Draft Action Plan for GIS Recommendations

-Ian Hamilton

The National Capital Region Planning Board (NCRPB) has the mandate for preparing a Regional Plan for the development of the NCR and for coordinating and monitoring the implementation of this plan; and for evolving harmonized policies for the control of land-uses and development of infrastructure in the region. This planning role also includes the preparation of Functional Plans; ensuring that more detailed sub-regional and development plans are prepared by the participating States; and coordinating the enforcement & implementation of the Plans through the participating States. All of these roles require the acquisition and analysis of data over time to ensure full understanding of the dynamic growth and development of the NCR. As such, a Geographical Information System (GIS) is a vital tool to capture, store, update, manipulate, analyse and display large amounts of geographically referenced data and information.

1 Current Status

The NCRPB used an in-house GIS system in the preparation of its Regional Plan up to 2005. The system consists of 2 UNIX based machines with ESRI GIS software. Both the hardware and software are now outdated with a system which is not transferable to the Windows OS machines used throughout the office. Future GIS operators and decision-makers will both require desktop/laptop machines with a range of current software applications appropriate for their specific tasks and responsibilities.

2 Inception Report

The following comments were made in the Inception Report (December 2008):

"*The team will strengthen the interventions suggested in the diagnostic study with relation to the GIS system as it relates to regional and sub-regional planning, and specify the inputs required for the operation of the system. We will also address the organizational structure to operate the GIS efficiently. In conjunction with this, we will investigate best practices elsewhere in the world, specifically in inter-jurisdictional locations. This will result in the following outputs: Draft Action Plan and GIS Recommendations - February 2009*." (Main Report page 8);

"*Other identified barriers to plan preparation include the following: (i) Lack of widely available digital base maps (especially cadastral) as a basis for creating a spatial database which can be shared through a GIS.*" (Diagnostic Report page 10)

"*It is proposed that the current capabilities of the NCRPB be examined with regard to the preparation of new Functional Plans and also the setting up of a Digital Spatial Database. It would need to be decided on the appropriateness of supporting a GIS/Database unit within the NCRPB (together with equipment and training). Other options or supplementary action would include the setting up of sub-units within the States and/or the outsourcing of some or all of the works to external consultants*". (Diagnostic Report page 13)

3 Feedback from Inception Report

Following the preparation of the Inception Report it was agreed that a local GIS Expert join the project to expedite the setting up of the GIS system. Draft ToR for this expert have been prepared and submitted to the NCRPB for consideration.

As part of his second input, the Urban Regional Planning Expert made a presentation on GIS to the NCRPB on 14th January 2008. The presentation covered the "Concept, Uses and Issues" relating to GIS. The presentation also included details of the proposed draft ToR for the GIS Expert and suggestions on what the NCRPB could do as its Next Steps.

4 Concept, Uses and Issues relating to GIS

4.1 What a GIS can and cannot do

GIS can been defined as “An organised collection of facilities to efficiently capture, store, update, manipulate, analyse and display all forms of geographically referenced data & information”. It includes 4 main characteristics:

- Remote Sensing. To Collect, store, manipulate & display raster data. From aircraft or satellite.
- Computer Aided Design (CAD). Design & drawing new objects. Limited links to databases & little analytical capabilities
- Database Management. Storage, retrieval & manipulation of mainly non-graphic data.
- Computer Cartography. Data retrieval & display. Map design

Assuming an appropriate choice of hardware and software, any GIS will only be as useful as the operators and inputted data allow. With accurate themes and qualified operators who are clear on the required output GIS can be an effective decision making tool in portraying and analysing the real world or querying possible events on the desktop. With inaccurate themes, few poorly trained staff and little direction there is no point in moving from a paper based to a digital working environment.

4.2 The NCR Setting

Apart from the in-house system mentioned above, none of the Cells in the States visited so far have GIS capabilities and nor do the States themselves (although Delhi is in the process of setting up a system) on a state-wide basis.

One of the first steps to be decided by the NCRPB will be the geographical use of any new GIS system. If it is to be used only for Regional Planning then a very basic system will be adequate. A raster image (Landsat would be sufficient) with population data at District level together with broad networks of infrastructure and locations of key land use would be sufficient to review the current plan. The satellite imagery or aerial photos can be compared to previous archived data and changes in land use can be mapped. This can be confirmed by comparing population figures from 2001 and forthcoming 2011 Census data.

However, if it is intended to use the GIS for detailed land use planning (Master Plans and Development Plans) then accurate themes are crucial. Ideally the base layer would be a cadastral map because all proposals will eventually impact on land and its owners. Owners will need to know exactly how much land is to be acquired for a new road or whether their plot has been rezoned for commercial uses. However, it is unlikely that such detailed and accurate digital data for the whole NCR will be available for some time. In which case, a high quality satellite image would be the best alternative as a base layer. It may not be necessary to acquire high quality and expensive imagery for the whole of the NCR: for rural areas which are expected to remain rural, lower quality imagery would suffice (although joining various images can be complicated).

Whatever the proposed level of use, the organisational structure and systems operation will also need careful thought. It is strongly recommended that the GIS operate on its own dedicated server but whether this is only accessed by individual computers over an NCRPB LAN or whether it becomes accessible via the internet will require extensive discussion. Much will depend on the future relationship between the NCRPB, the cells in each State and the States themselves with regard to both planning and implementation. Current thinking within the NCRPB is that the system should be a “standalone” with a dedicated GIS server located in the NCRPB. This is partly due to the costs and complexity of a web system but also due to data security concerns.

4.3 Accuracy of Themes

Whether the acquired base is a cadastre or a satellite image ALL subsequent themes should correlate with the base. As a start the datum and projections must be the same for all themes. However, it is extremely unlikely that all or any of the subsequent themes will fit the base. This is because many of the themes will have been developed from digitising paper maps or at a small survey scale. These paper maps may themselves have been created without reference to any agreed base map. It will be the responsibility of specific agencies to ensure that the themes for which they are responsible are based upon a nationally (or NCR) agreed base map. It is not appropriate for the NCRPB to amend any digital themes from other agencies: it is sufficient to inform the agencies that their themes do not fit with other themes. Any maps produced by the NCRPB using themes from other agencies should give that agency as a source on the map. Over time and as themes are created/updated directly from ground surveys the level of accuracy will improve.

The issue of "Scale" must also be addressed but in a different way to that used for paper maps. With paper maps a scale is chosen as the most appropriate to show and comprehend the contained information. With GIS this display scale is irrelevant and can be any number at all from 1:1 upwards. For GIS the issue of scale relates to the survey scale: at what level of detail was the information collected. So the location of the IHC, for example, should be more accurately plotted on a satellite image only showing Lodhi Road rather than one which shows the whole of the NCR.

Some simple rules on this are:

- Large scale equals a large amount of detail
- Scale, resolution, accuracy and content of a map are all related
- All layers of a spatial database should be stored in a common coordinate system
- When combining data at a variety of scales, resolutions and accuracy, the combined data should be considered as good only as the worst input.

In USA the following standards are used: For maps on publication scales larger than 1:20,000, not more than 10 percent of the points tested shall be in error by more than 1/30 inch, measured on the publication scale; for maps on publication scales of 1:20,000 or smaller, 1/50 inch. That translates to the following examples:

• For 1:100,000-scale maps:

0.02 x 100,000 x 2.54 / 100 = 50.8 meters (or 166 ft)

• For 1:24,000-scale maps:

0.02 x 24,000 x 2.54 / 100 = 12.2 meters (or 40 ft)

• For 1:10,000-scale maps:

0.03333 x 10,000 x 2.54 / 100 = 8.5 meters (or 28 ft)

4.4 Themes to be collected

The following list contains the general themes that would be required to commence operation of a GIS for primarily regional planning:

Themes	Output	Analysis/Notes
Remote Sensing	Land Use	Recent data & time series
Land Uses	Land Use distribution	Location & changes if time series
Topography	Heights & Slopes	Suitability for development
Administration	Base Map	Defining Authority & Plan areas

Themes	Output	Analysis/Notes
Soils	Constraints/Opportunities	Dept of Agriculture
Geology	Constraints/Opportunities	Often small scale (1: 500,000) maps
Forest Reserves	Constraints	Need revisions to fit cadastre
Roads/Railways	Base Map	Amend to fit plan
Rivers	Base Map	Update with new images
Cadastral	Base Map	State Land options. Large plots
Census 1991 & 2001	Densities, Changes	Pressure, Growth/Decline

These themes can be supplemented with more detailed data where required for urban and other more detailed use and as it becomes available.

5 Why move to a digital GIS?

5.1 Advantages of GIS

The following aspects can be seen as several advantages that a digital GIS has over a traditional paper based system:

- Easy to compare geo-referenced data
    - Can use time series to assess change from image to image
    - Add/Subtract Themes at will
- Can add field data through GPS
- Computing power to undertake calculations
    - E.g. how many people live within 5 km of road
- Easy to view, understand & query on map base
- Map production simple, quick & flexible
    - Can overlay themes if few solid colours
    - Each copy identical = minimise mistakes
    - Production time limited by printer speed
    - Revisions can be fast
- Easy to reproduce & distribute on CD
    - All documents in .pdf format so don't give away valuable data.
    - Can digitally link Maps with Written Proposals
    - Can add additional folders of information

5.2 Disadvantages of moving to a digital GIS

The following aspects should be seriously considered as to how they can be overcome or minimised during the move to a digital GIS:

- Not all useful Themes have been digitised yet
- Little analytical work possible so far with a limited number of themes
- Many themes do not fit well for detailed work
- Expensive Hardware & Software (although costs are dropping fast for hardware)
- Costly inks

- Maintenance Cost of system (both the equipment and the data)
- Security issue as base data is easily copied
- Tendency of staff to become office bound and not check real data in the field

6 Next Steps

It was proposed by the Urban Regional Planning Expert that a GIS system for the NCRPB could be set up over the period of one year using and addressing the following 6 steps.

		1	2	3	4	5	6	7	8	9	10	11	12
1	Agree data use/input/output/sharing system												
2	Identify capacity building recipients												
3	GIS and Dbase training (using local consultants)												
4	Acquire GIS software/hardware												
5	Delivery of Remote Sensing												
6	Commence basic data input/checking												

1. NCRPB to decide the use of the system, e.g. reviewing regional and preparing sub-regional/functional plans
   - Who would input data? e.g. from State Cells/Agencies to a NCRPB Core GIS Unit
   - Who would use/analyse data? e.g. State Cells and NCRPB
   - Who could share data/analysis? e.g. NCRPB
   - What is the system set up? e.g. web based
2. NCRPB to decide the organisational set up for GIS. e.g.. Centre/State/Outsource. Liaise with other GIS. Ideally a strong GIS section should be set up at the Centre to oversee the system.
3. Continuous Hands-on training tailored to specific uses, e.g. image analysis
4. Must be adequate for planned system uses and to link database to financial role on Projects
5. Recent high quality imagery required through NRSA. Security clearance. Alternative is to use that agency or Survey of India as a consultant partner. Older archived lower quality imagery is also publicly available at low cost.
6. Availability of data layers established at an early stage from responsible agencies/consultants. Use preparation of Functional Plan as a pilot study (e.g. Protection Plan) to involve all States

At a meeting on 5th March 2009, NCRPB and Project staff discussed Steps 1 and 2 with a view to determining the overall use and operation of the proposed GIS system. It was agreed that the NCRPB would next form a committee to discuss the best means of obtaining professional expertise to assist in setting up the GIS system. The NCRPB would then be able to decide whether this assistance should come from an independent GIS expert, a local specialist GIS company; or a government agency with extensive GIS experience. No date has yet been set for this action. However, it was agreed that the GIS would not only be intended for use at regional plan level but would also be utilised for the collection and analysis of data for use by the States in the preparation of sub-regional and development plans. This has significant implications for the level of detail required and hence the high quality of the initial remote sensing to be acquired.

One of the key topics identified for study during the upcoming overseas visits is the use of GIS for regional, urban and development planning. It is expected that additional feedback to the above Steps will be forthcoming as a result of access to best practices in selected Study Tour locations.