Public access to Indian geographical data*

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The Survey of India (SOI), a central government service organization, is the primary agency responsible for generating, storing, and disseminating geographical data in India. The consensus amongst the community of users in the country is that the quality and quantity of the data available with SOI is as good as, if not better than, the international norms. Access to the data, however, has left the community of users in general, including both scientists and practitioners of Geographical Information Systems technology, unhappy. The restrictions on access stem from two considerations: national security and copyright. There is lack of awareness in the user community about the details of either of these. There is also lack of consensus at the highest levels of policy makers on what the restrictions ought to be. Needed are reforms that cover the entire spectrum: from organizational setup of data gathering machinery to meeting the industry's needs for data in digital form. As discussed in the report, some of the reforms could be implemented speedily and easily. But others, particularly those related to policy on restricting data on grounds of national security, would require a major shift from present practices.

1. Introduction

Data is key to any scientific analysis which then forms the basis for valid inferences and decision making. The better the quality of data, both in terms of precision and statistical significance, better is the confidence level in the inferences made. As R. Narasimha pointed out in his opening remarks at the meeting (see Box 1 for programme of the meeting), if the data is made available more freely, it enables better analysis on the one hand and evaluation of the quality of the data on the other. In the Indian context, consistency of data put out by different government agencies is also a matter of concern. According to many scientists, the quality of data available with many official-data gathering agencies in the country remains questionable. Wider access helps in the cleaning up of data sets, a fact not generally realized, particularly in officialdom.

Perhaps because of the colonial legacy in the structure of service organizations and scientific institutions involved in data generation, access to data has been problematic. All data is restricted in principle with security considerations overriding. It is the Official Secrets Act (OSA) of 1923, and its very broad scope, which guides current restriction policies (see Box 2). Without a legislated classification and declassification policy in place, both are done on what seems to be an ad hoc basis.

In general, it would seem that the economic value of the data, which can be exploited by wider accessibility and use, is not realized. As a result, the scientific value of generation of data and the need for a critical assessment of its accuracy and reliability would seem to be grossly underrated. This may be because organizations engaged in the service of gathering scientific data are not treated as scientific organizations in the true sense of the term, an issue that needs more attention than has been given so far.

The importance of geographic information for developmental projects – in land use, urban development, water supply, irrigation schemes, rural electric supply or any other infrastructure like basic telephone services or highway development – is obvious. Geographical data is a very important component of scientific research and industrial activity that involves geological formations, landslides, tectonic studies, mineral and oil explorations and coastal and oceanographic studies. In recent years there has been a sudden spurt in demand for geographic information from the industry, both public and private. This has been primarily the result of the advent of the Geographic Information System (GIS), a system that includes computer software and hardware, spatial data or geographic information, and procedures to solve problems or provide solutions. Wide applicability of the system is seen as a potential market for GIS developers in the Indian computer software industry.

A GIS is generally capable of collecting, editing, storing, checking, integrating, manipulating, analysing and displaying data related to positions on the Earth's surface. Typically, a GIS (sometimes referred to as LIS or Land Information System) is used for handling maps of some type and the tabular data associated with the features in the map. These might be represented as several different layers where each layer holds data about a particular kind of feature. Each feature is linked to a position on the graphical image of a map, which is 'georeferenced' (i.e. geographically referenced). The GIS can therefore facilitate the implementation of any pro-

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*An overview of the meeting on *Public Access to Indian Geographical Data*, held on 14–15 July 1999 at the Indian Academy of Sciences, Bangalore.

Box 1.

Indian Academy of Sciences
A Discussion Meeting on
Public Access to Indian Geographical Data
(Organized by the Panel on Scientific Data of Public Interest)
Venue: Lecture Hall, Indian Academy of Sciences, C.V. Raman Avenue, Bangalore
14–15 July, 1999

Inauguration of the meeting by
N. Kumar, President, Indian Academy of Sciences

R. Narasimha, National Institute of Advanced Studies, Bangalore
Genesis of the meeting and its goals

S. V. Srikantia, Geological Society of India, Bangalore
Access to Indian geographical data: A historical prespective

R. N. Srivastava, Survey of India, Dehra Dun
Survey of India's plans to meet the country needs for digital geographical data

Ravi Gupta, Editor, *GIS@development*, New Delhi
Prospects and problems concerning use of GIS in India

J. S. Ahuja, ORG-GIS, Secunderabad
Issues to be resolved for public access to Indian geographical data

Raja Ramanna, National Institute of Advanced Studies, Bangalore
Towards a rational policy on geographical data of public interest

D. P. Rao, National Remote Sensing Agency, Hyderabad
Geographical data needed in interpretation of Indian satellite-based remote sensing data: Opportunities and realities

Rahul Matthan, Matthan Law Offices, Bangalore
Right to information and access to scientific data

N. Vittal, Chief Vigilance Commissioner, Government of India, New Delhi
Access to scientific data of public interest: Role of the Academy

Panel Discussion
Developing an action plan to address the issues concerning access to Indian geographical data

R. Narasimha, National Institute of Advanced Studies, Bangalore
Where do we go from here?

(The meeting was attended by 38 Fellows of the Academy and other invitees)

ject, whether it be watershed development or pipeline-laying. In short, any task that involves a location or spatial data can be handled in a GIS environment. Therefore, input spatial data becomes the key factor determining what type of problem can be studied with a GIS. The quality, source and scale of the data are all important to its application.

With the growing importance of GIS-based applications in economic development as well as research, any policy being evolved for the dissemination of data should keep in mind the requirements of working with a GIS environment, keeping in view the industry's perspective without, of course, sacrificing the security interests of the country and the necessary regulatory framework. Most importantly, this implies availability of geographical data in digital form. From a national perspective, there should also be standards set for exchange and sharing of data so that the data base in one software environment is on talking terms with that in some other environment. For example, in the execution of a single national project more than one group could be involved, each working with different software platforms. Such policies and appropriate infrastructure for GIS applications have already been evolved in countries like the USA, the UK and other countries of Europe. There is an urgent need for establishing and enabling

Box 2.

The part of the Official Secrets Act 1923 (amended at various times later) that is most relevant to the issue of data dissemination appears to be Clause 5, from which the relevant sections are reproduced below.

5. Wrongful communication, etc., of information – (I) If any person having in his possession or control any secret official code or pass word or any sketch, plan, model, article, note, document or information which relates to, or is used in, a prohibited place or relates to anything in such a place or which is likely to assist, directly or indirectly, an enemy or which relates to a matter the disclosure of which is likely to affect the sovereignty and integrity of India, the security of the State or friendly relations with foreign States or which has been made or obtained in contravention of this Act, or which has been entrusted in confidence to him by any person holding office under Government, or which he has obtained or to which he has had access owing to his position as a person who holds or has held office under Government, or as a person who holds or has held a contract made on behalf of Government, or a person who is or has been employed under a person who holds or has held such an office or contract –

(a) willfully communicates the code or pass word, sketch, plan, model, article, note, document or information to any person other than a person to whom he is authorised to communicate it, or a Court of Justice or a person to whom it is, in the interest of the State, his duty to communicate it, or
(b) uses the information in his possession for the benefit of any foreign power or in any other manner prejudicial to the safety of the State, or
(c) retains the sketch, plan, model, article, note or document in his possession or control when he has not right to retain it, or when it is contrary to his duty to retain it, or willfully fails to comply with all directions issued by lawful authority with regard to the return or disposal thereof, or
(d) fails to take reasonable care of, or so conducts himself as to endanger the safely of the sketch, plan, model, article, note, document, secret official code or pass word or information, he shall be guilty of an offence under this Section.

The key question is how the decision is made on which 'information' 'is likely to assist, directly or indirectly, an enemy or [which] relates to a matter the disclosure of which is likely to affect the sovereignty and integrity of India, the security of the State or friendly relations with foreign States'.

policy environment and appropriate infrastructure, proposals for which already exist on paper, like the National Geomatics Centre (NGC) and the National Geographical Digital Data Infrastructure (NGDDI).

2. Availability of geographical data: The current national scenario

Survey of India data

The present situation in the country with regard to the availability of SOI data, which R. N. Srivastava of the SOI explained in sufficient detail in his talk at the meeting, is as follows. The SOI, which at present is under the Department of Science and Technology (DST), is the primary national mapping agency, required to cater to both civilian and military needs. Established during British rule, it has been mapping topographical data of India (and neighbouring countries in the pre-Independence years) for the last 232 years. The contents of the topographical maps (toposheets), being of sensitive nature and of military value, are under the scrutiny of the Ministry of Defence (MOD), the Ministry of Home Affairs (MOHA), and the Ministry of External Affairs (MEA). Due to security considerations, there is in place a restriction policy on the dissemination of maps. It was apparent in the meeting that the scientific community was not fully aware of the restrictions on access to this data.

The present restrictions are governed by an official order No. F.7(7)/64/D(GS-III) dated 15 April 1968, which is an amendment to the basic order issued on August 25, 1967, by the MOD. According to these orders, all topographical and geographical maps (a) of areas between a line approximately 50 km inside the border (for example, see the thick line on the map shown in Figure 1 taken from the publication *Maps published by SOI*, January 1998) and the national borders on scales of 1:1 million and larger north of 20^0 latitude, including the maps of Bhutan on the same scale; (b) of the coastal belt on scales larger than 1:1 million (that is, 1:250,000 and above) south of 20° latitude; and (c) of outlying islands; viz., Andaman and Nicobar, Lakshadweep, Minicoy and Aminidivi, on scales of 1:1 million and larger, are all restricted; the rest in the interior of the thick line are all unrestricted. With regard to trigonometric data, the de-restriction in place (vide a notification of 26 February 1979) permits the SOI maps to indicate planimetric control data up to one minute of arc and heights above mean sea level rounded off to 10 metres in the restricted zone and up to 0.1 m in the unrestricted zone. There are restrictions with regard to the export even of unrestricted SOI maps of scales 1:250,000 and above.

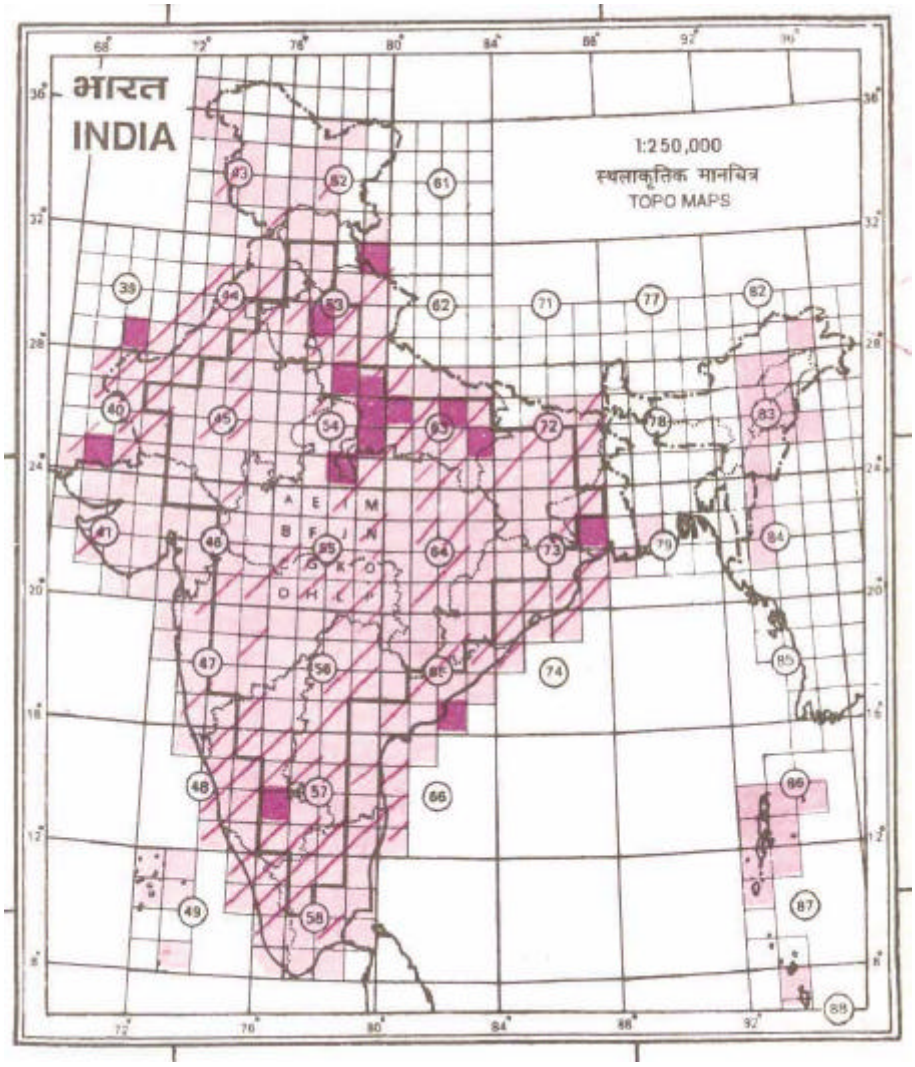

Figure 1. Maps on scales larger than 1:1 million of certain areas, published by the Survey of India (SOI) are classified as restricted. The limit of such areas has been shown by think line on the 1:250,000 index map above taken from the SOI publication *Maps Published by the Survey of India*, January 1998. The area inside the thick line is unrestricted. Colours and shading refer to the edition of maps available.

The 1967 and 1968 notifications are a further relaxation of the restrictions placed by the MOD order of 28 April 1965 which had permitted distribution of maps of scale 1:4M and less. This itself was a de-restriction of the policy governed by the 1950 order. Till 1950, the policy was basically a continuation of the British policy of restricting all topographic maps for 'official use only'. With the 1968 order, publication and distribution of maps of coastal states on the scale 1:1 million became possible. This is what Srivastava meant when he insisted in his talk on terming the government policy as one of gradual de-restriction. But, as Narasimha rightly emphasized, the country needs a proper policy of classification and declassification of this or any other data and not an ad hoc or case-by-case de-restriction.

Topographical maps on sufficiently large scales (of 1:250,000 and more) are needed by geologists, geographers, forest surveyors, engineers, planners and others. The index map released by the SOI in 1998 shows that India is covered by 394 toposheets on 1:250,000 scale (for example, square 39 D in the west part of index map in Figure 1), which are also called degree sheets. According to the 1968 notification, 163 degree sheets – about 41.5 per cent – are in the unrestricted zone. That is, about three-fifths of the country is in the restricted zone. Srivastava pointed out that even in the restricted zone, for applications such as district planning, some 1:250,000 toposheets have been de-restricted after a good deal of user interaction. Each degree sheet contains sixteen 1:50,000 toposheets and each 1:50,000 toposheet contains four 1:25,000 toposheets. While the entire country has been mapped on both 1:250,000 and 1:50,000 scales, only about 40 per cent of the country has been mapped on 1:25,000 scale.

Anyone can go and buy, or order, toposheets of scales up to 1:25,000 of the unrestricted zone from the map sales outlets of the SOI. Barring non-availability due to a particular toposheet being out of stock or certain areas not having been mapped on the 1:25,000 scale yet, there is absolutely no restriction on accessibility to these sheets. For the restricted zone, there is a procedure laid down that requires the filling up of forms O.57 (A) (and O.57(B), if necessary), duly countersigned by the appropriate designated government officials/authorities indicated therein (for certifying bonafide use of the indented data/toposheet), which should be submitted to the Surveyor General (along with the requisite charges). The application is scrutinized by the SOI according to certain guidelines of the MOD. However, during use, an annual certificate of safe custody of these maps is to be submitted by December 31 every year and, after use, the maps should be returned to the Chief Secretary of the State or to the SOI office from where they were issued.

According to Srivastava, no questions are asked, and the restricted toposheets immediately issued, if the forms have been properly filled, the purpose is clearly stated, and appropriate countersignatures exist. It must be pointed out here that, contrary to the general impression, vice-chancellors of universities and heads of scientific institutions can also countersign the forms for indenting restricted maps. For educational, scientific and other semi-government organizations, powers to countersign have been delegated to officials of the rank of deputy secretary and above in the respective departments/ministries of state governments. Only for private individuals, organizations and commercial firms is it required that a government official of the rank of joint secretary or above has to countersign and the same is to be cleared by the MOD. This means that the procedure is more involved for non-governmental individuals and organizations.

The issue of copyright of the SOI maps came up repeatedly during the meeting. It was quite apparent that there is considerable confusion among map users about what copyright means, the scope of the copyright law and the applicability of the law's provisions to the SOI maps in their sale, duplication, value addition and digitization. The presence of a legal view in the meeting, besides the expertise of V. Siddhartha (Defence Research and Development Organization, DRDO, New Delhi) in such matters, certainly clarified many of the issues. However, since security-related issues are handled by the military operations wing of the MOD, not much could be known on the rationale for MOD restrictions on maps and dissemination of geographical data from time to time. Unfortunately, in spite of the efforts made by the Academy, no one from MOD could attend the meeting.

The SOI has laid down a policy for publication/reproduction of their maps by other agencies, which makes it clear that the copyright on them is held by the Government of India. There actually exists a publicity document of the SOI stating the policy as well as the instituted procedures for commercial publications based on SOI maps. However, issues of royalty and other payments for the use of SOI maps in business are not addressed therein, perhaps because there is no policy on revenue generation from the IPRs on the SOI cartographic data. The document is dated 1987 and needs updating, particularly in the context of digital data and GIS-related applications.

So, while there is a formal process for the commercial use of restricted and unrestricted maps, and the legal provisions that govern them, it appears to be a cumbersome bureaucratic process that could be greatly simplified. For example, the procedure still requires formal approval, including security clearance from the MOD even for unrestricted maps, before publication. Similarly, the SOI has a list of 33 outline maps of the country on scales from 1:4.5 million to 1:36 million which can be bought at a price and used freely. Even here there is a procedure of clearance of the SOI involved before publication. This seems unnecessary when legal provisions can be invoked (Section 2 of the Criminal Law Amendment Act of 1961) for wrong use of boundaries, as has been done in 1999 in the case of the daily *Indian Express*. Rahul Matthan, a lawyer who participated in the meeting, explained the in-built provision of the 'fair use doctrine' in the copyright law that enables the use of the (unrestricted) cartographic data for research and non-commercial use by simply acknowledging the source.

In the case of restricted maps, however, it is the provisions of the OSA that govern their use, including 'fair use', by the indentor. As Matthan emphasized, the two issues – copyright and security restrictions – should not be confused. As per the certification of safe custody required by the September 1965 notification, which every indentor is required to submit after obtaining the restricted maps, the receiver guarantees that the map issued will not be communicated or reproduced by any means which would include publication in journals and books. Whether the MOD has a set procedure for seeking clearance for reproduction for 'fair use' of restricted maps is not clear. Perhaps this clarification should be sought from the SOI. Matthan also clarified an important point: digitization amounts to duplication, and would violate the copyright if done without authorization. This issue has assumed significance in view of the need of digitized data for GIS and other applications.

While post-Independence maps fall into restricted and unrestricted categories, pre-1947 maps have all been derestricted as archival material under the custody of the National Archives, according to Srivastava. One would assume, as Madhav Gadgil (Indian Institute of Science, Bangalore) did, that all archival material is freely acces-

sible, and maps older than 50 years should be free from copyright. Given that the current SOI maps of the Western Ghats (of the required scale) are restricted, and could not be obtained, Gadgil thought that he could overlay the flora of the Western Ghats on an old map of the Western Ghats to produce a reasonably accurate biodiversity map of the region. But he found that this archived map too was restricted for security reasons and it could not even be copied or traced.

Apparently, under an office memorandum (OM) of the MOHA, all archival material, while available for consultation and reference, has to be cleared for release and duplication by appropriate committees of the National Archives. And there is a special subcommittee for maps which scrutinizes any application for maps from the restricted region. This policy of restricting pre-1947 maps does not seem to make much sense because many maps of this period, and copies thereof, would in any case be available from other sources, particularly from Britain where these would have been taken before Independence. Siddhartha was of the opinion that it may be possible to ensure easier access to archived material through an executive order, or an OM, which the DST could issue in consultation with the MOD, the MOHA, and the MEA.

The current policy on digitization of SOI toposheets and data is governed by the Office Memorandum (OM) No. 2(5)/95/D(GS-III) of the MOD dated July 13, 1998. Effectively, this has de-restricted and decentralized the availability of digitized topographic data by designating nine agencies, besides the SOI, to 'undertake digitization of topomaps of scales up to 1: 50,000 of unrestricted areas already published by the SOI, after deleting defence/civil vital areas (VAs)/Vital Points (VPs) and important strategic locations'. Prior to this OM, the SOI was the 'only agency authorized to undertake digitization on the basis of ground survey data'.

As of date, the SOI has completed the digitization of all the degree (1:250,000) toposheets and of about 477 toposheets of scale 1:50,000 in the unrestricted zone. Of the total of 19,545 SOI toposheets on 1:25,000 scale – this is less than $4 \times 16 \times 394$ because it is impossible to map the Himalayan terrain on this scale – 40 per cent has been mapped as mentioned earlier and of this 61 have been digitized. According to Srivastava, digitization on this scale will be done only for regions where development projects have been identified. The OM also specifies the 'extent of digital data/map content of unrestricted areas which can be digitized and disseminated' by the nine agencies.

Non-governmental organizations (NGOs) and private agencies are required to register and enter into a Memorandum of Understanding (MoU) with any of the nine agencies for obtaining digitized data in the form they require. But there are conditions laid down which include any 'value addition' to the data provided by these agencies to be vetted by the SOI. Many private enterprises, concerned about the time delay in such a vetting process, feel that the phrase 'value addition' has to be defined and ask whether a mere colour change constitutes value addition, for example. Srivastava clarified that input of any additional data would constitute value addition, which is permitted only with the concurrence of the agency. Digitization of restricted areas will, however, continue to be controlled by the army headquarters and such data will be given only after clearance of the MOD. Further, digital data of restricted areas (even if released for use) cannot be posted over networks like the NICNET.

However, there is no executive order or a gazette notification yet that would make this OM operative. There are also no guidelines for the MoU which could clarify such issues as value addition. Moreover, it is not clear whether or not each of the nine agencies could issue an advertisement for signing MoUs. In fact, only because the OM somehow leaked into the public domain is there even a discussion on the issue. There is a committee constituted, with K. Kasturirangan, Secretary, Department of Space (DOS), as the chairman, to evolve the modalities of digitization and dissemination. Availability of digitized data to NGOs and private enterprises can begin after this committee makes its recommendations.

Indian Remote Sensing (IRS) satellite data

Maps based on satellite imagery are becoming more and more important as their resolution becomes better and better. According to D.P. Rao, National Remote Sensing Agency, Hyderabad, currently available IRS (PAN + LISS III) data of 5.8 m resolution (the best in the world civilian remote sensing market until the recently launched IKONOS began to sell its 1 m data) can be used to generate 1:50,000 scale geo-coded products and thematic maps. The mandate of NRSA is, in fact, only to generate thematic maps for specific applications like forestry, crop estimation, water body surveys, waste land mapping, irrigation schemes, urban rehabilitation projects, land use surveys, etc. What needs to be emphasized here is that the accuracy of maps based on remote-sensed satellite data depends on the accuracy of the geo-coding or the ground control points (GCPs) of the ground-surveyed base maps that are used to orient and fix the satellite imagery. This point is not generally appreciated. And SOI is the only source of such base maps.

Remote sensing enables a quick way of getting a map substitute as well as updating and revision of existing survey maps. All satellite images are cleared for public dissemination only after the MOD masks certain areas containing civilian/military VAs/VPs and strategic loca-

tions – about 200 locations on 5.8 m resolution images. High resolution satellite images of Indian and foreign origin are being used by government and non-government organizations for spatial planning, research and developmental projects.

According to Rao, all satellite images of 10 m resolution and above were earlier restricted. But when French SPOT data (at 10 m resolution) became available, this was relaxed. When IRS 1C images became available, the NRSA had again to seek a further de-restriction on these. Now that images from IKONOS with 1 m resolution are available, further de-restriction will be required. This will also enable public access to ISRO's *Cartosat* imagery at 2.5 m resolution which will become available in the next couple of years. Explaining the security restrictions, Srivastava said that all satellite imageries of higher than 10 m resolution undergo MOD scrutiny because they are geo-referenced with respect to the GCPs on the geodetic-datum based on the Everest Spheroid (see Section 4) which the SOI supplies to the NRSA.

The base maps that are used by NRSA for generating its thematic maps are the SOI's 1: 50,000 maps. With these, the location accuracy that NRSA thematic maps achieve is about 50 m. Even when higher-resolution satellite imagery becomes available the absolute accuracy of any geo-referenced location will be constrained by the accuracy of the underlying base map. According to Rao, where higher scale topomaps are not available, there are techniques to improve the accuracy of IRS data up to 20 m with the help of GCP of any other ground section in the satellite path. However, the height and planimetric accuracy achievable (even in maps based on stereo images) is much less than that of SOI maps. Also, the contents of maps from satellite imagery are less by about 40 per cent. With *Cartosat* data of 2.5 m resolution, and data processing techniques, Rao claimed that 1:25,000 scale base maps (which do not at present exist for the entire country) could be generated with an accuracy of 5 m using the GCPs derived from a country-wide Global Positioning System (GPS) survey to be undertaken by the DoS. To re-emphasize, unless this satellite data is geo-coded with respect to geo-referencing used in SOI maps, this accuracy will only be relative and not absolute.

Data from independent surveys

The existing regulatory framework does not prevent any other agency, government or private, from carrying out independent surveys in the unrestricted zone to produce topomaps of any scale, to digitize such survey data (but with a geo-referencing different from that of the SOI), to use them in a GIS environment, or to market them. For example, the National Informatics Centre (NIC) has undertaken a 1:10,000 scale survey of Delhi for an infrastructure project. There are also many private agencies that have undertaken such surveying (including aerial surveys) and digitizing such data.

Till now only the NRSA was permitted to carry out aerial surveys besides the Indian Air Force and the SOI. Vandana Aviation, a NOIDA-based company, for instance, is one of the few private companies that has been given sanction to carry out aerial surveys and aerial photography. In fact, the Bangalore Water Supply and Sewerage Board has recently issued an open tender for ortho-photomaps for its projects. But aerial surveys and photography have to be carried in the presence of an air force officer on-board and the aerial photographs so taken are vetted by the MOD.

Also, any map so published or sold within the country, even if based on independent survey data, has to be vetted by the MOD. The restrictions on the SOI digital data also apply to other government agencies that have undertaken independent surveys. For instance, the NIC, which is one of the nine agencies identified to digitize and disseminate SOI data, cannot disseminate the topographic data of its own surveys without the clearance of the MOD.

Only a very few private enterprises may, however, undertake independent surveys given the cost of such surveys. One of the major reasons for the growing demand for digitized SOI data is that no private agency can afford to survey and digitize topographic data. During his observations at the meeting, J. S. Ahuja of ORG-GIS, Secunderabad, gave a figure of Rs 1 lakh/sq km; according to other industry sources aerial surveys (where time saved is enormous) cost about 5 per cent more than land surveys. Industry sources say that World Bank and Asian Development Bank projects have now begun to make surveying and topographic plan a prerequisite to project funding.

Other data

Like the restrictions on topographic data, there are security-related restrictions on other geophysical data (both analogue and digital), such as gravity anomaly data and magnetic data. As pointed out by the geologist S. V. Srikantia, even though the country has been geologically surveyed on a 1:50,000 scale, only 72 geological quadrangle maps (or degree sheets) have been produced and 23 of these are restricted. Indeed, Srivastava felt that the SOI was being unfairly singled out as the culprit for not releasing the data, whereas, as a government service agency, the SOI was only respecting official policies and guidelines that are applicable to all other data generators as well. He emphasized that many of the restrictions were put in place on the recommendations of the scientists of the DRDO. If, for whatever reason,

the curbs are relaxed tomorrow, the SOI would only be too happy to disseminate the data, he said.

3. Public perceptions and problems of access to data

That there indeed is a problem in accessing geographical data was affirmed by V. S. Ramamurthy, Secretary, DST. In the note he sent to be read out at the meeting, he stated: 'The country needs clarity on this issue, not only to further research and academic pursuits but also to steer our economic and development activities on a more scientific and sustainable route'. He felt that various development schemes like watershed development, on which thousands of crores of rupees were being spent, suffered because of a lack of adequate basic data on topography, hydrological characteristics and SOI parameters. 'Greater efforts and a measure of clarity would be required as we gradually shift from analogue data and maps to digital data sets,' he said.

The title of Srikantia's March 1999 article in the *Journal of the Geological Society of India*, 'Restriction on Maps – An Anachronism that Needs Removal', is indicative of popular perception, including that of the scientific community, on the government's policies on dissemination of cartographic and other geophysical data. In this article Srikantia, who has had 33 years of surveying experience with the GSI, has listed four arguments that he reiterated in his talk at the meeting as well. In these he has argued for removing all restrictions on topographic maps after civil and military VAs/VPs and strategic locations have been removed from the SOI maps:

1. Satellite-based remote-sensed high resolution imagery has revolutionized the map-making process. The range and depth of satellite observations with regard to the so-called security aspects is so enormous that the information contained in 1:50,000 toposheets pales into significance. Thus restricting toposheets serves no purpose.
2. The MOD insists on the deletion of coordinates (lat-long) before the publication of geological maps. The satellite-based Global Positioning System (GPS) – for which even hand-held receivers are now available – can determine very accurately the coordinates of any point on the globe. In the light of this MOD's restriction is meaningless.
3. The 1:250,000 scale toposheets that are restricted by the SOI on security grounds are available for sale from foreign agencies like the Stanford International Map Centre, London. Satellite imageries of even larger scale, which provide all the geographic and topographic information, are easily available abroad.
4. Satellite data is amenable to digitization, easier processing, computation and, therefore, serve as input data for GIS. The data can also be easily used to generate large scale base maps. And these are today available from foreign sources and even on the Internet.

Ravi Gupta, a GIS specialist, and editor of a magazine published from Delhi called *GIS@development* felt that the GIS environment has not been allowed to grow in the country. This has happened despite enormous potential (1998 turnover of the GIS industry, with about 25 active agencies, was stated to be Rs 50 crore) because of the restrictive policies on availability of geographical information. There was scarcity of geographic information of any kind. Because 80 per cent of any data is linked to geographic information, all information-based developmental activity, he said, is increasingly relying on GIS and it was becoming an integral part of the information base. According to Gupta, the only operational GIS that he was aware of was the one implemented by the Dutch consultant Scott Gibbons in the Mirzapur municipality which has helped the district change its economy.

Gupta explained how even though GIS as a tool had been first developed by Canada's Land Department to manage rural areas, the US has today emerged as the world leader in GIS due to the visionary approach of the US government and academia. The National Spatial Data Infrastructure (NSDI), which had its origins in the early 1990s, was established in 1994. The Mapping Science Committee of the US National Research Council, constituted to look at the research responsibilities and the future of the National Mapping Division of the US Geological Survey, had recommended the creation of the NSDI. Today the NSDI serves to implement data standards and facilitate sharing of data through what is called the National Geographical Data Clearinghouse. It has also formulated the National Digital Spatial Data Framework. All these measures, together with copyright-free access to large-scale digital geographical data, have facilitated the growth of the GIS industry in the US, Gupta said.

Gupta also compared the prevailing spatial data policies, the availability of geographical data and GIS use among the US, the UK and India. A point he made was that since the Government itself was the major user of geographical information, it was in Government's interest to make easier access to such data. He said that there was a lack of mandate on the SOI, which had the monopoly on geographical data, to disseminate. He called for a national strategy for the development of the GIS industry.

An important issue, which N. Vittal, Chairman, Central Vigilance Commission, raised, and which did not get clarified, was how security-related issues are handled in countries like the USA. It is true, as Siddhartha

pointed out, that security concerns of India and the US are different and what we need is not a 'copy cat' approach but an indigenous approach. But the fact is that there has neither been a technical review nor an assessment (at least in the public domain) of whether there is a one-to-one correspondence between the security risks and the restrictions placed on access to geographical data. In this light, knowing how such things are handled elsewhere would help.

The general view was that large scale data was easily available in the public domain abroad. Narasimha's opinion based on own experience (in the California region), as also of K. S. Valdiya, of the Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR), Bangalore, was that high-resolution maps could be easily obtained but with information on strategic locations and the like deleted. Srivastava mentioned that the US had two series of maps, one for military use and one for civilian use, with the latter having as much as 30 per cent less information. In other words, these were 'tailored maps' for civilian use. Unfortunately, no one present could throw light on the technical issues related to this aspect. Specifically, in what respects do the two series differ? Is the geo-referencing in the two series different and based on different geodetic datums? Or, in the context of the post-GPS scenario, is the civilian series based on coarse acquisition (C/A) data and Standard Positioning Survey (SPS) and the military one based on selective availability (S/A) and Precise Positioning Survey (PPS)? Equivalently, what is the difference in positional accuracy between the two series?

In his talk, Ahuja, who had served the SOI for 30 years, expressed the view that a series of 'tailored maps' showing the key features generally required by the majority of the users should be brought out on various scales. The key features should include the principal drainage patterns, the communication network, roads and railways, point location of habitats and their names, forest areas/plantations, mining areas, cultivated areas, contours and heights, water bodies, administrative boundaries/coast line and latitude/longitude. He felt that this should be possible within the existing policy framework keeping in mind the security aspects. According to him, the 1989 National Committee on Security had also recommended this.

With regard to digitized SOI data, he said that the July 13, 1998, notification had only raised more questions as to how and where the nine agencies would get the digitization done. He felt that invariably the job will have to be contracted out to private vendors. If so, what would be the criteria for the selection of these vendors? Further, how can it be to ensured that duplication of work among these agencies is avoided? He was of the opinion that a better solution would have been to have a centralized agency (SOI or any other) to do a complete digitization of all the maps and disseminate it as per requirements on some standard formats. He said that this was the approach in many countries and Germany was the best example where a situation similar to ours existed some time back.

A pertinent point which both Rao and Srikantia made was that topography (or any other geophysical feature like geology) is not restricted to unrestricted areas and will be the same across the demarcation which is only an imaginary line. There must be ways of carrying out studies across this demarcation using appropriate base maps. It was pointed out that the GSI has not been able to publish the geological map of the Cudappah Basin since 1981 for this reason. With foreign companies coming into such areas as infrastructure, mining, etc., standard base maps that are available to foreign companies should be in the public domain as NRSA maps are, Rao said. He also pointed out an instance where an educational series on satellite imagery was prevented from showing latitudes and longitudes.

Besides the restriction of not permitting coordinates (latitude-longitude) and heights to be shown in maps of restricted areas, another aspect that has been of concern to researchers and other users is that gridded maps that use Lambert's Grid are restricted. According to Rao, the 1989 committee on security had proposed the use of an arbitrary grid for the country as a whole but the SOI had not designed it so far. It appears, however, that the idea of the alternate grid had not been cleared by the MOD. Similarly, sample 'tailored maps', as recommended by the 1989 Committee, have not been prepared because such 'tailoring' too was apparently not cleared by the MOD.

Rao averred that accessibility of restricted area toposheets and aerial photos to NGOs and private agencies was a real problem and the 'single window clearance' – namely the SOI – of maps and aerial photos was not time-effective. Indeed, the inordinate delay in clearances has been a recurrent problem; very often, even if the forms O.57 (A&B) are submitted with appropriate authorization and certification of bonafide use, there is usually no response for months. Also, though there was a proposal to simplify the forms O.57 (A&B), this has not happened, he said. According to Ravi Gupta, the time taken to obtain copyright clearance from the Surveyor General for carrying out value addition was anywhere between 6 months to a year.

A random query with many agencies revealed that government agencies seem to have no serious problem in gaining access to the SOI data, analogue or digital. NGOs also do not have any serious problems if they are involved in a government project. However, in both the government agencies and the NGOs there appears to be an undercurrent of dissatisfaction about access to SOI data. The problem is much more serious for private individuals, consultants and private companies. There also

seem to be problems when layers of data from different government agencies are overlaid on a single base map. Since even the government agencies are not always supplied with the ground control data and projection parameters (unless asked for on O.57 (B)), there has often been incompatibility between maps produced by different agencies. Very often, local projection parameters and local origins that are chosen are not always the same as those of the SOI.

Also there are complaints that there does not seem to be any standard format for supplying these GCPs and projection parameters. While these do not cause any serious problems for applications related to a single toposheet when matching and merging of toposheets or thematic maps are prepared, errors seem to show up. Indeed, the point about the lack of well defined norms for data exchange and data sharing was emphasized by Ramamurthy. He observed in his note that difficulty in accessing all kinds of geographical and geophysical data, not merely cartographic, lay not necessarily in the security-related restrictive policies but in problems of this kind.

A major shortcoming of SOI maps seems to be that the toposheets are, more often than not, very dated, sometimes over 25 years. The SOI itself undertakes revision of maps only once in 15 years mainly due to lack of financial resources and manpower. This has nothing to do with security policies but still hampers the development activities of even the government agencies, like the Forest Survey of India, because the maps do not show reforestation areas, for example. Besides this aspect the SOI maps, it was generally felt, were very extensive and accurate, and the quality of topographic data were considered very good.

At another level, a general view is that since this is government data and government has collected this at enormous cost using tax-payers' money, a citizen of the country has a fundamental right to access it. 'If this information is not made available to me, I feel cheated,' Srikantia said. Unlike the US, or other countries, India does not yet have something like a Freedom of Information Act. A Right to Information Bill is, however, pending in the Parliament. Matthan, who had dwelt at the meeting on legal issues governing public access to data/information, explained how, even though Article 19 of the Indian Constitution does not specifically mention 'right to information' and 'right to knowledge', they actually follow from the other fundamental rights enjoyed by every citizen. He cited some specific cases where this aspect had been clarified in courts.

However, there can be restrictions on grounds of national security and sovereignty even to such fundamental rights of the citizen. And the OSA is one such law below the Constitution which is concerned with actions that jeopardize national security. But the OSA provisions are over broad and could lead to misuse, Matthan said. In particular, OSA does not define what an official secret is, which makes it unclear whether restricted geographical information constitutes an official secret. However, it should be noted that the official orders promulgating the restrictions carry the implication that the restricted SOI maps and data are official secrets.

Given the above, Matthan was of the opinion that, if the information needed by the scientists and others was not accessible, the courts could be petitioned. The act by the government could be challenged as being violative of a fundamental right to freedom of information so long as it can be proved that the information is necessary and not prejudicial to the interests of the country. In legal terms, he saw two ways ahead: one, amend the Constitution (a difficult proposition), or include 'right to information' in express terms; two, replace OSA by more rational legislation and enact an appropriate statute in areas not covered by other legislations.

The above argument, however, does not really serve the cause because the regulations on restricted data specifically invoke the OSA and, therefore, by definition, geographical data become official secrets which cannot be challenged in courts. In 1989, V. P. Singh did set up a committee to reform the OSA, in particular to arrive at a definition of 'official secret'. The committee could not come up with any effective resolution.

The upshot of the above discussion is that unless the basic question 'what constitutes a security risk?' is answered in technical as well as operational terms, and a correspondence is established between the restrictions and the security risks, it would be difficult to make much headway in relaxing at least some of the curbs, and making geographical data on large scales more easily available.

4. Security considerations

The security environment in India is drastically different from that of the US or any western country. Besides the external threat, in recent times, there has been a great deal of internal threat as well with extremist acts ranging from bomb explosions in public places and sabotage in strategic installations like bridges, railway lines, etc. to attacks on army depots and units. Moreover, sections along the border areas are under dispute with neighbouring countries. When a country like the US, which does not have any great external threat in post cold war times, and which has the most advanced technological wherewithal and capability, imposes restrictions on national security considerations – for example, it has intentionally degraded GPS data through spoofing and C/A coding for civilian access – it only stands to reason that India should devise appropriate restrictions to prevent national security-related risks. Of course, any such restriction should have a rational basis.

Unfortunately, in the context of geographical data, the restrictions are perceived to be without much logical basis. From the point of view of the MOD, the user community does not appreciate the intricacies of security risks and the consequent restrictions whose imposition is necessary; making all topographic data free and open, as is being demanded, is not a feasible proposition. From the SOI's point of view, on the one hand, the technicalities of cartography are not fully understood to appreciate why certain restrictions have been put and, on the other, as a service agency the SOI is bound by regulations of the government. The reality perhaps is somewhere in between.

The kind of restrictions that have been placed on data have all to do with the aim of limiting the positional accuracy of locations that can become known to the adversary. The restrictions cover: the scale of the maps; information on VAs/VPs and on latitude and longitude; contours of heights with respect to the mean sea level; accurate heights and planimetric data; national scale grid (Lambert's Grid on which military operations are based); precise ground control data; and the national scale projection parameters.

Whether all these restrictions have to be placed simultaneously, or whether some of these can be relaxed and some retained depending upon the specific requirements of a project and the corresponding topomap, are issues which should be technically addressed and answered. From the point of view of users, one would like to know whether these restrictions are generic or they can be made flexible depending upon use. Unfortunately, there does not seem to have been any attempt in this direction. All this would depend upon knowing what is the window of tolerance in positional accuracy that will not jeopardize security? This, of course, is specified by the military and known only to the SOI through the guidelines of the MOD. But a discussion with the MOD on these questions does not seem to be an easy proposition.

More pertinently, considering that all the topomaps produced by the SOI (or for that matter maps produced by any other agency) are in any case vetted by the MOD and security cleared (by masking or obliterating information pertaining to military/civil VAs/VPs) before they are released for publication, one could ask what is the necessity for all these restrictions. There should seem to be some rationale for this, which would be worth understanding in our own terms.

Any mapping is geo-referenced with respect to certain ground control data, which comprise a network of GCPs across the country, whose co-ordinates are accurately determined through geodetic surveys. These GCPs define the 'geo-referencing' for the country. For geodetic surveys, an appropriate spheroid for the area of survey (which approximates the curvature and flattening of the earth locally) is chosen. This is a mathematically smooth surface with respect to which all computations of coordinates are carried out. However, actual geodetic measurements are made with respect to the datum defined by the geoid – the (irregular) surface of equal gravitational potential – because the plumb-line is perpendicular to the tangent to this surface (see Figure 2). The normal to the spheroid is, however, differently oriented to the plumb-line vertical and, besides more accurate determination of the GCPs themselves, this 'deflection of the vertical' is a key gravimetric measurement that is constantly improved upon and updated to define the geodetic datum.

The geodetic datum for the Indian region is defined through actual physical measurements with respect to the mathematically defined ellipsoidal surface (by specifying the semi-major axis and flatness) called the Everest spheroid, first defined in 1830. The coordination of geographical data is done by a series of triangulations using the GCPs. That is to say, mathematical computations are carried out on the Everest spheroid while physical measurements are made on a geoid defined with respect to that ellipsoidal surface. The Indian geodetic datum has been constantly improved upon and currently a precise determination of the 'deflection of the vertical' is being carried out by the SOI.

Cartography or plane projection of this data as maps involves appropriate choice of projection parameters. So clearly, to go from a toposheet to physical data requires knowledge of the datum parameters (or the ground control data) and the projection parameters.

With the development of both intermediate and long range weapon systems, geodetic problems have become more critical than ever before. For effective targeting by such weapons, detailed cartographic coverage of areas of strategic importance are needed. For the weapon systems to be effective, it has become necessary to carry out geodetic computations between the target and launch sites which are often on unrelated geodetic datums. These requirements necessitate unification of major geodetic datums.

By 1940, every technically advanced nation had developed its own geodetic system to an extent governed by its economic and military requirements. Neighbouring countries did not use the same geodetic datum because there was no economic requirement for common geodetic information, and the use of common datums was contrary to the military interests of each country. However, for countries like the US, as military distance requirements increased and the capabilities of the various weapon systems increased, datums of at least continental dimensions have become essential, especially for geodetic information required for the inertial guidance of Inter Continental Ballistic Missiles. The best solution to the problem of meeting the increased military distance requirements was the establishment of a 'single' datum for a large area and adjusting all local systems to it.

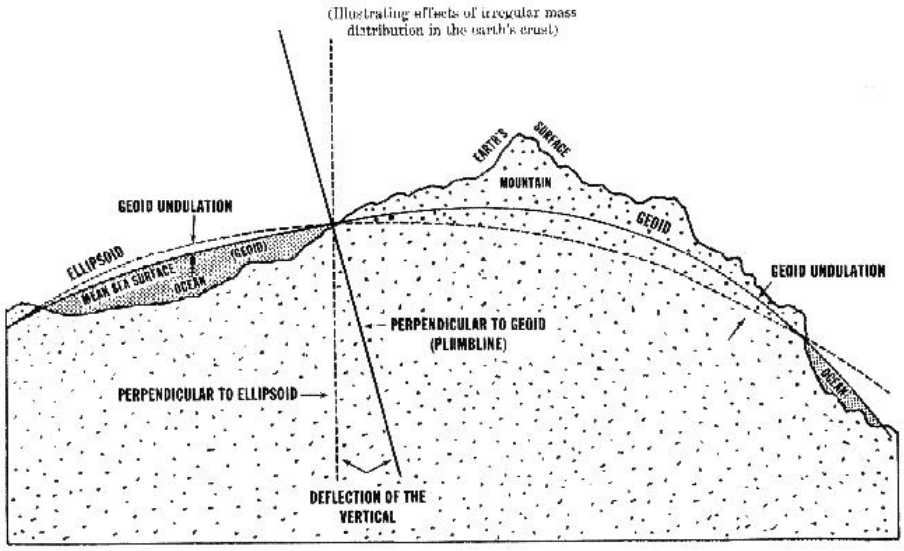

Figure 2. Relationship between geoid and ellipsoid, taken from *Geodesy for the Layman*, Defense Mapping Agency, Building 56 US Naval Observatory, DMA TR 80-003, Washington D C 20305, 16 March 1984.

While the US has established connections to its datum over various large datums – like the Tokyo Datum and the European datum – in its attempt to put militarily significant geodetic data on a global-scale geodetic framework, the Indian datum computed on the Everest Spheroid has been one of its weakest links because local triangulations across Asian and South Asian countries have not been carried out to establish connections across the various datums in these parts. The GPS is now a tool that is available for the US military to establish geodetic coordinates across continents through its S/A signals, which are not available to others. This GPS based geodetic data is geo-referenced on the World Geodetic System (WGS), a datum under constant refinement. The present one is called WGS-84, and it is likely to be replaced soon by WGS-87.

In areas of overlapping geodetic triangulation networks, each computed on a different datum, the coordinates of the points given with respect to one datum will differ from those given with respect to the other. The differences occur because of the different ellipsoids used and because the centres of each datum's ellipsoid could be oriented differently with respect to the earth's center (see Figure 3). Also, a difference in the scale of ground control data may result in a stretch in the corresponding lines of the geodetic triangulation network.

Therefore, coordinate values resulting from interpreting latitude, longitude, and height values based on one datum, as though they were based in another datum, can cause position errors of up to one kilometer. (Since the different datum surfaces are not parallel to each other, the errors could be less in some regions and more in others.) Regardless of the accuracy of the individual datums for computation within themselves, to perform distance and azimuth computations between unconnected geodetic systems is not an easy task. But there do exist transformation formulae to go from coordinates of one set to another – the unrefined three-parameter shift formulae and the seven-parameter Molodensky formulae.

Now, all SOI toposheets carry marks of the GCPs. Larger the scale, the better is the accuracy with which the co-ordinates of the GCPs can be read. This is one of the reasons co-ordinates of some locations in toposheets are not allowed to be indicated. As data on Indian GCPs become increasingly available, it enables the complete parameterization of the Indian geodetic datum and hence conversion from one datum to the other.

It appears that one of the reasons for restricting digitization of SOI data (even of unrestricted toposheets), as in the notification of 13 July 1998, is that once the data on Everest Spheroid GCPs is available in digital form, manipulation with it becomes easier and the relative accuracy of the GCP coordinates is not lost in value addition (which could include strategic locations) or scaling. This point is, however, not entirely clear and people who handle digital data would be in a better position to clarify this issue. Narasimha remarked: 'Why is digitization being treated so differently? This business seems funny to me because I do not see how you can stop any one from putting a map on a scanner and digitizing.' In fact, Ramamurthy, had observed in his note: 'For some unknown reason, an unrestricted toposheet becomes restricted when it gets digitized'.

One could, of course, argue that increasing proliferation of GPS receivers and their easy mobility could result in a self-consistent and accurate co-ordination of the country based on WGS-84 and thereby an adversary

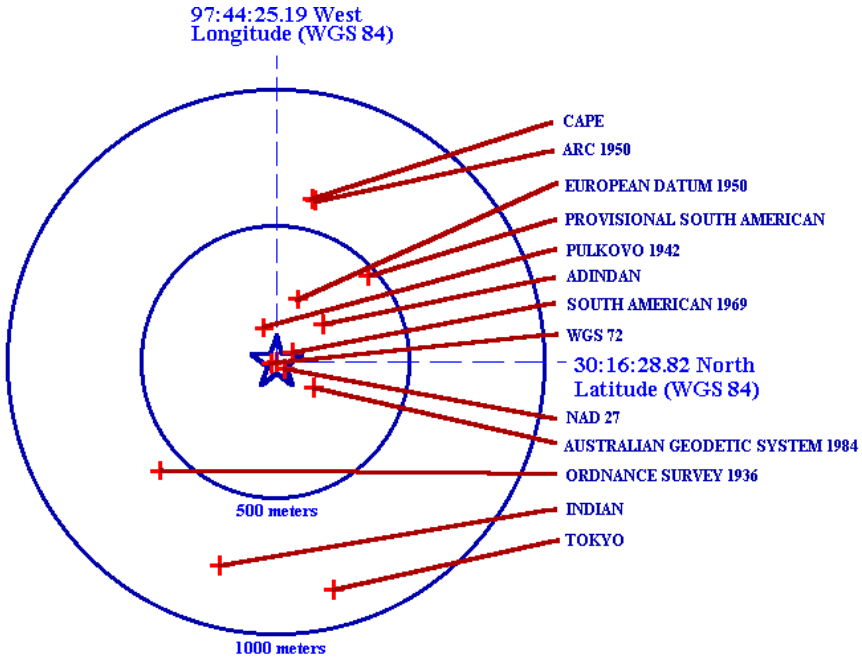

Figure 3. Position shifts from datum shifts. Figure is taken from Peter H. Dana, The Geographer's Craft Project, Department of Geography, The University of Texas at Austin. Copyright © 1998 Peter H. Dana.

can circumvent security restrictions on the Indian datum and the corresponding geophysical co-ordinates. But it does not seem to be as easy as it is made out to be. Civilian C/A signals have their positional accuracy errors. Use of S/A-based differential GPS (dGPS) can yield sub-metre accuracy. But with a given GPS receiver, one apparently needs to carry out repeated measurements for over 24 h to remove systematic biases and ionosphere-induced errors. If this gets done, in spite of physical security around VAs/VPs and strategic locations, it would amount to espionage and so would be no different from the security risks due to other kinds of espionage.

The issue, therefore, is to assess and evaluate the relative risks involved in relaxing the restrictive provisions on geographical data. For instance, what is the tolerance window with regard to positional accuracy that the MOD can accept, and whose public access can be permitted, without compromising on security. This is an involved technical question and should be addressed as such notwithstanding the probable fact that earlier restrictions were not based on any such technical evaluation of the risks.

5. Policy initiatives

As mentioned earlier, in the post-1950 period, there has been a gradual de-restriction in the access to topographic data. But the general perception is that, at any point of time, the extent of de-restriction does not seem to have been either commensurate with the requirements of applications in research and industry or in tune with technological advances, notably computer-based GIS. So the issue of restrictions on geographical data has been a subject of discussions of seminars, symposia and conferences and has periodically led to the constitution of expert committees to assess the situation and issue recommendations. It is not, however, clear whether these committees made use of scientific expertise to technically evaluate security risks to make appropriate recommendations on policy reforms. It is here that the Academy's initiative in the matter should go a long way to make recommendations that are scientific, realistic and feasible.

In 1989, the National Committee of Secretaries on Security reviewed the restrictions with regard to topographic data and made several recommendations that were discussed during the meeting by Rao. These included: exploring the possibility of 'tailored maps' for civilian use; single window clearance of restricted maps and aerial photographs; modifying the forms O.57 (A) and (B) and simplifying the attendant procedures; and evolving a single arbitrary grid for the country as a whole to ensure uniformity in data sharing and exchange. But, as he pointed out, many of them have not been implemented.

Later in 1995, following deliberations on data availability for watershed development programmes in the Department of Electronics (DoE), and thanks to DoE's initiative, a committee for Dissemination of Digital Data and Maps (DMAPS) was constituted by the Department of Rural Development under the chairmanship

of secretary, DST. N. Seshagiri, Director-General, NIC, and N. Vittal, then secretary, DoE, were its other members. The terms of reference of this committee were to arrive at a minimum set of parameters which are functionally used in the planning process and which should be accessible from SOI toposheets without any restriction. As per its recommendation, digital data are today being given in 'tailored form' to government organizations. The need to supply digital cartographic databases to NGOs, which had been recommended at several official levels in the past, was also endorsed by the DMAPS Committee.

This led to the constitution of a Committee of Secretaries under the Cabinet Secretary in 1997 to go into the entire issue. The committee appointed a sub-committee called the Technical Group on Map Data Policy (TG-MAP) chaired by N. Seshagiri, DG, NIC, for evolving an appropriate map and GIS data policy. The TG-MAP Report was submitted to the government in January 1998. The IT-Task Force report, issued on 4 July 1998, endorsed the recommendations of the TG-MAP as one of its 108 recommendations. The TG-MAP recommendations were considered by the MOD which resulted in the OM of 13 July 1998 giving directives to the SOI and nine agencies regarding digital cartographic data dissemination.

6. Policy on access to digital data

Restrictions on digitization of topographic data have led to considerable controversy in recent times, particularly following the episode of banning the sale of CD-ROMs of Delhi guide maps produced by Eicher Ltd. The maps in analogue form are, however, not restricted. These maps had been produced using SOI data. The cover of one of the recent issues of the magazine *GIS@development*, which is where the 13 July 1998 OM first became public, said in bold headlines: 'Now it is official; digitization is illegal'. At a conference on GIS held in August 1999 in New Delhi, called Map India 99, during a panel discussion, a highly placed government official created a stir by criticizing the official policy on map data restrictions in general, and the July 13, 1998, OM, in particular. It does seem that there was little consultation by the MOD in arriving at this OM, and that there is no consensus on the issue at the highest level of policy-makers. Though not explicitly stated by the MOD, it appears that there are three distinct kinds of rationale for the continued restrictions on digital SOI map data: (1) the issue of copyright; (2) control over value addition; and, (3) security concerns.

As Matthan explained, without proper authorization from the SOI, the owner of the copyright on topgraphic data, digitization indeed is illegal because 'digitization is a copy' in the sense of the Indian Copyright Act and, therefore, violative of SOI's right. The widespread digitization of the SOI toposheets that was apparently going on in the GIS industry over the last few years, without proper authorization, seems to have been the trigger for the clamp-down.

The exact nature of the recommendation of the TG-MAP as regards the modalities of disseminating digital data is not known because the recommendations have not been made public. But, on the face of it, the move does mark a step towards de-restriction of the data and decentralization of control and monitoring, although it may not as yet fully serve the industry's interests. Srivastava in his talk had made the point that there being no monitoring agency, maps of restricted and unrestricted zones were being digitized by various government and non-government organizations in violation of the copyright law. He also pointed out that value additions were being carried out in an unsystematic manner resulting in a lot of incompatible data of varying accuracy and reliability.

Issues of the need for the NGOs/private enterprises to register and enter into an MoU with the nine agencies, and the need for the value added digital products to be vetted by the SOI, were raised during the panel discussion. Srivastava clarified that the registration was felt necessary to ensure bonafide use as well to prioritize the dissemination only to those 'development-specific' projects being executed by these agencies where digital data was becoming essential. This way, Srivastava pointed out, given the agreement of non-disclosure to third parties in the MoU, there is some control over the dissemination of data, and it can be ensured that copyright is respected. Moreover, it can be ensured that only those kinds of value addition that are required by the projects are carried out, and that too in consultation with the agencies.

Another important point he emphasized was that the mechanism also ensured that data is generated across the country in a consistent manner rather than have every vendor come up with different, incompatible data of varying reliability. 'There is a proposal to set up a National Geomatics Centre (NGC) to provide a homogeneous database and ensure uniformity at the user end. Till such time, this mechanism should suffice,' Srivastava said.

The third rationale for disseminating digital data only on a need-to-know basis is, as indicated above, security. Though this was discussed earlier, the point may be re-emphasized here. A key issue with regard to the Eicher case seems to be, as Ravi Gupta pointed out, 'the CD-ROM was too accurate' which means that digitized SOI control data had been used. Now this is what the SOI and the MOD are trying to preserve by controlling the digitization so that Indian datum parameters do not become open secrets.

It was also pointed out that there are several lacunae in the wording of the MOD's OM, and that it raised

serious bureaucratic and procedural questions. It would appear that such an OM should have come from DST, as the department concerned with the affairs of the SOI; even now, the final Executive Order based on this OM should probably be issued by DST and not MOD.

7. Meeting future needs

A pertinent observation that Vittal made was that the discussion had been focussed on restricted maps and restricted data only and what economic potential had been lost because of the policies in place, right or wrong. He asked of the GIS business community as well as the research community what had actually been achieved by it using the topographic information and data of *unrestricted* areas which, after all, constituted a fair part of the country. Unfortunately, no answers, or even indicative information, that could provide the basis for assessing the future needs of data, was forthcoming. The needs of the projects themselves are not going to change across the dividing line, he said, echoing something which had been said earlier with regard to geophysical characteristics.

As mentioned earlier, the SOI has proposed the setting up a National Geomatics Centre (NGC) and the National Geographical Digital Data Infrastructure (NGDDI). Srivastava presented the details of both these proposals at the meeting. The former is meant to be a single window clearing house for a coordinated dissemination of 'stripped digital data' of SOI topographic information and maps to the users, as well as for providing consultancy on geodetic and allied geophysical surveys, topographical surveys, digital cartography, etc. The latter, on the other hand, is envisaged as a centre that would create appropriate digital geographical databases keeping in view such issues as standards, exchange formats for data sharing, and prevailing technologies in the GIS environment for the country as a whole.

The NGC has been mooted to meet the increasing demands on the SOI to provide easy access to digital topographic data for use in research and in developmental projects that use GIS techniques. The nine-agency route has been adopted for meeting these needs in the interim, according to Srivastava. The NGDDI is a proposal that was made to the Standing Committee on Cartography and Mapping of the National Natural Resources Management System (NNRMS). The NNRMS is a national project being executed for many years with the DoS as the nodal agency, for effective use of remote-sensed data generated through ISRO satellites in resource management and associated developmental projects. It has been conceptualized to be part of a National Spatial Information Infrastructure (NSII) that Kasturirangan has spoken about in recent times to meet the various needs of the NNRMS.

The proposals need an assessment of information needs, such as input parameters, modelling and transformation, output formats and parameters, techniques being used for data analysis, and other sources of data like satellite imagery. Therefore, the SOI circulated a questionnaire in October 1998 to a sample of government agencies and NGOs numbering about 15. Only six had replied. According to Srivastava, there seem to be diverse data exchange formats and GIS software being used. As a result, the accuracy achieved in the hard copy representations was not always uniform. There was also no mechanism for exchange of digital data between agencies, nor any coordination to avoid duplication of efforts. Even uniform standards for meta data (data on data) with regard to map contents and thematic contents were not being adopted, even though the SOI and the NRSA had evolved meta data standards and an exchange format standard called DVD-III, an improved version of DVD-I that has been in use.

If this is indeed the situation, the problems would continue to show up when data from agencies are compiled even under the nine-agency proposal. Also, according to a government user agency, meta data on SOI's topographic databases should technically include GCP data and projection parameters. But they do not, and no alternative for the country as a whole has been evolved. Apparently, the exchange DVD-III has not been fully developed and the inadequate DVD-I was still in use.

Clearly, the OM of 13 July 1998 can be operationalized only after at least some, if not all, of the above issues can be resolved. According to Srivastava, the implementation of the OM itself can provide the leverage for assessing the requirements of job-specific digital data which, in turn, can help evolve guidelines for the NGC and the NGDDI, and eventually the NSII. These can be done gradually, keeping in mind technological developments, on the one hand, and the security restrictions, which also may get amended in time. In fact, given the lack of resources within the governmental set up, Srivastava hopes that these proposed centres would have the mandate to make use of external agencies, including private companies, who could be contracted out specific jobs. An example of such jobs would be doing the GPS measurements across the country for GCPs based on WGS-84.

The important issue of copyright, royalties, and charges for dissemination has also been addressed in these proposals with the aim of generating revenue that will partly fund the establishment of these centres. It has been proposed that these centres may be identified as the data generators having exclusive copyright of the data. The need for evolving a realistic data pricing policy has been articulated by Ramamurthy who in his note made the remark that the present emphasis on earning revenue had led to a strange situation with regard to one

of the data generators, the GSI. The GSI maps and reports have been priced so high that it has become out of the reach of the scientific community. In this context, a dual pricing policy, with a lower tariff structure for the research community and government enterprises, as compared to a higher tariff for private companies, may be considered.

8. Way ahead and the Academy's role

There seems to be an all round demand – and this was evident at the meeting as well – to de-restrict all topographic data generated by the SOI, and make them freely accessible, with multiple outlets including bookshops, on the grounds that restrictions have not really served security interests. Srivastava, however, felt that the demand is misplaced because there are security issues to be considered and the SOI is only acting according to the directives of the MOD, the MEA and the MoHA. That restrictions on topographic data have proved to be futile is, however, an assertion which needs to be conclusively established in technical terms because the issue is technical involving a whole lot of questions relating to security risk evaluations, cartography, geodetic surveys, etc.

'What is beyond doubt is that even the position regarding the various issues is not clear to most of us and, where the position is clear, it is not known,' Narasimha said in his concluding remarks. The general feeling was that restrictions provided a safe way out for the officials when there is a fear lurking in their minds. 'We should work towards persuading the government to accept the principle that all data that is not explicitly classified are open. There has to be a classification only if necessary,' Narasimha said. A move towards this can be worked out only after a joint discussion of people from defence, the scientific community and those who use and analyse the data. The general opinion was that the initiative for this has to come from DST, and that an interaction with DST was essential. A consensus at the meeting was that at the very least, the Academy should urge DST to get together a smaller group that could produce a document to ensure that these inconsistencies are removed.

This smaller group should be in the nature of a scientific fact-finding committee that will analyse the issues from a technical standpoint to 'establish for ourselves the one-to-one correspondence between security risks and restrictions on data,' as Siddhartha had desired. Government directives to other geographical data generating organizations like the GSI and the Naval Hydrographic Office should be analysed, and it should be ensured that there is a consistency in the restrictions placed on the various data generators so that there are no contradictions when different data sets are compiled together. The mandate could also include how other countries addressed security issues with regard to topographic data on the one hand and the legitimate needs of the research community and industry on the other.

The recommendations of such a committee would help in clarifying what currently is at best only a plausible rationale for putting restrictions, and in evolving a long-term map policy. 'In the meanwhile, if there are executive actions (*a la* Siddhartha) that can be taken, consistent with security interests and the copyright issue, I am convinced that a great deal can be done,' Narasimha opined. As he correctly observed, the different branches know what they can do and what they cannot do. In that sense, the SOI is clearly constrained by the government policies. Narasimha also advocated action in the direction of ensuring freedom of information and the citizen's constitutional right to know. It was not, however, clear whether he wanted that action in the form of challenging the restrictions in court, as Matthan had advised.

At a basic level, the promised improvement and simplification of the forms O.57 (A and B) and simplification of procedures for the annual certification for safe custody of maps, as recommended by the 1989 Committee on Security, have to be implemented. It should be possible to do these immediately while progress on other more complex issues concerning restricted data is dependent on policy reforms in the long-term.

One of the first things that the Academy can do, and should do by persuading DST, is to assess the extent of the problem. This itself seems to be lacking. There may be a number of individual problem cases, for one reason or the other, but a quantitative handle on the issue would also go towards knowing the kind of data that is in demand. For restricted data, the record of O.57 (A and B) forms submitted and the actions taken on them over the last few years (particularly after the advent of GIS) would provide a good data base for evaluating the situation. The SOI should have such a database and DST can easily access it. This would also help in arriving at a minimum set of parameters that a generic user requires. It would also serve as a guide for a basic 'tailored map' and, eventually, reforms in the national map policy.

Answering quantitatively the question that Vittal raised about the extent of usage of unrestricted data is also equally important. There is a need to know whether the restriction policy alone has hampered development projects or there are other related issues. However, even for *unrestricted* analogue and digital cartographic data/maps, there are problems of access that can be addressed even within the existing policy framework and sorted out in the near term.

A widespread criticism of the SOI data is that they are very dated. The SOI itself, as mentioned earlier, undertakes updating of these once in 15 years which is certainly inadequate. The problem is one of financial

resources and, more importantly, lack of survey manpower. Srivastava in his talk had made a rather cryptic remark: 'We are a non-scientific body, but not an unscientific body.' A probe into what he implied shows that many of the problems, including the one above, can be traced to the structure and management policies of this agency. The SOI was transferred to DST in April 1972. Prior to this it was under the Department of Education and Culture. In a recent meeting with him, the Surveyor-General mentioned that it has become increasingly difficult to get Field Survey Officers for recruitment. The policy of recruiting from the Armed Services was apparently discontinued in 1984. Of the 20-odd officers that the SOI needed, they have been able to get just two, and very often people who are selected choose to go over to some other organization even if it meant a lower grade. This was mainly because of the difficult nature of the field surveying job, often requiring to work, for days together, in inhospitable conditions and terrain. And for these 'foot sloggers', as he referred to the surveyors, there is no commensurate higher salary scales nor monetary benefits.

Even after being placed under DST, issues such as funding and management of the SOI have largely remained unchanged. Consider this. The annual plan allocation for the SOI, a vast organization with over 700 people, is around a mere Rs 4 crore. For some reason, there does not seem to have been a conscious attempt to treat it as a scientific body requiring larger financial allocations that can enable it to undertake improvements and innovative measures as technologies advance. Lack of funds is also a major constraint to undertake new surveys, update older ones and, not the least, initiate such programmes as digitization and develop GIS packages and related products. This is also the reason for not being able to print and maintain large stocks of quality topomaps that can meet the growing demand.

Interestingly, unlike other scientific bodies under DST, there is no scientific advisory board for the SOI which can assess the long-term plans of the organization, review ongoing programmes, and recommend appropriate funding. Whatever is being done appears to be largely through individual project-related external funding and extra-mural funding. A related, but important issue, is that, even though recruiting officers from the Army may have ended, the SOI has the mandate of carrying out surveys for the military as well. It is the links with the military survey wing of the Army that gives rise to the general impression that the MOD exercises great control over SOI's plans and programmes.

Since the agency is not treated at par with other scientific bodies under DST, even though the officers do scientific data gathering, they do not enjoy the personnel and promotion policies of a scientific institution. For example, besides salary grades, the flexible complimenting scheme (FCS) for promotions, etc. is not applicable. Even the India Meteorology Department, the other service organization under the DST, seems to have relatively better personnel policies. The GSI, which is under the department of mines, appears to be in a worse situation.

When one talks of the inability of scientists to publish scientific work because of the restrictive policies on geographical data, the same is true of the work carried out by the SOI officers. They put in equal, if not more, intensive work than other field researchers and do not get any commensurate recognition for excellence. There would seem to be an urgent need to address these institutional issues and rectify this situation if one expects organizations such as SOI to be more responsive to the needs of other government agencies, the scientific community, the NGOs and the industry. This would help to move away from what may seem to an external observer to be, as Siddhartha pointed out, a 'dog in the manger attitude'. There may even be the danger of the tendency of blaming the SOI for everything backfiring, resulting in a hardening of SOI's stand.

To conclude this report, the following specific steps can be taken with regard to *unrestricted* data so that these are easily accessible and better utilized, even as the Academy works towards reforms in restrictions:

1. Though there is close interaction between the DOS/NRSA and the SOI, a conscious effort at updating the SOI base maps using satellite imagery and aerial surveys, through a well funded and coordinated programme, should be undertaken. Similarly, as Rao mentioned, where SOI toposheets/base maps are restricted, with MOD's clearance, satellite imagery itself (which is in public domain) can be used to generate new base maps using different GCPs. These could be based on a datum different from the Everest Spheroid (say, WGS-84), on different projection parameters, and on different coordinate grids. The DOS is actually launching a consortium approach, which will include the SOI as well, to obtain ground control data with respect to WGS-84 datum across the country before the *Cartosat* goes up. This programme will have to be given priority so that the required data are ready by 2001.
2. The minimum set of data, and the standardization of scale/resolution of data in relation to applications, should be determined through assessment studies of projects that have been carried out in the past.
3. The recommendations of the 1989 Committee on Security should be taken up again with the MOD and the SOI to see how best they can be implemented. These include defining some arbitrary national grid for use on the national scale, de-restricting aerial photos of unrestricted areas, making de-restricted toposheets and aerial photos more easily accessible to the NGOs and private organiza-

tions/individuals, and preparation of sample 'tailored maps' (which will include coordinates on an arbitrary grid). One needs to properly understand why, as the SOI has stated, 'tailored maps' that meet the MOD directives are not feasible.

4. Steps should be taken to make the archived SOI maps of the pre-1947 period, deposited with the National Archives, open without any restrictions, perhaps through an executive order as suggested by Siddhartha.
5. Issues relating to unrestricted (but regulated) digital data:

(a) The questionnaire sent by the SOI to get a profile of users and their needs (see Section 7) should be sent immediately to a wider cross section of SOI data users, including researchers, NGOs and the GIS industry. The form may be posted on the web site of different organizations like the SOI, the NIC, the NRSA and even the Academy. (Incidentally, the SOI site (URL: http://www.nic.in:80/snt/SOI1.htm) is very weak and should be completely redesigned and content increased so as to be more useful to consumers of SOI topographic data.)

(b) The Kasturirangan Committee's recommendations on the modalities of implementing the July 1998 OM on the dissemination of SOI's digital data should examine ways to bring clarity on a number of issues. Definition of terms such as value addition and development-specific data, formats of data exchange, specifications of the arbitrary grid, criteria for registration with the nine agencies, etc., all need more clarity than what is available at present. It is also not clear whether mere raster scan data will be supplied or whether vector data too will be provided. Nor is it clear whether or not projection parameters and ground control data on some other datum would be provided.

(c) Meta data standards should be established along the lines indicated by the SOI so that the basic parameters of data holdings are the same across agencies and users. (This information has not been disseminated widely enough and should be put on the SOI website.) Similarly, data exchange format standard DVD-III needs to be developed (if not already done) and supplied to all potential users.

(d) Standardization of data storage procedures across major agencies should be ensured so that the digital cartographic data bases are compatible.

(e) A project to evolve the transformation parameters for going from Everest spheroid coordinates to WGS-84 must be immediately taken up as a joint effort among selected research institutions, the SOI, the DOS and, if required, even the GIS industry, without sacrificing security interests. This would require a measurement of WGS-84 GCPs in various parts of the country using GPS techniques. Since the DOS is already embarking on this aspect of the problem, a concerted effort to compute the transformations would go a long way to enable uniformity of data across agencies and applications. There is no reason why DST and SOI could not undertake this as a project, but it is not clear whether MOD would approve of it.

(f) The setting up of the NGC and the NGDDI proposed by the SOI, and eventually NSII, should be funded and promoted by the DST and the DOS as a priority national project.