

## SUNDERBAN A GIS APPROACH

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### INTRODUCTION

The Sunderban region is located between 21deg 32 Min.latitude & 22deg.40Min. attitude north and between 88deg.&05Min.and 89deg.longitude east and constitutes the watermost part of the gangetic delta.



**Bio-spheres Reserve throughout the world**

The region is demarcated by the river Hoogly on the west, the Bay of Bengal on the south, the Ichhamati-Kalindi-Raimongol rivers on the east. It comprises nineteen blocks of north & south 24-parg. Districts of West Bengal.

There are 54 islands in this region. The land area measures about 9629 sq.km. of which 4493 sq.km inhabited by people and the rest is reserve forest. The total number of mouzas under the region is 1093. major ecosystem type is tropical humid forest, mangroves. habitat and land cover types are tropical semi-evergreen forest including mangrove such as avicennia albs, bruguiera gymnorhiza, cerioplastagal, rhizophoraapiculataetc, agroecosystems, silviculture, pisciculture,

prawn culture etc. water and soil characteristics of estuaries mechanism of situation in the tidal river system soil related problems and fertility of coastal soils and a wide diversity of flora, fauna and medicinal values of mangrove species, plankton composition and its population density also a very important issue for sustainable development. Socio economic status is mainly dependent on the fishery resources of sunderban.

There is a vast difference between the other bio-sphere reserve and sunderban, because it is world heritage site as well as largest mangrove area in the world. ecologically it is a very important place as well as it is under MAB(Man and Bio-sphere) project.



**Bio-spheres Reserve throughout the INDIA**

### **MAJOR OBJECTIVES OF GIS APPLICATION IN SUNDERBAN:**

Main object to create a GIS based data base for the following information's  
To generate various reports for the management as a decision support system.

- **Brick-paved road, culverts and bridges.**
- **Jetties.**
- **River Channel.**
- **Fisheries program.**
- **Socio- Economic information.**
- **Mangrove plantation.**
- **Strip plantation.**
- **Farm forestry.**
- **Agricultural extension program.**
- **Tiger conservation project & Animal resource programe.**
- **Rural water supply.**
- **Installation of solar photovoltaic system.**
- **Cottage and small scale industries.**
- **NGO's**
  
- **Brick-paved road, culverts and bridges:**

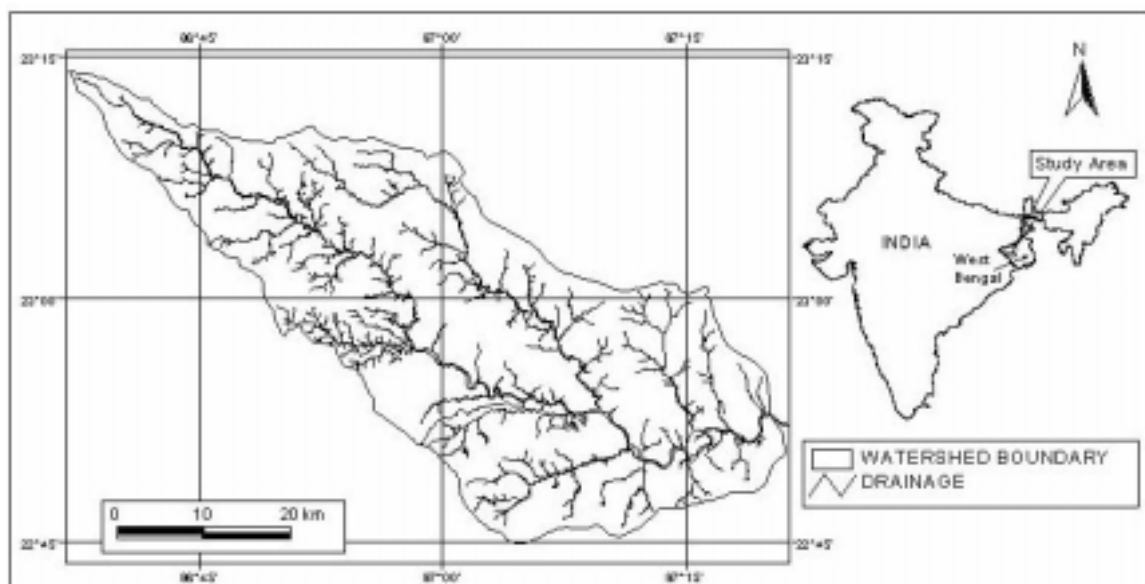
Till the end of march 92,840 km. of brick paved road has been constructed by the board in sunderban area. This has opened up new horizons for the local people. It has brought about considerable mobility in the remote sunderban areas where transport and communication was previously difficult specially during the monsoon season. The GIS based information system can help in making future development and logistics planning for local community development.

- **Jettis:**

Since 1981-1982 the construction of 37 jettis has been completed. The provision of jettis has been made for promotion of landing facilities in the riverine sunderban areas. The Jettis are serving an estimated population of 15.6 lacs spread over about 250 villages from 60 to 3500 persons per day. Apart from this GIS can develop a proper system at Chemaguri and Kachuberia points cater to needs the pilgrims from all over India during the Gangasagar Mela.

- **River Channels:**

About 427.7 kms of channels have been re-excavated till the end of March 1992. It is estimated that more than 6000 ha. of land have been brought under the fold of a second crop in the dry season with the sweet water stored in this re-excavated channels. In all probabilities, in the coming years, this figure will move upward. The farmers within the command areas of re-excavated channels are always advised to cultivate those rabi crops which reasonably less irrigation water. Conditions of these channels along with the re-excavation of Govt. bonds can be monitored through GIS and remote sensing application along with a proper model of development.



DRAINAGE MAP

- **Fisheries Programs:**

The program element “Brackish aqua culture” the Fish Farm Activities were introduced by the SDB (Sunderban Development Board). GIS based model can help the objective of boosting the production of Brackish Water Fish and to provide technical supervision and marketing facilities in the area.

- **Socio-Economic Information :**

Under this Social Forestry Program (SFP), SDB was initiated in 1981-1982 . At the outset the program size was small compared to the other program elements of the project. The initial program was as follows:-

Strip plantation- 1000 Kms.

Experimental Mangrove plantation 100 ha.

After the initial success of the program the target was revised upward with the approval of World Bank Review Mission and a new program element of farm forestry was introduced. If we can apply GIS , the objective of SFP will be more effective to supply fodder for animals, oil seeds for commercial use, poles and bamboos for rural house holds and easy for maintenance of ecological equilibrium by preventing erosion and soil productivity. Such programs also discourage poaching in the reserve forest area.

- **Agricultural Extension program :**

The economy of the Sunderban Region is dependent primarily on Agricultural activity. About 90 % of the people of the region fall back on agriculture alone for the livelihood. The Sunderban Region having a total Geographical area of 431893 ha. With a cultivable area of 299419 ha. Is mainly monocrop, the main crop being kharif paddy. Over 50 % of the people are landless laborers while over 40% of the farming house holds of the region operate in less than 2 ha. of agricultural land. The problem of agriculture in sunderban is initially related to salinity and water logging. Inadequate drainage, during monsoon, affects the paddy crop adversely. A huge portion of land remains fallow land during the dry season for want of irrigational facility. A GIS based drainage and irrigation program can create potential farming activities for the region. The cropping intensity, drainage system, irrigation potentiality can be judged distinctly through GIS system. Apart from this the economic condition of small and marginal farmers can be measured and a master data base with the help of spatial information can introduce for the decision support system.

- **Tiger Reserve Project& Animal resource development:**

Animal Resource program was introduced in the year of 1991-92. For improving the breeding stocks, bucks and rams were distributed in 9 blocks and for creating veterinary aid in the sunderban region 48 lacs rupees in the forms of transport subsidies was provided to the Veterinary Services Directorate. With the help of GIS technology we can understand the current status and identify the developing segment of the region. Also with the help of GIS monitoring of tiger project can also possible.

- **Rural water supply:**

During 1990 -91 the SDB undertook a scheme of sinking tube well under its Rural Water Supply program in the sunderban region aiming at providing safe drinking water in deficient mouzas in the region. A sum of Rupees 36 lacs was allotted to Zilla parishad of south and north 24 paraganas for execution of the scheme. If we can use GIS to locate the safe drinking water zones more and more people will be benefited by this program.

- **Installation of the Photo voltaic system:**

The department of non conventional energy sources, Govt. of India, was started this program in the year 1986 –87 with street lights (25 units). Today they are also using bio-mass gasifier for rural electrification. To identify the potential areas for these types of system GIS and Remote Sensing is a very effective tool. In a remote area like sunderban these technologies is very helpful to understand the natural resource balance and their equitable uses as an energy source.

- **Cottage and small scale industry:**

Under this program the district rural development agency (DRDA) of south and north 24 paraganas districts have been imparting vocational training to the village women folk in group also there are different production centers for the region. With the help of our system they can understand the growing needs of the people and locate different skills & resources for further improvement.

- **NGO's (Non Government Organization):**

SINCE SUNDERBAN IS A WORLD HERITAGE SITE, THERE ARE DIFFERENT DEVELOPMENT PROGRAMS FROM STATE AND CENTRAL GOVERNMENT ALSO PROGRAMS FUNDED BY DIFFERENT FOREIGN AGENCIES. NGO'S ARE PLAYING A VITAL ROLE FOR THE DEVELOPMENT FOR THIS REGION. THEY BECAME CATALYST BETWEEN LOCAL PEOPLE AND GOVERNMENT. SO A COMPREHENSIVE DEVELOPMENT MODEL (GIS BASED) CAN HELP THEM TO INTEGRATE DIFFERENT INFORMATION'S AND GIVE THEM CLEAR VIEW IN UNDERSTANDING THE OBJECTIVES OF DIFFERENT DEVELOPMENT PROGRAMS FOR THE PEOPLE.

### **METHODOLOGY OF THE PROPOSED CONSERVATION PROJECT**

The development planning of such a vast area for identification of degraded stretches of sunderban requires various data information to identify the terrain, slope of the river, affected land areas in order to draw, on the block map and the bank of the river, the proper passage of channel to prevent loss of land as well as to maximize potential.

Implementation of GIS Application development with the Remote Sensing data (Satellite images), layering of Topo Survey data from Topo maps (1:25000 to 1:50,000 scales) available from the Survey of India and digitization of relevant block maps, as well as verification of draft contour maps in the field will only be able to prepare micro-distribution system within a short time and with more economy.

- **Identification of surroundings-**

The accessibility of the different parts of the local bodies can also be studied and mapped with the help of GIS.

- **Modeling-**

Planning is done with the assumption of future population. With the application of GIS the local planners can assume the environment, health & education conditions of the local bodies in future and take policy decisions accordingly.

- **GIS application on water resource management:-**

In order to satisfy water demands of today and tomorrow and protect the resources in long term, the decision makers need tools to make decisions based on reliable data. It would therefore be imperative to view the facts of water management as:

- Design installation and use of GIS based information system.
- Creation of management tools.
- Drawing up of master plans and development schemes for water management.
- Drawing up of multi-data set maps to help in decision making.

From above facts, decision makers to arbitrate in conflicts of water use, whether present or future and manage crisis situation (drought, pollution). These applications are useful for planning at national, regional and local levels specially for developing purpose and for preparing strategies to relieve drought and flood affected areas.

- **GIS based People biodiversity register (PBR) format**

GIS based PBR format will be used for natural resource estimation in sunderban area. Following points are included in the PBR format for the estimation.

1. A brief profile of the village with the following information:-

- a) Full address giving details about the Blocks, Districts, and State.
- b) Population of the village and its approximate break up into various castes.
- c) Infrastructure- Accessibility by road, distance from state or national highway, provision of educational facilities, nearest place for higher education, provision of electricity and drinking water.

2. Landscape map:-

The map should show all the boundaries of the village clearly. Only geographical elements (GE) and major landscape elements (LSEs) may be shown.

3. The complete list of GEs of the village along with the LSE types and LSEs within the each GE.

4. GE data sheets for all GEs of the village, each GE datasheets should include.

5. User group datasheets for all the user groups of the village, the datasheets should include the complete list of the user groups and their sub groups in the village broken up into primary and secondary user groups.

Consolidated information from datasheets:-

6. Full species list consolidation from all the GE datasheets, by local taxonomic categories.

7. User group maps showing the resources catchments of each user group.

8. Species lists by user list for species being used for following purpose may be

prepared.

9.a) food, b) fodder, c) fuel wood, d) medicinal use, e) cultural or religious use.

f) timber, g) species traded commercially, h) species of artisan value.

i) nuisance species.

10. GE general information table.

11. GE ownership, usage and access table.

12. User group calendar of activities table.

13. Multiple use species table.

14. Nuisance species table.

15. Commercial species table.

16. Ecological history. it should have the following information :-

a) sectoral histories (e.g.-agricultural paternalism).

b) major historical benchmarks.

c) information on driving forces.

d) conservation efforts by local community.

e) conservation efforts by government agencies.

f) historical landscape change maps.

17. Management option by user groups according to the categories given in the manual.

18. Conflicts: the following information should be recorded for each identified conflicts.

a) the actor involved.

b) brief description.

c) category of conflict.

d) brief history.

e) impact of the conflict on species, SEs and user group.

19. Conservation strategy and action plan:

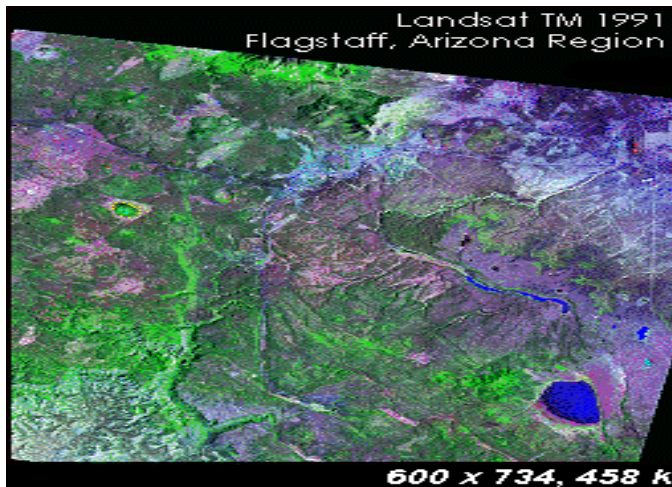
The following points should be noted down for the action plan –

a) Brief reports of the gramsabha.

b) Decisions taken at the gramshava meetings.

- c) Species, LSEs and user groups involved in the decision.
- d) Progress made on the action plan.

### USE OF REMOTE SENSING & ARIAL IMAGE IN MAPPING



All of the pictures received from remote sensing and which we view on the computer are 8-bit digital images, which means that they have 256 colors ( $2^8$ ). The image in the right illustrates this principle. Digital images are tables of numbers, which in this case range from 0 to 255. The "bright" squares (called pixels) have high number values (ie. 200 to 255), while the "dark" pixels, have low

number values (ie. 50-100). This image is an extreme close-up of a satellite image of West Hancock. The dark region is a stream valley, which has low reflectance, while the bright area is a gravel pit, which has high reflectance. The satellite sensor records the reflectance in its field of view, and then scales the signal to an 8-bit number (0 to 255).

Remote sensing is the science and art of obtaining information about a phenomenon without being in contact with it. It provides a unique perspective from which to observe large regions. Sensors can measure energy at wavelengths which are beyond the range of human vision (ultra-violet, infrared, microwave).

Compared to traditional satellite remote sensing IRS-1D also, provides significantly higher resolution. It has the ability to collect both panchromatic and multispectral images of the same object from the same perspective. The collected imagery can be output as one-metre pan-sharpened (color) and 4 metre multispectral (color). These images provide excellent accuracy for mapping surface of the earth. Remotely sensed images contain both spectral and spatial information. The spectral information provides various properties and characteristics about the surface cover at a given location or pixel (that is, vegetation and/or soil type). The spatial information gives the distribution, variation, and topographic relief of the cover types from pixel to pixel. Therefore, the main characteristics that determine a pixel's brightness/reflectance and, consequently, the digital number (DN) assigned to the pixel, are the physical properties of the surface and near surface, the cover type, and the topographic slope. In this application, the ability

to detect and map lineaments, especially those related to fractures and faults, is critical. Therefore, the extraction of spatial information from the digital images was of prime interest.

Cadastral Level Mapping is needed for this type of projects, which is only possible with Aerial Survey. We can create 1:10,000 level map with the help of this survey.

The Satellite Remote Sensing data has proved to be a highly reliable for extracting the land use, land cover, the river and its bank etc. of any region in a given time and also in a cost effective manner due to their inherent capability of providing very high spectral and radio-metric integrity and consistency. Due to these capabilities satellite remote sensing also facilitates rapid but accurate changed detection studies which also forms an integral components of environmental impact assessment and to site a location for sustainable developmental growth of the entire conservation area.

### GIS IN LAND MAPPING:

With GIS techniques, maps are produced that are similar in appearance to hand-drawn maps; to



the eye, each elevation map may appear not to conflict with the elevation maps of other stratographic units. However, to develop a truly internally consistent set of maps, the maps are processed into a raster (gridded) format. Then, conflicts in elevation between horizons (and larger conflicts across several horizons) detected in reference to block maps. The Topo survey maps always provide some benchmark and are therefore very useful in

contour preparation either manually or electronically. Topographical maps of India made by Survey of India were started more than hundred years ago. Since then the land information is based on the Topo Maps of Survey Of India for various purpose. But there is some constraint in Topo maps as information is little bit older. So Topo Maps could be very helpful to read with the Remote Sensing Images, which is today's scenario.

Now, it is needless to say that anyone can derive contour maps at various intervals from various Topo maps at various scales. According to Survey of India 10m, 20m and 30m interval contour data are available from 1:25000 and 1:50,000 scale maps

***DIGITIZED BLOCK MAPS PROVIDE THE NECESSARY FRAME OF THE MAP TO BE DRAWN AND ALSO HELP IN PHYSICAL VERIFICATION IN THE FIELD FOR THE ERRORS THAT MIGHT OCCUR INSPITE OF HIGH PRECISION OF THE IMAGING. IN MAPPING A TERRAIN ESPECIALLY WHEN IN PLANE IT IS HIGHLY POSSIBLE THAT ERRORS MAY OCCUR IN DEFINING THE SLOPE AND ELEVATION THROUGH IMAGING. ON THE OTHER HAND RELIANCE ON ENTIRE MANUAL PROCESS MAY ALSO LEAD TO ERROR DUE TO FAILURE OF ESTIMATION THROUGH HUMAN EYES.***

### **CREATING A VECTOR MAP**

For creating a vector map we create three products: a three-dimensional perspective view, an elevation map of the upper surface, and a thickness map. Mapping of each unit was an iterative process that, through re-examination of stratigraphic data and maps, gradually refines the understanding of the vertical and lateral distribution of each unit. To map a unit, we should plot the stratigraphic control data, then prepare a hand-contoured map based on the data and an understanding of the regional distribution of the materials and geologic history.

### **CONSIDERATION IN MICRO LEVEL PLANNING**

Micro level planning with MIS with GIS Application is to visualize upto block level data, various related information, and contour maps at layout plan of Sunderban area. But for execution or implementation of a project planning, detailed information about drawings/maps are required to work at ground level.

To prepare a detailed map of layout plan of Channels at each block level, the following tasks are required to be carried out .

- Digitization of the block sheets, and the river basin, collection of various data of maps and storing in the database for future reference.
- Mosaicing/ Stitching of block sheets of the river bank to prepare a complete block map with individual database for preparation of the said block.
- Design of database for interpolating R.L. (reduced level) taken at certain interval block maps to create a contour map of individual blocks.
- Preparation of channel layout plan on blocks map on the basis of the contour map taking references from the river channels.

### PREPARATION OF CONSERVATION PLAN

In order to prepare authentic base maps, a pre – requisite to any Conservation Plan, the use of Satellite images in conjunction with contour maps are essential planning task, which has been addressed here.

Information available from Topo maps are as follows:

1. Village, Building, etc
  2. Water Features / Water bodies.
  3. Telegraph lines.
  4. Railway Lines, railway crossing and bridges.
  5. Roads and Bridges.
  6. Embankments and cuttings
  7. River and Canal
  8. Contour plan and lines at specific interval and heights
  9. Hill and Mountain features
  10. Heights, Trigonometric symbols and abbreviations.
  11. Coastal symbols
  12. Hints for the scientific study of topographical maps
- Preliminary information
  - Observation of Topography
  - Picturing the sheet as a whole
  - Observing the relief
  - Observing the drainage and its pattern
  - Observing the change of the river bank
  - Vegetation
  - Observing the human settlement
  - Observing the means of communication and irrigation.

A GIS based approach can merges nature conservation, buffer zone development and participation of local communities in the management of large areas in the Sunderban area. Projects on integrated conservation and development can establish along the line of Biosphere reserve model. Other important aspects are to collaborate with local communities, improve the conditions for the local population and work for sustainable development. This model can initiate

and promote approaches to education, training, research that integrate ecology, economics, technology and social development.

### **CONSIDERATION IN MICRO LEVEL PLANNING**

Micro level planning with MIS & GIS Application is to visualize upto block level information, data, and contour maps on layout plan. But for execution or to implement a project planning, a detailed information and drawings/maps are required to work at ground level. To prepare a detailed map of layout plan of Micro planning at each block level the following tasks are required to be carried out .

- ◆ Digitization of the block sheets, collection of various data of maps and storing in the database for future reference.
- ◆ Mosaiking/ Stitching of block sheets to prepare a complete block map with individual database for preparation of the said block.
- ◆ Design of database for interpolating R.L. (reduced level) taken at certain interval of block maps to create a contour map of individual blocks.
- ◆ ***PREPARATION OF LAYOUT PLAN ON BLOCK MAP.***

### **SYSTEM ARCHITECTURE**

- **Hardware & Software Platform**

The proposed Application Software will follow three tier architecture where oracle-9i will work as database, ASP as front-end and IIS as web server.

So, initially it will be an independent domain based Network which will graduate incrementally for connectivity and integration for remote client interface to the main application domain and centralized data repository.

- **Data Flow Requirement /Connectivity Requirement**

As a backend database oracle-9i will be used on TCP/IP as the underlying protocol with provision for scalability and upgradability. The Software will conform to the Microsoft Windows NT platform specification. The same Networking protocol (TCP/IP) shall be established among all operating areas in future. Primarily the data will be captured at block Office. will be required to set up. WBSWAN (West Bengal State Wide Area Network) will be used for connectivity among the server and the nodes in the system. Alternatively, for remote connectivity to server at Microsoft RAS based connection will be used with telephone lines and dial-up modems

Backend Database : Oracle 9i  
Client End Operating System : MS Windows 98 / 2000  
Network Operating System : Microsoft Windows 2000 Server

- **Software Development**

**There will be two applications software for this project**

1. Planning for the system on the block maps
2. Management information system for which the following modules to be developed:
  - a) **Fund allocation, Budgeting, Computation of various expenditure Heads**
  - b) **Generation of various reports as per standard format**

- **Data Security**

***FOR SYSTEM APPLICATION AND USERS, SECURITY MEAS, SECURITY MEASURES WILL BE TAKEN CARE OF AT DIFFERENT LEVELS, EXPLICITLY AT THE ADMINISTRATIVE, FUNCTIONAL DATABASE AND OPERATING SYSTEM LEVEL.***

### **DELIVERABLES**

- Digitization of existing Layout plans, Road maps and Networking
- Compilation of Network Plan/Map for GIS application.
- Layering of Digitized Maps with Satellite Images
- Mapping of Blocks and other information as stated above as GIS application.
- Design and generation of Analysis Report as per requirement.
- Design of data base for various information/data of Blocks to generate reports of desired information..
- Preparation of Land use Maps of the whole area.
- Preparation of conservation Master Plan Map.

### **FOR MICRO-PLANNING**

1. GIS Application to visualize the SDA and various information/ data as stated above on SDA at block level.
2. Digital Elevation Model (DEM) preparation to visualize the SDA.
3. Preparation of block level master planning and verification of the field with the assistance of department Personnel.
4. Correction, if any, of the said maps after field verification and submission of the same to the department as final output.

### **FOR INFORMATION MANAGEMENT SYSTEM**

1. Status Report (Information Requirement for adhoc release of funds)
2. Requirement as per Centrally sponsored Development Program Format
3. Progress wise Financial Progress Report
4. Project wise Physical Progress Report
5. Special Component plan for SC/ST under CAD Program
6. Certificate in respect of Audited statement of accounts
7. Utilization Certificate
8. Certificates for the requirements of funds under CAD Program
9. Statement showing the achievements under field channels and utilization of Potential created.
10. Cost estimates of various activities
11. Financial and physical achievements project wise
12. Financial and physical achievements and irrigation potential utilities
13. Productivity
14. Account of other work to be accomplished through coordination-project wise
15. Details of farmer's association
16. Monitoring of Project / Schemes for a definite period
17. Statement showing the government of India approval of adaptive trial etc.

### **TRAINING PROGRAM**

Officers and staff of the Authority will be provided with proper on hand training for operation of the software along with the following works which will be necessary to produce contour maps and for the preservation of data and the output generated from the computer.

- 1) Identification of area and classification of satellite images (LISS & PAN) on segmented zone of gross command area (SDA) and procurement from National Remote sensing Agency (NRSA).
- 2) Image processing and Mosaicing of multiple satellite images and fusion of LISS and PAN images.
- 3) Digitization and Mosaicing of Topo sheets, layering the same on satellite images over SDA.
- 4) Digitization and Geocoding the block maps by using Global Positioning System (GPS).
- 5) Digitization and Mosaicing of Block maps and overlaying the same on Digital Elevation Model (DEM) and geocoding the same.
- 6) Digitization of block Maps and storing the same in CD-R for future references and stitching the same to block level

### **CONCLUSION:**

COMPUTER MAPPING REQUIRES TWO TYPES OF DATABASES INTERACTING WITH EACH OTHER. ONE IS CARTOGRAPHIC DATABASE SHOWING, FOR EXAMPLE, COAST LINES, ADMINISTRATIVE BOUNDARIES, ROADS, RIVERS, LOCATION AND SHAPE OF HOUSES AND BUILDINGS. THE INFORMATION SOURCES FOR ACQUIRING THESE TYPES OF DATA ARE SATELLITE AND OTHER REMOTE SENSING DATA, EXISTING MAPS, AND LAND SURVEY DATA.

THE OTHER DATABASE IS AN ATTRIBUTE OR THEMATIC DATABASE. IT MAY INCLUDE THE NAMES OF PLACES AND BUILDINGS, STATISTICAL DATA SUCH AS DEMOGRAPHIC INFORMATION, LAND USE CLASSIFICATION, AND OTHERS. THESE TYPES OF DATA ARE SUPPLIED IN VARIOUS FORMS SUCH AS PRINTED STATISTICAL REPORTS, DIGITAL TAPE DATA, OR CD- ROM.

THE ADVANTAGES OF COMPUTER MAPPING ARE THE REDUCED TIME AND COSTS OF DATA UPDATING AND MANAGEMENT. INITIAL DATA CREATION AND INPUT TO DEVELOP THE GEOGRAPHIC DATABASE REQUIRES LONG HOURS OF WORK. WE HAVE RESEARCHED THE LATEST EQUIPMENT AND TECHNOLOGY AVAILABLE TO PRODUCE A WORKFLOW SYSTEM FOR HIGHER EFFICIENCY AND IMPROVED ACCURACY.

IN ORDER TO ACQUIRE DATA DIRECTLY FROM SATELLITE DATA, WE USE A SUITE OF VARIOUS HARDWARE AND SOFTWARE COMPONENTS TO OPERATE SYSTEMS: SUCH AS HIGH-RESOLUTION PRECISION PHOTO-SCANNER AND SOFT-COPY-ORTHO-PHOTO MAPPING SYSTEM. OTHER SOFTWARE AND HARDWARE COMPONENTS CONTROL DIGITIZING TABLES USED TO CONVERT EXISTING PAPER MAPS INTO DIGITAL FORM. OTHER SYSTEMS PROCESS LAND SURVEY DATA FROM GPS AND TOTAL STATIONS, WHICH COLLECT LAND, SURVEY DATA. ORIGINAL IMAGE ENHANCEMENT AND GEOMETRIC CORRECTION OF IMAGE DATA ARE PERFORMED WITH THE AID OF AN IMAGE PROCESSING SYSTEM TO MEET REQUIREMENTS IN THE LATTER PHASE OF MAPPING WORKS.

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Map Asia 2003

Natural Resource Management