A PROPOSED BASE FOR GEOGRAPHIC INFORMATION SYSTEM FOR INDIA

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ABSTRACT

Attempts have been made by different organisations in India to organise data in order to develop a most suitable information system. These attempts were oriented towards specific use, such as natural resources, data management, thematic mapping and the like. In some attempts software have been developed for some specific purpose. Obviously, it is not an easy task to develop an information system for a country like India. The extent of the country along longitudes and latitudes is more than the average size of the countries. There are federal and state agencies for collection of data and preparation of maps. The geographic information concerning India is available from the following sources : (a) administrative set up : states, union territories, districts, sub-districts and villages; (b) survey sheets; (c) remote sensing imageries; (d) aerial photographs, and (e) thematic base of NATMO. There are other map series available which have been used for socio-economic mapping. By the end of 1986 the Indian Remote Sensing Satellite will be launched and then remote sensing data would be easily available. Considering the geographic bases available in the country, five levels can be identified for developing an information system for India. Some of the thematic maps at 1:1M scale can be used for initiating the Geographic Information System.

INTRODUCTION

Organising data for a large country like India is not an easy task at all. There are 29 states and union territories of reasonable size. Each of these states do not always have similar basis for data collection. As a result, the cartographic base and statistical contents vary considerably. On the other hand, the federal agencies for mapping and data collection follow moresoever homogenous policies for the entire country. The example of such data sets are population and housing censuses, livestock census, survey of industries, topographical sheets and thematic maps. India had developed space technology and soon remote sensing data will also be available from IRS-1. Some places have drawn special attention, and large scale maps and detailed information is available for these places. For priority areas, photographs at large scale can also be made available.

The geographic information of the country is available from the following sources :

(a) Administrative set up : The country is divided into 22 states and 9 union territories, or 418 districts, or about 3,500 sub-district administrative units known as tahsil, taluk, thana (police station), sub-division, or 605,224 revenue villages.

(b) Survey sheets : Covering the country on specific scales (e.g. 1:50,000 or 1:250,000) showing specific items, such as physical features with contour lines, rivers, settlements, general land use, transportation lines etc.

(c) Remote sensing imageries : Coverning the country on a scale of 1:1,000,000.

(d) Aerial photographs : Covering the country at various scales and photographed at different times. For specific areas, such as urban region or tea growing areas, large scale photographs are available.

(e) National Atlas & Thematic Mapping organisation (NATMO) base: Covering the whole country at 1:1,000,000 or 1:2,000,000 scales. The maps at these scales are on same base and can be compared.

Socio-economic base

Majority of the states have produced maps at 1" = $\frac{1}{4}$ mile scale maps for each of its administrative units at sub-district level, locally known as tahsil or police station or Majmuli maps (in short P.S. Maps). These maps show the revenue village boundaries and location of important settlements in the village with jurisdiction list numbers. Basically these maps are for administrative or revenue purposes, but have been widely used for mapping and data collection purposes. This is the only base available where the lowest level administrative boundaries are shown. There is no other source to provide this information. At one stage attempts were made to include village boundaries in the survey sheets (e.g. in Champaran district in Bihar state), but later it was given up. These maps have been widely used as pre-census maps and almost every district census handbooks contain these maps, however at modified scale. Due to the uniqueness of these maps, they provide a base for socio-economic mapping of the country. Since sub-district level administrative boundaries are available in the survey sheets, these maps can be linked with the overall geographic and cartographic base of the country. On the other hand, the P.S. map series can be linked with the age old cadastral map series at 16" = 1 mile or 32" = 1 mile scales. This map series at very large scale show property lines, built-up areas and plot numbers. Both the maps series are fairly accurate and reliable (Nag, 1984 A).

A district map on established geographic base can be developed showing administrative set upto revenue village level. A map of this nature can be used as a base for plotting 75-100 items of

general and crop land use, or 80 items related to population and housing, or 135 items of livestock census for each unit shown in this map. Further, all the other information related to planning, development and administrative statistics can be mapped based on this framework. A base of this nature has to be included in the Geographic Information System (GIS) for considering socio-economic parameters.

Table 1 : Geographic Bases

No.	Geographic bases	Scale
1.	NATMO Thematic Maps	1:1,000,000 or 1:2,000,000
2.	Remote Sensing Imageries	1:1,000,000
3.	Survey Sheets	1:250,000
4.	P.S./Tahsil/Taluk/Majmuli Maps	1" = $\frac{1}{4}$ mile
5.	Survey Sheets	1:50,000
6.	NATMO Landuse Maps	1:50,000
7.	Air Photos	1:15,000 - 1:60,000
8	Cadastral Maps	16" = 1 mile or 32" = 1 mile

There are point based and line based information as well. For example, the metereological data and distribution of industries, universities, livestock markets etc. The location of such points are to be included in the base map for using the data. Similarly, the line based data, such as related to railways, road, waterways can be included in the GIS.

ATTEMPTS FOR DEVELOPING INFORMATION SYSTEM

National Natural Resource Management System

In 1982, it was felt that the country should adopt a comprehensive approach to the management of natural resources. As a result it became "necessary to have accurate inventories of resources such as land, water, forests, mineral resources, ocean etc to utilise this information in order to achieve maximum national benefit with least damage to the ecological system"(I.S.R.O., 1983). Considering the above necessity, Government of India recognised the need of establishing a National Natural Resource Management System (NNRMS). In the following year National Task Forces were appointed to look into the aspects related to :

(i) Agriculture
(ii) Cartographic representation of data
(iii) Forestry
(iv) Geology
(v) Natural resource information system
(vi) Oceanography, marine resources and costal studies

(vii) Soils and Landuse

(viii) Urban and rural studies

(ix) Water resources.

These task forces were required to study the present and the existing system of information genereation, data processing, management aspects highlighting the strengths and weakness; and identifying the specific elements amenable to remote sensing techniques presently and possible in the near future (I.S.R.O., 1984). Almost all the above task forces have submitted their reports which will help in building up Natural Resource Information System, the Task Force V. Obviously, the above activities are based on the potentialities of the Indian Remote Sensing Satellite-1. In addition to the above task forces, several 'end-to-end experiments' were also identified.

Natural Resource Data Management System

Another project with similar objectives was sponsored by the Union Department of Science and Technology, known as National Resource Data Management System (N.R.D.M.S.). The purpose of this pilot project was to evolve appropriate methodology for collection, collation, storage, analysis and dissemination of data on natural resources in a specific region in its totality. Here the data on human resources was also included. The aim was to evolve a standardised format in natural resources and socio-economic data could be presented in an integrated manner so that linkages among various hierarchical units, viz state, district, blocks and villages could be studied (D.S.T., u.d.).

This project also aims to develop an information system with grid of 2.5 minutes square of the entire area concerned. For littoral areas, economic zone and deep sea area, the grid sizes were larger. Several indicators were identified to be included in six data sets. Software has been developed to generate thematic maps compatable with the geographic referencing system. Maps of different scales at 1:1,000,000, 1:250,000 and 1:50,000 were generated. The socio-economic information was collected from administrative sources and by selecting one village per grid with sample households. An integrated study in the Ghaghara -Gandak sub-basin for multiple data base was taken up.

RSDCATLG System of S.A.C.

Considering the possible increase in information sources which brings in various image reference schemes, it is becoming increasing difficult to make a selection of multi source data. "Operation users, for whom remote sensing is not of main interest, may not like to spend time in understanding image reference schemes and coverage patterns of various data sources" (Goel and Dasgupta, 1984). Space Applications Centre (S.A.C.) of the Indian Space Research Organisation has developed and implemented a RSDCATLG system based on VAX-11/780 computer for automated catalogue search facilities. The user can have the access of the availability of information based on relevant

sources, period of collection and concerned geographical area (Goel, 1984). Geographic query is possible by refering the concerned area by all types of methods possible, e.g. survey sheet numbers, administrative boundaries; lines, points and polygons with longitude and latitude coordinates, etc. Software packages available with VAX-11/780 system were used for this purpose. Obviously, this system has been developed keeping in view of the possible information from IRS-1 and other satellites. Such designs would also help in developing the N.N.R.M.S. Task Force on National Resource Information System.

Data Bank of NATMO

National Atlas and Thematic Mapping Organisation (NATMO) has a data bank considering the nature of its work. This bank consists of a large variety of information in manuscript form, printed books and reports, mimiographed copies, air photos, imageries and maps. Mostly information is available for post 1951 period (NATMO was established in 1956). For example, classification of area, land use, and production of crops data is available from 1951-52 onwards. Similarly, information about livestock, agricultural implements, fisheries, and cattle is available from 1961 onwards. Printed data, such as census or health statistics is easy to handle. There are several other data bases pertaining to single or more than one maps of the National Atlas of India or thematic atlases. In the International Seminar on Environmental Maps and Atlases held in Calcutta in 1983, it was recommended that NATMO should develop a data bank on environment-related issues (Nag and Dutta, 1986). Though NATMO has one of the richest collection of data, practically no automation has been introduced in the whole process of building an information system (Dutt and Nag, 1985).

Some other institutions in India are also trying to develop their own information system with particular orientation to needs. These are National Informatic Centre and the Department of Environment and the like.

Remote Sensing Activities

With successful launching of Bhaskar-I, Bhaskar-II and Rohini, India is now planning to put IRS-1 in space later this year from Soviet Cosmodrome. Much of the success of the proposed information system will depend in the IRS which will provide real time data. The feature of the IRS is as follows :

Table 2 : Some Features of IRS

Bands	Microns	Sensitivity to
1	0.45 - 0.52	Sedimentation, discrimination of conifers
2	0.52 - 0.59	Green reflectance of healthy vegetation
3	0.62 - 0.68	Chlorophyll absorption of vegetation
4	0.77 - 0.86	Green biomass

Source : N.N.R.M.S. Bulletin, Vol. 1, No. 1, April 1983.

Table 3 : Anticipated daily through-put requirements for IRS data products.

Type	Format (mm)	Requirements
Browse products	70	400 band scenes
Standard products	240	80 band scenes
Precision products	240	40 band scenes
F.C.C.	-	20
C.C.T.s	-	4
Special products	-	4

Source : N.N.R.M.S. Bulletin, August 1983.

In addition to the IRS sources, India will get remote sensing data from SALYUT-7 TERRA Experiments, SPOT and Thematic Mapper (LANDSAT 5). The receiving station for Thematic Mapper is now ready and projects have already been identified based on this source of information.

PROPOSED BASE FOR G.I.S.

After assessing the sources of information, data bases, experiments on information systems, and possible sources of new information, it is worth considering the nature of a proposed base for India. For a sizeable country like the one in question with different types of data sets within its federal structure, a greater flexibility is required. Five levels of spatial information can be worked out according to the availability of data, potential sources, and mapping work already carried out. These levels are as follows :

(a) Level A - 1:1,000,000

At present, maximum information is available at 1:1,000,000 scale. The LANDSAT data is useful at this scale. NATMO has developed a geographic information base at the same scale. Whole country is divided into 15 plates and this base has been used for mapping of various aspects, such as administrative set up, physical aspects, population, transport and tourism, landuse, and cultural landscape. Some of the map series at 1:2,000,000 scale can be enlarged to this scale for additional information. These maps are on slope, rocks and minerals, rock types, rainfall, drainage, water resources, wild life and wet lands, forest types, density of rural population, crop regions, soil regions and working force. Some of the maps prepared by other institutions are based on this scale. NATMO has also developed a base where boundaries at sub-district level (3,500 approximately) have been matched with the geographic set up of the country.

If we consider a single map series at 1:1,000,000 scale, e.g. "Cultural Landscape", we will find that the following information has been mapped :

i) Boundaries-international, state, district with headquarters.

ii) Archaeological, pilgrim site or place of tourist interest.

iii) Airport and important settlements (towns and villages).

iv) Roads and their types.

v) Railways with station.

vi) Streams, dams, barrages, canals, waterways etc.

vii) Agricultural/rural landscape (irrigated, unirrigated, shifting cultivation and settlements).

viii) Industrial/urban landscape - predominant urban activity (primary, secondary, tertiary), mining and builtup areas.

ix) Pastrol/fishing landscape (grass, scrub, fishing areas).

x) Wild landscape (reserve, protected, unclassed forests, barren land).

xi) Airport, sea port, sea route, bus service, distance from point to point, rest house, temple, cave temple, Buddhist monument, mosque, tomb, church, palace, fort, ruins, view points, resorts of all types, power stations, bridge, ferry etc.

xii) Insets of important places.

On this base, other information files or data bases can be superimposed and corrected. This base can provide a useful framework to initiate Geographic Information System (G.I.S.) for India. It can be enlarged to the extend the details of data available for specific use.

(b) Level B - 1:250,000

From Table 1 it is apparent that survey sheets are now available at this scale. It is expected that with better resolution of remote sensing data, such as IRS or SPOT, mapping at this scale would be possible. NATMO is bringing out a series of District Land Use Maps at this scale. Village location can be shown at this scale, but the mosaic of village boundaries would be clumsy. The greatest advantage of this scale is the availability of air photographs.

(c) Level C - 1:50,000

Two important map series are available at this scale. First is the survey sheets, and second is the rural land use maps being prepared by the NATMO. At this scale village boundaries can be adjusted with the geographic features. Some air photographs are available at this scale. It is estimated that remote sensing data can be useful at this level as well. The advantage of this level is the availability of a uniform and accurate survey sheets. A lot of research and survey work is being carried out at this level.

(d) Level D - 1:15,000
The Police Station (P.S.) map series are approximately at this scale. Some detailed photographs for priority areas are also available at 1:15,000 scale. In addition, there is a plan to prepare survey sheets at this level basically for controlling flood in flood prone areas of northern India. Detailed physical features will be shown in such proposed maps.

(e) Level E - 1:5,000
No information source is available at this scale. The closest one is the cadastral map series. Maps at this level would be useful for high density areas, such as towns and cities. An urban area authority would like to have such maps showing details of property lines and tax and planning purposes.

CONCLUSION

All these five levels can be integrated into one system with suitable hardware system and software packages. Hence, the proposed information system can be made scale free upto certain extent. The details of information available will indicate at what approximate level one can go. Probably, the whole process from 1:1,000,000 can be initiated and files of different thematic contents be developed step by step. To initiate a G.I.S. at this scale for the size of the country like India, it is not an easy task at all. But, technology to handle such a situation is now available and even larger countries have been successful in doing so (Nag, 1984 B). Some sttempts have been made in this regard which will guide the future course of action of developing a Geographic Information System for India.

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