial data will be substantial factors in the society's reconciliation of competing social, economic and political interests in electronic data, generally.

2. Evolution of international legal framework and trends

With the advent of satellite remote sensing, the UN led the way for an informed debate on the use of satellite images via a basic legal framework on the conduct of outer space activities. A landmark development was the adoption of a resolution by the UN General Assembly in 1986 on Principles Relating to Remote Sensing of the Earth from Space (available at http://www.oosa.unvienna.org/Space- Law/rs.html). In general, UN resolutions are recommendatory in nature, and not legally binding, unlike international agreements. In many cases, however, UN

resolutions incorporate already adopted Principles from prior treaty law or international customary international law and, if so, to that extent such Principles remain binding [3]. The Remote Sensing Principles essentially recognized that imaging from space required no prior consent of the sensed country. At the same time, it was also stipulated that remote sensing activities from space should not be conducted in a manner detrimental to the legitimate rights and interests of the sensed states. The resolution also established the guiding principle of non-discriminatory access by the sensed state to data concerning its territory. While reiterating the goal of promoting international cooperation in the conduct of remote sensing activities, the resolution emphasized that remote sensing activities should be conducted with due regard to the needs of developing states. These principles, although adopted in the form of a non-enforceable resolution, enjoyed a wide consensus, guiding and providing a basis for several international agreements between the providers and recipients of remote sensing data.

However, since the time of adoption of the UN resolution and the above initiatives, significant changes have occurred in the fields that make them less relevant [4]. These include: (i) improvements in technologies that enabled satellites to provide data with much better spatial, spectral and temporal characteristics, (ii) the entry of many more state players who owned and operated remote sensing satellite systems and (iii) the advent of commercial systems providing high resolution data. From a legal perspective, the last of these trends assume great significance. A significant trigger for the development of commercial systems for high-resolution data was the new atmosphere of the post-cold war era. This encouraged the new legal and policy measures adopted in the USA, such as the Land Remote Sensing Act of 1992 and the Presidential Decision Directive (PDD) of 1994, which provided the framework for licensing private remote sensing satellite systems and loosened restrictions on the sale of images to foreign entities. Similarly, the Canadian and Indian governments have issued a policy document on images (and there may be other nations that have similar policies). The recent Presidential Decision Directive of 2003, which superseded the 1994 PDD, further lays down US policies in commercial remote sensing [5].

In contrast, information from maps, which had more historical origins, was not subjected to an international debate and remained in the purview of individual nations. Many governments had a stronghold on map censorship, concealment and information falsification for military and economic amelioration. Harley defines two main categories of government censorship manifested in maps—secrecy and silence. While secrecy, or concealment, was an obvious military necessity, silence was generally used to hasten societal and political agendas [6]. With the incessant European state of warfare, the secrecy of maps was vital to military strategy. While some military maps were intentionally falsified to leak "misinformation" to the opposition, many were accurate representations of territory and would prove detrimental if confiscated by enemy hands. Even maps drafted for civilian purposes were kept under tight military control. Not only was map concealment of military importance, it was essential to commerce and the development of capitalism in world society. Today, mapmaking is inundated with precision measurement technology. The spectrum of precision technology encompasses the use of advanced mathematics, surveying techniques, and computers, with computers providing the boldest technological advances in the industry. Another issue is the use of map information and images for commercial or competitive benefits—which brings many important decisions to play based on the availability of good GI and images. Thus, the growth of business and commerce has also been a major factor in the way map information is available and accessible. This has changed the demands on and legalities regulating mapmakers.

The policy regimes for GI and map information have always been a national perspective and, even now, there are rarely debates at the international level to come to an international understanding on map information. What is needed is a pragmatic policy consideration—which can emerge from international debate and an inclusive process for all nations. Such a policy must deal with the protection of private or intellectual property rights and the conditions of fair use of spatial data by others. It must also deal with governments' interests, and the public's right to information collected by government—interests and rights that arise from creating, storing, accessing and disseminating information [7].

3. Core issues that need to be understood

It is instructive to draw some parallels in order to bring the issues into perspective and define why their policy and legal aspects are becoming important today.

First, imagine that a person is photographed, without his knowledge, by an ordinary camera as part of a group, his individual details not being recognizable. As against this, imagine that the same person is photographed, again without his knowledge, but this time using a very high quality and sophisticated digital camera enabled by technological advances. In all probability, in the former case the individual would not be too worried about his being photographed (as the image so generated would not show graphic details of any individual in the group. But, in the latter case, the individual might be immensely worried. At the moment, however, he could easily get legal protection (under national or international law), provided he could prove he had been photographed and the harm done.

Something akin to this is what is happening in the remote sensing image arena. Earlier, with the resolution of the imaging systems being coarse, the UN Principles provided sufficient "protection" for nations being imaged— and they were not too worried because of the broad resolutions and coarse information. However, with the availability of high-resolution images, nations are starting to worry (just like the individual mentioned above) as they feel that they have no control over the imaging of information on their territories.

The parallels do not end here. If the detailed photograph of the individual is then sold commercially and made use of by different groups to endorse a product (commercial use) or create gossip (infringement of privacy) or harass the person (individual security issue) and so on, then the individual is further extremely worried. His worry is that information about him (which he considers personal) is now available, without his knowledge, to one and all—thus contradicting the fundamental aspects of a good society.

Thus, when nations see that detailed high-resolution images of their countries are being acquired and sold, without their having any control over the process, and that the information is being used to the advantage of certain specific groups and sometimes without the involvement of the related nation (an issue of national interest) or even against the nation (an issue of national security), they are also extremely worried.

With modern techniques of photo and image processing, it is possible to morph, suture, compose and merge photographs and create images quite different from the original photograph, and use the same to threaten or blackmail an individual (the threat perception). On similar lines, nations are worried that images of their land could be 'processed' and create trouble for them from abroad.

To continue with our analogy, suppose there are extremely advanced techniques and methods (exclusively available to a select group) to extract a multitude of information about the individual (who was photographed) from the photograph itself and generate a comprehensive biological and financial database of that individual. If this database of various parameters is then integrated with some other external information available to the select group, and is utilized for the benefit of the individual, that may be acceptable. However, if the information is commercially or otherwise exploited, which may not be to the benefit of the individual (or may even be detrimental), this would lead to serious repercussions for the individual and society.

The same can happen in a GIS. Where information on an event, nation, resource or business is organized in a multi layered database and is used for a variety of "good applications" for society this is a positive trend but, if the information is exploited against the interest of the local society or nation, that society will have serious objections. A multitude of issues comes to the fore and the need for protection from such "abuse or misuse" of the database becomes very relevant.

Thus, we can see how issues of privacy, national interest, threat perceptions, commercial benefits, societal good, etc. become relevant—not just in the context of the examples mentioned above but very much so for images, GIS databases and other elements. Of course, technological changes and developments—especially the ability to image in great detail, digital processing technology, internet technology (allowing easy dissemination of information) are also major "drivers" that are creating changes in the environment and culture for the creation and use of images and GI.

While we cannot wish away these problems, we must understand them and create a regime that provides comfort for one and all. (Just as the individual want to feel safe and comforted but is always on guard, nations too like to feel safe and comforted from such technologies and possible damage.)
Let us see how these can be addressed.

4. Images and GI as a societal good

One definition of 'a public good' comes from economics. A private good is one that solely benefits the person who has possession of it while the benefits of a public good are shared [8]. Examples cited are defense as a public good and a consumable such as a chocolate bar as a private good. Characteristics of 'a public good' are thus that there is nonrival consumption and that the cost does not depend on the number of users [9]. This implies that 'a public good' is something that is valued but would not normally be supplied by a market economy. Thus government, by default, must be the supplier.

Under these definitions, spatial data that a government has generated are a public good to the extent that they are non-rival in consumption. The possession of a satellite image or a GIS layer of an area in no way decreases another person's ability to have the same image or map. In fact, with the wide dissemination of data through a medium such as the Internet, it has been increasingly easy for several users to have access to data at the same time. However, if access is restricted, the data can also have market value. For example, data might be of considerable value to a company if they provide exclusive access to the condition of the wheat crop in a rich agricultural area. In addition, there are resources and costs involved with transforming such data into information. Should the government be involved in transforming data into information? If so, how does this change the compensation picture?

In Pricing Government Information Love asks "Are information goods in general public goods?" [9]. His answer is "sometimes yes, sometimes no, and sometimes partly yes and partly no." In order to better answer the question of availability of government information, Love introduces the concept of 'merit good'. A merit good is one "for which consumption should be encouraged, based upon non-market value judgments by society." Education is cited as an example of a merit good. Much government information, Love says, also fits this example. Thus, the information should be made available not solely using economic judgments but also using social criteria. Although Love does not elaborate on what the basis for these social criteria would be, he does put the question into the proper realm, for questions of law and policy exist not just in the economic sphere but are really questions of values.

One criterion for determining societal value is the utilitarian concept of "the greatest good for the greatest number." Although the concept is easy to understand in general terms, the application of the utilitarian principle to specific cases can be problematic. One value in the USA is that of an open society where the greatest good can be achieved with an informed electorate. This implies ready access to data with that access ensured through government subsidy if necessary. The electorate can only be informed, however, if it can afford access to information. Another value in the USA is that of the market economy. The greatest good is achieved by allowing the market to distribute scarce resources.

Welfare and 'good' also have an impact on GI product market perception. The arguments are made considerably more complex by the fact that the information in GIS is a non-excludable public good (e.g. one which exhibits nonrivalrous consumption) produced jointly with a private good in a competitive market. Land survey maps are private goods in their use in land transactions: one person's plan cannot be used in another's land transaction. On the other hand the GI in the plan is a public good. Since each new unit of information can be provided at no additional cost to all purchasers (and assuming that more information is better), then the demand for the information will depend not only on the per unit price, as is true for private goods, but also on the quantity of information produced [10].

While the change in welfare per work resulting from complete protection is ambiguous, there is an unambiguous increase in welfare thanks to the creation of new works. Therefore, if there is a significant increase in the number of survey plans produced, then a net increase in welfare is more likely, as the welfare increase from the additional works is more likely to dominate the ambiguous effect on welfare per plan [11].

5. Legal and policy perspectives for images

Since the mid-1990s there have been significant changes in the policy and technological environment affecting remote sensing activities around the globe. Most important among these are the following:

- Emergence of commercial remote sensing systems in the late 1990s providing high-resolution remote sensing data globally as a sequel to several policy measures in the USA.

- Spread of the internet, which facilitated global access to digital remote sensing data, triggering a new era of transparency and making some aspects of regulations on the flow of remote sensing data and information obsolescent.

In 1992 the US Congress enacted the Land Remote Sensing Act repealing the earlier Land Remote Sensing Commercialization Act of 1984. Landsat was returned to government control. The act observed that development and provision of commercial value-added services should remain exclusively a function of the private sector. This act partially relaxed the non-discriminatory distribution policy for private sector operators, who were no longer obliged to make their raw data available to all users on a non-discriminatory basis, but might be required to make such data available to the government for archiving, with a view to eventual public availability [12]. The Act further required that all domestic, privately owned remote sensing systems be licensed. In the new atmosphere of the post-cold war era, several private companies in the USA applied for licences to operate remote sensing satellites. The Presidential Decision Directive in 1994 further loosened the restrictions on the sale of images to foreign entities, and about a dozen companies in the USA received licences for operating commercial remote sensing systems.

The high-resolution commercial imagery sale, started in 1986 by the French SPOT-1 satellite capable of providing images of 10m resolution, saw steady advances through Canada's Radarsat (2m images) in 1995, the Indian IRS- 1C satellite (5.8m images) in 1996 and Space Imaging's Ikonos satellite (1m resolution in 1999). The trend is continuing, with satellites such as Orbview, Earth Watch, EROS (Israel), Cartosat-1 and 2 (India) and several others which are already providing operational services. Augmenting the products of these spacecraft are the high-resolution images which were declassified from the archives of the US satellites of 1960s and 1970s. Similar declassified highresolution pictures from Russian satellites have also been made commercially available in the public domain.

The present policies of dissemination of and access to data make it extremely difficult for satellite operators to specify who the ultimate users of the data are and for what purpose they will use them. As much as data could be used for various vital contributions to society, they can also be used for not so benevolent uses, such as support for terrorism, espionage by industrial competitors, intelligence on disadvantaged regions and populations, and so on. There have also a couple of instances of images being misinterpreted in the media and even by governments.

5.1. High-resolution images—"conflicting" commercial and national considerations

Principle IV of the UN Resolution stipulated, inter alia, that remote sensing activities "shall be conducted on the basis of respect for the principle of full and permanent sovereignty of all states and people over their own wealth and natural resources, with due regard to the rights and interests, in accordance with international law, of other states and entities under their jurisdiction. Such activities shall not be conducted in a manner detrimental to the legitimate rights and interests of the sensed state". The advent of commercial systems, with the capability for world-wide dissemination of high-quality remote sensing images, showing many details of land surface and oceans, may pose a direct challenge to the sovereignty concerns of states.

The availability of improved quality remote sensing data, particularly at a level of 1m resolution or better, has also raised growing concerns in various states about the legitimate and proper use of data. The ready availability of 1m resolution images in the market place and the promise of new data of similar or higher resolution with better spectral characteristics, including hyper-spectral data and even improved all-weather radar data are leading to an era of growing transparency. Apart from contributing to several beneficial uses, 1-m resolution images can also detect vehicles and identify aircraft. Tanks can be distinguished from trucks and road and bridge conditions can be seen. In view

of their potential for military use, governments are concerned about the widespread dissemination of such data in the public domain [13].

The events of 11 September 2001 created a new awareness across the globe of the critical need for effective measures to ensure security. Of particular relevance to remote sensing is the information that can be derived on certain vital installations of infrastructures that have a bearing on national security, public health and safety, the economy and public morale. This will mean meeting a twin set of requirements—first, to generate information which will assist governments in the task of protection and, second, taking necessary safeguards to ensure that such information is used exclusively for legitimate purposes. These concerns imply that sensed states do not have any jurisdiction over commercial entities from other states that carry out imaging over their territories and sell images to anyone who pays. In light of this, they consider that the spirit of UN Principles and their own legitimate rights and interests are compromised: (i) if they have no definite means to know whether their territory is being imaged by commercial operators; (ii) if they have no access to the data on their territories on a non-discriminatory basis soon after they are imaged. Since satellite operators have no obligation to know and control the ultimate end use or to identify the end user, there are issues for the governments of sensed states in terms of how they protect their vital installations from acts of terrorism or prevent misuse of information on resources which are under their sovereign control [14].

Since the data availability from commercial systems providing high resolution data will be mainly driven by the market considerations, the affordability of access to such data will be another major issue for a large number of states, particularly developing states. The policies adopted by the commercial operators show that the sensed states do not have priority in the acquisition of data over their territories if they are unable to pay the high premium demanded, which customers in any other parts of the world are ready to pay, even if those customers make such requests later than the sensed state.

It is noteworthy that certain measures have been taken in the USA to impose conditions on its licensees such as the so-called "shutter control" obligations (which can be imposed during specific periods when the national security or foreign policy interests of the USA are determined to be compromised) and for provision of access to the US government of downlink formats and data. Further, the US government has also stipulated that licensees should make available to the government of any country unenhanced data concerning the territory under the jurisdiction of such government as soon as such data are available and on reasonable cost terms and conditions, subject to all other conditions of its licences. However, such measures are not universally applicable and since more commercial players are bound to enter the market from different countries, there will be increasing conflicts of interests and diversity of regulatory measures.

Such trends in the regulation of remote sensing data are apparent in many nations. International law entitles all states to freely acquire satellite imagery without the consent of sensed states. Subject to the applicable principles of international law, a sensing state is entitled
to determine the distribution or denial of satellite imagery. The 1986 UN Resolution recognizes the right of the sensed state to have access, on a non-discriminatory basis, to satellite imagery of its own territory. However, contrary to the provisions of this Resolution, several states have started making such access subject to their national security concerns, foreign policy interests or international obligations [15].

5.2. Right of sensed state (ROS)

As mentioned above, the affordability of access to remotely sensed data will be another major issue for a large number of states. As there are concerns about governments losing some degree of control over information about their territory, there could be tensions, particularly if a state considers that entities abroad have exploited information about its territory, when it had no fair and affordable access to the same—as a result of commercially driven policies. There are real threats to the right to privacy— because of the possibilities of industrial espionage, and the potential use of imagery by anti-social groups. Commercial corporations from one country could gather information on exploitable natural resources in another country without the knowledge of its government and could possibly gain a strategic advantage in negotiations.

The ROS will be a major issue in the international regime. The manifestation of the ROS will not just be to operators but also to service providers – who use images and GI to provide trans-national service, many on the web and in open access. Many nations have already responded to such RIGHST when Google started to display images of nations – many nations objected to such open display of their sensitive areas.

5.3. Issue of global transparency

There are, however, significant benefits in the transparency created by the availability of high-quality images, including their use by NGOs, the media, environmental groups and governments. These benefits cannot fully fructify unless the international community develops a means to harmonize policies and legal measures. National regulations to restrict the physical flow of information products in the age of the internet are ultimately not going to be very productive. Hence there is a need to develop acceptable legal norms for the operations of commercial providers—taking into account the basic needs of civil societies' rights to information and the legitimate concerns of governments to maintain the rule of law in the territories under their jurisdiction.

Global transparency will be yet another important issue. Unless the transparency is totalitarian and equal to all there will be a tendency to have a divide.

5.4. "Shutter control"— turning off the flow

The unimpeded observation and distribution of data gathered from space, particularly in the high-resolution range, through commercial channels have thus raised policy questions on the rights of sensed state over access to data and also their ability to safeguard the right of privacy. Concerns have also been expressed on the proper use of images to meet national security needs and ensure friendly relations among nations. The USA has responded to this situation with its "shutter control" policy—which allows the US government to limit the collection or distribution of data by US commercial satellites during specific periods when national security or foreign policy interests could be compromised. This policy balances the goals of promoting the commercial interests of industry on the one hand and meeting the USA's national security and foreign policy interests on the other.

The US government imposes on its licensees certain conditions to protect the interests of sensed states and also to secure its own national security and foreign policy interests. US licensees are obliged to make available to the government of any country (including the USA) unenhanced data concerning the territory under the jurisdiction of such government as soon as such data are available, and on reasonable cost terms and conditions subject to all other conditions of the licence. The government has also stipulated that its licensees shall use a downlink format that allows it access to and use of data during the periods when national security and international obligations may be compromised. Further, licensees are required to maintain all satellite tasking operations for the previous year and to make these available to the government, as requested. Thus, the US government has ensured a fair degree of control over the operations of its licensees besides access to the information gathered by them.

While these measures may satisfy some governments, they have no universal appeal because of the lack of a multilateral framework in their application. The vagaries of unilateral policies could also affect the realization of full commercial potential. Thus the remedies which currently exist are not satisfactory. The policies adopted by the USA are applicable to its licensees only. What will happen when there are more players from other countries? Each country could follow its own regulations and there could be conflicts of interests, to the detriment of the healthy development of the commercial sector. Moreover, common global needs, such as monitoring and protecting the environment, tracking illicit activities, promoting public health and responding to natural disasters can be satisfied only through a broader international understanding and consensus. Pending development of such common norms, states will probably develop the means to live with the new era. They could negotiate over a satellite operator's conditions to satisfy their concerns, as they provide access to their markets. Some countries might also try to camouflage sensitive targets or take recourse to counter measures (which in extreme cases would constitute a hostile step, triggering confrontation).

5.5. Images vs. information: right on value-addition

Access to images versus access to information is yet another area of debate—opening up the issue of the right to value-add on images to generate "information"—yet another dimension of value and related to a nation's sovereignty. It is possible that somebody could buy all the images on a country and value add to generate a variety of social, cultural, physical and resources information on the country and make it available—either in conjunction with or separately from the images. Would this provide other advantages—either security-related or commercial—over the nation? Would images and information become potent tools of "armament"?

6. Legal and societal issues for GI

GI forms part of the spatial data infrastructure that is emerging in the transition to an information society. Along with the positive effects of GIS, the negative impacts of the technology and databases need to be considered, weighed against the positive, and divulged, eliminated, minimized, or accommodated. What is the likely distribution of the social benefits and costs of GIS databases in respect to poor versus wealthy persons, urban versus rural communities, large versus small businesses, and developed versus developing countries? Will use of GIS widen or narrow socioeconomic gaps between different segments of the population? How will different societal attitudes toward the proper role of government in handling personal data affect society's ability to benefit from the wide-scale sharing of geographic information? Can or should the technology be instituted in such a manner as to promote equity in the distribution of its benefits and costs?

Legal issues differ based on what type of GIS product or service is being considered. GIS tools, data sets, Application Program Interfaces and embedded functions need to be treated under existing and proposed software protection legislation. Specialized GIS applications such as land registry, land use, utilities and environmental monitoring may contain personal data or data with far-reaching financial, health or safety consequences. Any misuse or commercial loss resulting from poorly constructed or managed systems will have legal ramifications to the vendors and users. GIS containing personal data such as marketing research, census data, public authority data etc., will be governed under data privacy or data protection legislation. Also, GIS in critical systems such as flood control and civil protection, require high data accuracy, and this has implications for protection of life or property. Inaccuracies could render data providers and software interface developers liable to prosecution. Further, the new possibilities for incorporating Virtual Reality (VR) functions into GIS products may give rise to problems of ownership of data, software elements, search engines, and so on. Hence the basic problem is one of the different actors involved in creating a product or service. There are also other issues, such as using GIS as the "value added" element to permit legal resale of otherwise "not for resale" data sets drawn from the public domain. In summary, the various legal issues that could apply to GIS products and services will include the following:

- IPR/copyright and neighboring rights;
- data protection;
- confidentiality/data privacy;
- competition law;
- licensing;
- consumer protection/fitness for purpose;
- product and services liability;
- censorship and other content-related issues;
- health and safety legislation;
- patent law—especially as GIS systems become more complex [16].

The above legal issues are becoming significant elements in the development and use of GIS technology. Different actors involved in the production and use of GIS products and services must be educated and supported in these legal aspects depending on the nature of their involvement. As these products or services are globalized, data could come from one legal jurisdiction and then be transformed into a product or service and sold in an area of different legal jurisdiction. The rights and liabilities of the collector of the data, sellers, other intermediaries and users thus become difficult to determine and need further consideration.

6.1. The role of governments and private sector

The future growth of GI and its range of applications is not simply determined by the advent of new technology: such technology enables but does not dictate destiny. In practice, the expansion of the use of GI for operational tasks—as opposed to one-off research experiments—is bound up with the national political culture, the legal framework, the organization of its bodies, international obligations and history. One reason for this is that the availability and supply of spatial data—a key determinant of GI expansion—is largely determined by these factors. Even today, in many nations government is typically the ultimate source of most 'core' or commonly used spatial data. Although there are notable exceptions, the government trend world-wide seems to be towards charging more for use of these data at a time when copying it is becoming cheaper. Some attribute these price rises to ideologically inspired actions of government. Indeed, virtually any sale of government data seems to be anathema to three classes of people—individuals who believe that everything the state holds should be freely available to its citizens, vendors who recognize that its price influences the sales of their software and those who, unconcerned with the operating efficiency of government and its cost to the taxpayer, continue to see the state simply as the provider of subsidised services and goods. The wide variation in the competences of different levels of government is also reflected in the nature of the data collected and the rules which are applied. Superimposed upon these within-nation state variations in regard to data and some moves towards 'subsidiarity', there are increasing numbers of international rules, agreements or pressures to act in a harmonized way. Typically, then, all countries have a 'cocktail' of laws, policies, conventions and precedents which determine the availability and price of spatial data [17].

6.2. GI as a commodity

Is GIS becoming a tradeable commodity? It appears so as GIS data seem to have value for at least some of the populace. It is now possible to supply GIS to those who are willing and able to pay for it and exclude its use by those who do not wish to pay for it. Its provenance is now proveable and laws must exist which permit the protection of intellectual property rights. It is often said that the market for spatial data is an immature one. It is, however, clear that the market is not operating perfectly at present so far as GIS is concerned. The requirements for an efficient market, such as perfect awareness on the part of the purchasers, are not being not met. Moreover, the presence of market distortions thanks to subsidies, legal constraints, public perceptions, etc. and the existence of substantial externalities further renders the existing markets sub-optimal. One example of the externalities is readily summarized—duplication of massively expensive operations like the creation or updating of detailed national spatial data sets seems inherently wasteful. Putting a value on such externalities is difficult, especially since the costs are visited on those at the end of supply chains and are often discovered long after the data have led to mistaken conclusions.

6.3. GI access rights

There is a growing tendency among governments in different nations to move away from treating publicly held information as a public good—to alter the status quo of current open records policies and to move towards commercially selling spatial data products and services. Yet little empirical evidence is available with respect to the possible advantages and disadvantages of differing approaches. Current evidence that supports the competing public policy, legal and efficiency stances is largely anecdotal.

Comparisons might be made in the USA at the local government level among free access approaches, marginal cost recovery approaches with no restrictions on the subsequent use of data, marginal cost recovery approaches with subsequent restrictions, and approaches pursuing greater than marginal cost recovery. Similarly, at the international level, one might compare the effect of US freedom-of-information laws on the uses of federally produced geographic information with (for instance) the effect of the cost recovery approaches of the UK's Ordnance Survey on the uses of similar geographic information.

Another issue involves the current move towards creating a national infrastructure that will allow citizens more readily to acquire and use geographic information. Most within the GIS community

assume that any infrastructure used for accessing and transferring spatial data will be part of this overall information infrastructure. The eventual networked system is envisioned as supporting data transfers and transactions not only for the education and research sectors, but also for private citizens, government and commercial interests. Many envision the national network as creating an electronic marketplace where, for instance, potential sellers of geographic data sets will be able to find buyers and vice versa, and where the many thousands of users of the network will create a wide ranging demand for geographic data. Investigating alternatives for addressing the political, legal, and technical constraints in establishing an electronic publishing capability for spatial data (or an electronic library capability for spatial data) could provide valuable insights for wider electronic publishing and library endeavours. Many studies have drawn lessons from a comparative analysis of the history and jurisprudence surrounding public access to legal and medical databases and conclude that no generic information policy covering all government data realms is likely to emerge or be successful. Many even suggest that sorting out sensible policies relative to spatial data may be more complex than for legal or medical data, as national security issues are also involved.

6.4. GI: issue of infringement of privacy

Linking information about individuals with where they live and work is a highly sensitive issue with the general public. Before the development of present-day computer capabilities, it was impractical for government and private industry to maintain such information, but technically and economically the building and networking of detailed databases on all members of a community, their property, and their habits is now a practical reality. As the ability of portable computers to store and query large spatial databases expands, privacy concerns are becoming more pronounced.

Laws that compartmentalize data on individuals have been in place in the USA for some time. However, the laws impose few restrictions on the private sector's "mixing and matching" the same databases that government is prohibited from manipulating. As a result, businesses are often able to compile substantial information about individuals. For instance, businesses are interested in building profiles on individual households in their market areas. Governments engaged in selling spatial data sets to the private sector have found that cadastral data (i.e. household-level data that tie ownership information to the location and physical attributes of the land) are in more demand than any other layer of information. Having this parcel ownership and household-level information allows businesses to conveniently aggregate information through computer cross-matching. When local jurisdictions fail to have cadastral data available or readily accessible in digital form, businesses have found their own survey methods to generate 'simulated" spatial data sets which they use and market. We have entered a new social and technological era in which conflicts involving privacy no longer affect individuals singly but affect everyone in the community. The degree to which the aggregation of personal data through cross-matching of GIS files with other files should be allowed is not clear.

The practice of "profiling" customers raises the issue of where the line should appropriately lie between a "permissible exchange of facts to pursue a commercial goal" and an "impermissible intrusion" on personal privacy.

6.5. GI: copyrights and IPR

Copyright protection for spatial databases raises a series of emerging, unresolved theoretical questions. Although maps have been with us for centuries, a theoretical foundation based on solid policy objectives explaining what aspects of maps warrant protection is lacking. Representation of geographic data in digital form, with its own uncertain status in property law, adds to the theoretical complexity. Resolving rights in spatial databases implicates the theoretical shortcomings of copyright law both as applied to geographic representations and to computer representations.

Copyright compensates creators of original expression as an incentive for them to continue to bring forth knowledge and information that others in the community may exploit for social or commercial gain. To this end, copyright protects expression, but not the underlying ideas, which can and should be used without compensation to the creator. Even though a spatial database might cost hundreds of thousands of dollars to compile, its claim to copyright protection is typically far weaker than that of, for instance, a novel. One reason is that spatial data are largely factual in nature and "facts" are not subject to copyright. Facts, algorithms, physical truths and ideas exist for everyone's use. It is difficult to argue that the outline of a building, the bounds of a land parcel, or a line of constant elevation on a

map (a contour line) are expressions of originality. Any other person or sensor attempting to represent these physical facts would have little choice but to do so in much the same way. To represent the features by other than points, lines, polygons, or image bits would make the representation non-standard, greatly decrease the value to others, and make the data useless or cumbersome for computer processing. Experts even suggest that protection of maps in digital form ultimately will require either amendment of the Copyright Act or a federal sui generis database protection statute.

Even if a copyright claimant argues the existence of originality in the selection, coordination or arrangement of a data compilation, the typical GIS user is primarily interested in the data themselves and not in the original aspects of the data compilation. Database ownership interests are further complicated in GIS environments because much of the data in them are copied from existing paper maps—some of which are in the public domain but many others of which involve potential pre-existing copyright. However, if the spatial data are indeed largely factual and political biases are absent in their selection or arrangement, the dilemma arises that the data are then also unlikely to be copyrightable. As a result, many government database builders, along with the private sector, are resorting to contract and licensing instruments to impose limits on the use of the digital data they supply. These practices raise the issue of whether and how these legal devices might be applied to facilitate participation of data proprietors and users in a networked electronic marketplace, and whether alternative devices may be available for protecting government interests in spatial databases.

The unresolved legal and public policy issues regarding the application of copyright and other work product protection devices to spatial databases present a host of potential problem areas for research activity by the academic community. Longhorn (2001) argues that the lesson for producers of GIS products and services, especially those without prior experience of publishing either software or information products, is to be aware, question the business plan and look for the potential negative effects on the future success of your product which might be caused by legal problems. He suggests not focusing all efforts simply on technical virtuosity and market research.

6.6. GI: liability

Liability is a subject of much interest in the GIS community. The value of any database lies in its use. When an action or decision is taken based upon the information and analysis in a GIS, the liability exposure of those involved with the development of GIS software and databases, or with provision of information based upon analysis in a GIS, can be important. The only certainty is that, under current legal principles, liability can never be eliminated, merely minimized. Those who have been hired specifically to provide spatial data for a database or those who are offering data for sale to others are responsible for some level of competence in the performance of the service or for some level of fitness in the product offered.

Is liability exposure or the perception of liability exposure a significant impediment to the willingness of businesses and others to share geographic information or offer it for sale? Liability exposure may have a substantial impact on whether businesses and others will be willing to share GIS data and whether they will be willing to offer GIS data for sale in a networked electronic marketplace. Evidence needs to be gathered on whether current liability exposure is an actual threat or primarily a perceived threat. Evidence also needs to be gathered on what legal arrangements are currently best accommodating both liability and business operation concerns. The evidence gathered and any conclusions reached should be helpful in the design of an electronic marketplace for geographic information.

7. Conclusion

7.1. Key points for image and GIS policy definitions

In summary we point out some of the critical points that are prime in defining a good national and international framework for a policy on images and GI [1]:

- There is a need to look again at the 1986 UN Principles on Remote Sensing and arbitrate a new international regime of understanding for images from satellites. This framework will have to encourage nations to recognize the need for an over-arching understanding for satellite operators (both government and commercial), nations that are imaged and global image user community.

- We must recognize that satellite images, including high-resolution images, are essential to support development activities. As has been mentioned earlier, many societal development activities or "societal goods" depend critically on the availability of satellite images—disaster management support; land and water management; environmental monitoring; various sorts of mapping; planning and managing urban facilities/infrastructure; rural development; cadastral mapping; national infrastructure development—roads/ highways, telecom, power and many others. Many of these societal issues are transnational.

- National (security or commercial) interests will have to be fully taken into consideration to ensure that nations' interests are not compromised. The necessary steps for non-disclosure and second-order dissemination are already being discussed.

- We must recognize that imposing any control on foreign private satellites for "imaging" over any region is truly not possible. With the high-resolution satellites, images of any region can be acquired and made available to any user in any country—especially where commercial considerations and demand drive data sales. While shutter-control is available to the country licensing a satellite (so, say, the USA can regulate imaging/ dissemination/use of images over its or a specified territory), the "sensed state" will not be able to control the commercial satellite imaging its territory.

- The "rights" of the sensed state may emerge more strongly in the future and it may be difficult to ignore this aspect in defining the international framework. However, an international consensus needs to be built on the role and privileges of the "sensed state". It may be appropriate to move towards a consensus that provides comfort to "sensed states" by sharing information on users who use images of their territories.

Key points underlying a GI policy would have to consider:

- Creating high quality spatial data is very expensive.

- Data maintenance can be almost as expensive as de novo data creation. As a result, many data; originators will be devoting much effort to this aspect in the coming years.

- Many organizations are capable of creating data on a limited area, project basis. Creating, updating and managing detailed national spatial databases is, however, a very different and non-trivial matter. Those with these skills and track record have a real competitive advantage, especially where intellectual property rights are vested in the holders of the data.

- Private sector data sets are typically derived from public sector ones and a good copyright regime is called for.

- It is possible to sustain a solid intellectual and economic case for either complete cost recovery or nil cost recovery; any position in between is essentially pragmatism. Where only a fraction of the populace directly benefits from the existence of spatial data, cost recoveryn policies provide greater equity through ensuring that the user rather than the taxpayer pays costs.

- Changing the method of access to spatial data may well facilitate different charging regimes: both through perception and charging metrics, online access to data fosters and permits much larger numbers of small-value transactions.

- Standards for documentation, archiving, distribution of information, geographic control, and accuracy of analysis should be promoted. These standards could be developed in collaborative processes with research and resource management institutions. They need not be mandatory, but should be widely known so that all institutes have a reasonable idea for what is expected of them.

- Liability exposure may have a substantial impact on whether agencies and others will be willing to share GIS data and whether they will be willing to offer GIS data for sale in a networked electronic marketplace.

7.2. Need for informed debate under a multilateral framework

An effective solution to the predicament brought about by the convergence of various tools and techniques like GIS, GPS and Remote Sensing data, world-wide access to databases through the internet revolution, interfaces with emerging technologies for visualization such as VR and multimedia applications, coupled with commercial availability of high-resolution data warrant a harmonized international framework of legal norms. An appropriate multilateral forum such as the UN Committee on the Peaceful Uses of Outer Space (COPUOS), the UN Regional Cartographic Conference (RCC), the Global Spatial Data Infrastructure (GSDI), and the ISPRS etc., would address various concerns over access to spatial data, its use, rights of privacy, security and state sovereignty. It is clear that the world is currently facing far more new challenges, which were not anticipated at the time of the evolution of the UN Remote Sensing Principles. An urgent debate on the issues raised is essential to ensure that the full potential and benefits of remote sensing images and GIS are available to society.

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