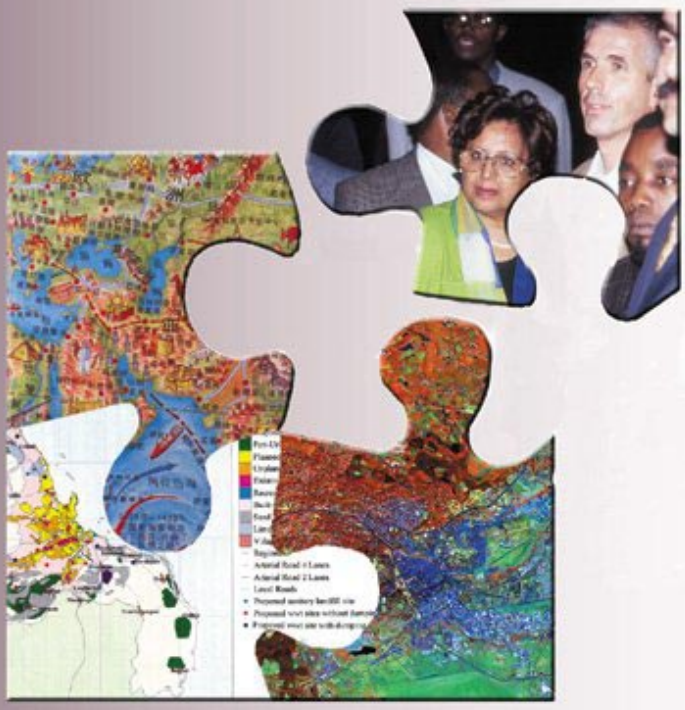
Sustainable Cities Programme (SCP)



Building an Environmental Management Information System (EMIS)

United Nations Centre for Human Settlements (UNCHS Habitat)
United Nations Environment Programme (UNEP)

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Building an Environmental Management Information System

The SCP Source Book Series

Building an Environmental Management Information System (EMIS)

Handbook with Toolkit

Prepared and written by the staff and consultants
of the Sustainable Cities Programme

About the SCP Source Book Series

The SCP Source Book Series provides detailed operational guidance for the benefit of people implementing city-level projects within the Sustainable Cities Programme. Each volume in the Series covers either an important part of the SCP process or an important topic which is central to urban environmental planning and management. The volumes currently being produced (1999) include the following:

Volume 1: Preparing the SCP Environmental Profile
Volume 2: Organising and Running the City Consultation
Volume 3: Establishing and Supporting the Working Group Process
Volume 4: Formulating Issue-Specific Strategies and Action Plans
Volume 5: Institutionalising the EPM Process
Volume 6: Urban Air Quality Management Handbook
Volume 7: Building an Environmental Management Information Systems
Volume 8: Integrating Gender Responsiveness in EPM
Volume 9: Measuring Progress in EPM[1]

[1] In general, the SCP Source Books are developed based on city experiences or are developed as operational tools which will then be fine-tuned, adapted and applied in cities. An SCP Source Book can be process-specific (Volumes 1 - 5), topic-specific (Volume 6) or of a cross-cutting nature (Volumes 7, 8 and 9)

The emphasis in this Series is on **relevance** and **realism** These volumes are the *product of experience* - field-level experience gained over the past eight years in SCP city projects around the world. Precisely because it is drawn from the lessons of experience in so many different cities, the information contained in these volumes is not city-specific but can readily be adapted and applied to the tasks of urban environmental planning and management (EPM) in virtually any city context.

The Sustainable Cities Programme (SCP) is a global programme of the United Nations Centre for Human Settlements (UNCHS - Habitat) and the United Nations Environment Programme (UNEP). It is the leading technical cooperation programme in the field of urban environmental planning and management and is the principal activity of the United Nations system for operationalising sustainable urban development and thus contributing to implementation of *the* globally-agreed *Agenda 21* and *Habitat Agenda*. The SCP is currently active in the following places:
Africa: Accra (Ghana), Dakar (Senegal), Dar es Salaam (Tanzania), Ibadan (Nigeria), Lusaka (Zambia), Maputo (Mozambique), Moshi (Tanzania), Nampulo (Mozambique), Zanzibar (Tanzania)
Asia: Colombo (Sri Lanka), Madras (India), Cagayan de Oro, Tagbilaran, and Lipa (Philippines), Shenyang (China), Wuhan (China)
Middle East: Ismailia (Egypt), Tunis (Tunisia)
Latin America: Concepcion (Chile)
Central & Eastern Europe: Katowice (Poland), Moscow (Russia), St Petersburg (Russia).

Further information about the SCP Source Book Series, or about the Sustainable Cities Programme itself, may be obtained from:
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User's Guide

This document is divided into three parts, each of which has a different purpose and is designed for a different audience:

Part A

Introduction and Overview

Part A describes the Environmental Management Information System (EMIS), explaining its role and purpose in urban management. It includes a brief introduction to the various uses to which an EMIS can be put as well as an overview of how to introduce an EMIS into the partner cities of the Sustainable Cities Programme (SCP). This section of the book is targeted at decision-makers and urban managers concerned with the Environmental Planning and Management (EPM) process and at others with a general interest in the EMIS concept.

Part B

The Guide: Building an Environmental Management Information System (EMIS) Step-by-Step

Part B is the main section of this handbook. It gives a step-by-step explanation of how to build up an EMIS. The explanation is detailed and systematic, aimed at the professionals and practitioners who will actually be using the EMIS. This section contains not only explanations and step-by-step guidelines, but also special tips and practical advice based on experiences in other SCP partner cities. Part B is designed as a reference guidebook, which the project staff and partners can consult over and over again.

Part C

Toolkit

To assist the implementation of the EMIS, the Toolkit contains examples which can be applied immediately to the process of building the EMIS. For instance, there are sample Terms of Reference for contractors and consultants, information on organising support for the system, and step-by-step descriptions for preparing databases and maps. This material will be of great value during the EMIS development process and will save the SCP project staff time and energy. Relevant bibliographic resources are also provided, as are the names and addresses of useful contacts. You will also find all of these descriptions and some additional tools on a CD-ROM which will be published at a later stage.

To get the best out of this Source Book, however, users need to have a good understanding of the overall Environmental Planning and Management (EPM) process, of which the EMIS is only a part. It is therefore strongly advised that users familiarise themselves with the SCP Process Source Books and related background material.

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Introduction and overview

Information is crucial to any planning and management activity. This of course is a truism. The problem is (a) to determine what data and information is needed for the purpose at hand; (b) to find out if it exists and where; (c) how to get hold of it if, it exists, and how to collect it if it does not; (d) how to store this information in easily accessible and referenced form; (e) how to interpret the data, resolve questions of quality, contradictions and incompleteness; (f) to determine who needs the information, when and in what form(s); and (g) to actually disseminate it as required.

If these steps are formalised, institutionalised, and made sustainable, one can talk of an information system rather than an ad hoc data gathering exercise. By *formalised*, we mean standardised and explicit procedures and formats, which at the same time are flexible and not rigid; by *institutionalised*, we refer to the integration of the system into a permanent organisational structure, independent of any critical individual input; by *sustained* we mean that the system receives ongoing support in the form of necessary resources (funding, staffing, etc.) and 'political' backing, that its services are actively sought, and that it satisfies this demand.

Management Information Systems provide concise, to-the-point and timely information which is directly usable by decision-makers in making decisions or formulating actions. The key words are *concise*: a decision-maker usually is very busy, and does not have time to assimilate more than a page or two at any given time; *to-the-point*: the manager wants to know what the information means and what she or he can do with it; *timely*: if information is not available when decisions are taken, then it serves no purpose; it is better to provide partial information in time, rather than complete information which comes too late; and *usable*: the information has to be formulated in a way that the intended users can understand and relate to, especially as these users are generally being non-specialists.

EMIS stands for Environmental Management Information System. Such a system consists of formalised steps to capture information, as well as fixed procedures to retrieve this information. Generally speaking, the EMIS covers the gathering of all relevant information for the Environmental Planning and Management (EPM) Process. The EMIS includes the collection of information about the various environmental issues facing a particular city, supports the Issue-Specific Working Group process, continues with supporting the strategy formulation and action planning, including the mapping, and last but not least covers the gathering of information necessary for institutionalisation of the EPM process. By its nature, the EMIS is a participatory information system for managing the collective know-how of relevant stakeholders. All this information will be stored in archives, databases and in maps.

The intention of this Handbook is **not** to give a comprehensive description of GIS. Countless books, papers and articles have been written about Geographical Information Systems and Remote Sensing. All major GIS software developers provide handbooks with extensive descriptions of their products, cartographic background and GIS in general. Thousands of internet websites give information on GIS. This book refers to the concept of environmental planning and management (EPM) elaborating on the particular elements which are most relevant to a well-functioning EMIS. An EMIS can be built incrementally at different levels of sophistication. A highly sophisticated EMIS, however, uses GIS as a state-of-the-art spatial management tool.

Particular EMIS steps provide support to the various stages in the SCP process as outlined in the SCP Source Books, e.g. Environmental Profile (EP), Strategies and Action Plans, etc. You will find that the SCP Source Books make specific references to these EMIS steps. This Handbook supports all the stages of the project cycle, that is focussed on the mapping part of the information system.

A1

Using EMIS to support better urban management

Cities play a vital role in social and economic development. Efficient and productive cities are essential for national economic growth, and, equally, strong urban economies are essential for generating the resources needed for public and private investments in infrastructure, education and health, improved living conditions, and poverty alleviation.

Unfortunately, the development potential of cities is all too often crippled by environmental deterioration. Aside from its obvious effects on human health and well being (especially of the poor), environmental degradation directly holds back economic development. For development achievements to be truly 'sustainable', cities must find better ways of balancing the needs and pressures of urban growth and development with the opportunities and constraints of the urban environment.

Environmental deterioration is not, however, inevitable. Although many, perhaps even most, cities are still suffering severe environmental and economic damage, there are encouraging signs. Some cities are learning how to better plan and more effectively manage the process of urban development, avoiding or alleviating environmental problems while realising the positive potentials of city growth and change.

Environmental goods and services are the resources on which all development ultimately depends: the management of these resources is therefore an integral concern in development planning and management. The tools available to decision-makers for influencing development towards optimal and sustainable use of environmental resources are limited and can only be effective if they are applied in a consistent and co-ordinated fashion. Environmental resource management uses information to reconcile competing interests (i.e. environmental policy co-ordination) and to support development decision-making (i.e. policy implementation).

Urban managers are confronted almost on a daily basis with a number of recurrent questions. These questions cover issues such as: Which areas are available for city expansion? Where can we establish new housing areas? How can we revive certain parts of our city? How can we improve health and recreation conditions for our citizens? Where are flood-prone areas? How can we stop air pollution in various parts of the city? To which areas shall we guide investors? What consequences will it have to build a shopping centre at a particular site? Where can service delivery be improved and expanded?

These questions have three typical characteristics. They

- are frequently asked;
- have long-term importance; and
- are of a cross-sectoral nature.

Example: A lack of spatial understanding leads to wrong decision-making

During the 1970s, the city of Lagos built a road through a wetlands area. This route was chosen because the costs for the plots in that area were really low. This road opened up access to a whole new area in the wetlands, leading to the spontaneous development of housing areas. The city then needed to provide more infrastructure such as power, water and a sewer system. This infrastructure was difficult, and therefore expensive, to build. When these expenses were added to the initial cost of building the road, this road became by far the most expensive road ever built in Lagos. This example shows the importance of establishing a system of knowledge and information to prevent decision-makers from making wrong decisions.

All these questions relate to the planning and management of space in the city, so the answers have to be geographically linked. This Handbook addresses the spatial aspect of the Environmental Planning and Management process, and aims to help urban managers to give more accurate answers to these typical questions.

Spatial information about a city is usually scattered in different public institutions, according to the different work areas and specialisations. Data storage systems often differ from institution to institution, making it difficult to compare and combine information. Another important drawback is while typical routine urban management questions refer to specific areas in the city, the way spatial data is stored often makes it impossible to relate the information to specific areas. While routine urban management questions have always been answered, usually only some of the information about the consequences has been taken into consideration. Only a few possible solutions are considered and assessed. Sometimes this approach works out nicely, but sometimes it turns out to be a very costly decision for developing the city. Getting the answers to typical routine questions may take several days if not weeks, and in many cases potential investors have turned around to look for better options by themselves.

To reach sound solutions in urban management the EPM process offers an approach for inter-departmental and inter-institutional co-ordination of information through a participatory working method. Issue-specific Working Groups are the main providers and the main users of spatial information and are supported by mapping professionals, cartographers, surveyors and experts in geographical information systems (GIS). The rapid development of information technology has revolutionised surveying and mapping towards 'geomatics'.

The definition of geomatics is evolving. A working definition might be "the art, science and technologies related to the management of geographically-referenced information." Geomatics includes a wide range of activities, from the acquisition and analysis of site-specific spatial data in engineering and development surveys to the application of GIS and remote sensing technologies in environmental management. It includes cadastral surveying, hydrographic surveying, and ocean mapping, and it plays an important role in land administration and land use management.

With the appearance of increasingly powerful computers, it is much easier to store and to process large quantities of spatial information, as well as to share information between different offices. It is becoming easier to access all the information necessary to answer routine urban management questions quickly and comprehensively. Through using an EMIS to answer routine questions, many of traditional drawbacks, such as dispersed data, incompatible data formats and the sheer volume of data, can be overcome. EMIS is designed to link dispersed data about urban and environmental issues to a series of different types of maps about a particular area or even city-wide. This linkage allows users to combine, query and analyse all this information in an area-specific way, and therefore to get more precise answers for routine questions. The proper set-up and operation of the system, will – ideally - generate a comprehensive response for a routine question within few hours.

As the EMIS is a tool for participatory urban environmental management, it concentrates on the interaction between environmental resources and hazards, and development activities. The system is designed to illustrate the various possible results of environment-development interactions. For example, establishing an EMIS in a SCP partner city supports a better understanding of this interaction throughout the various steps of the SCP process cycle. An EMIS can be operated by using a traditional manual system of storing and displaying information (library, manual drawing of maps). Today, however, a computerised EMIS usually uses a Geographic Information System (GIS) as a tool to handle and process the spatial and non-spatial data.

Some short definitions of a Geographic Information System (GIS)

Strictly speaking a GIS includes both manual and computer-based information systems, but in practice, all contemporary information systems are computer based. There is no consensus on the definition, but a GIS includes three major elements: hardware and software; database; and application and infrastructure. (United Nations, 1996)

A GIS is an information system capable of holding and using data describing places on the earth's surface. Today, it can be described as an organised collection of computer hardware, software, geographic data and personnel designed to efficiently capture, store, update, manipulate, analyse and display all forms of geographically referenced information. (GeoInformation International, 1995)

A GIS must accomplish three main tasks: firstly the storage, management and integration of large amounts of spatially referenced data. Secondly it must provide analysis tools, and last but not least the organisation and management of the data so that it is easily accessible to all users. (Scholten, H.J., 1990)

Please note: There is a clear distinction between EMIS and GIS. EMIS is an information system for managing information on the urban environment according to the EPM process. GIS is one of the tools which may be used for applying an EMIS.

What makes EMIS special is its participatory approach. Very often a GIS is reserved for specialist use. The system is set up, but then it is not fully exploited for urban management purpose afterwards, because the people querying the data are missing. Through the participatory approach of the EPM process, many people will be involved in gathering information for the system and setting up the EMIS. All these persons will become users of the EMIS, and the system will grow as they use it.

A2
How does EMIS fit into the SCP project cycle?

The Sustainable Cities Programme (SCP) is a worldwide technical co-operation activity of the United Nations. It works at city level in collaboration with local partners to strengthen their capacities for environmental planning and management (EPM). Each city-level SCP project is adapted to the particular needs, priorities and circumstances of that city; nonetheless, all SCP partners cities follow a common approach and all are implemented based on the following principles:

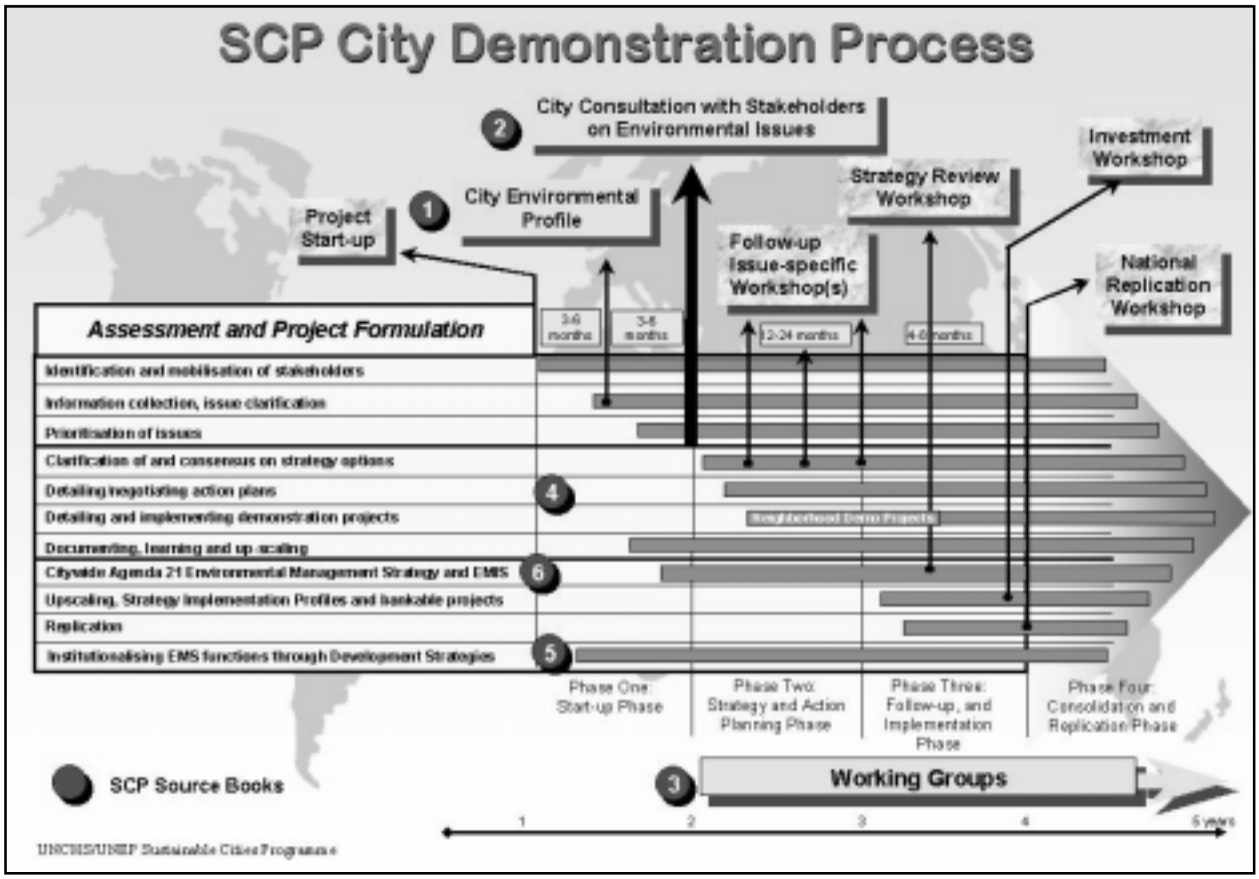
- central focus on environment-development interactions;
- broad-based participation by public, private and community sector groups;
- concern for inter-sectoral and inter-organisational aspects;
- reliance on bottom-up and demand-driven responses;
- focus on process: problem-solving and 'getting things done'; and
- emphasis on local capacity building.

The SCP process consists of a sequence of activities, which are logically and practically connected, together with a number of specific outputs, which are important for the progress of the project. The key point to remember is that following the SCP project cycle builds an effective environmental planning and management process which is designed to be integrated into local government practices.

The SCP project cycle has three main phases:

The **First Phase** (*Assessment and start-up*) is a 6 to 9 month initial period, which normally includes the following main activities:

Figure 1: The SCP Project Cycle



- identification and mobilisation of project participants and partners;
- familiarisation of project partners with the core EPM concept and SCP approach;
- preparation of the Environmental Profile (EP) and initial identification of priority environmental issues;
- review of available resources, tools and information and initial design of an environmental management information system (EMIS) specifically adapted to the city's needs;
- working out the organisational structure, work plan and operational procedures for the project;
- organising and holding the City Consultation; and
- establishing the Issue-Specific Working Groups.

The City Consultation is a major event that brings together the work of Phase One, consolidates social and political participation and support, and launches the SCP project into Phase Two. (Volume 2 of the SCP Source Book Series - *Organising, Conducting and Reporting the City Consultation* - provides detailed guidance.)

The EMIS provides considerable support during this first stage. A basic map, showing the location of the city and some additional thematic maps on environmental and development issues will be included in the Environmental Profile (EP), and all the environmental data collected for the EP will be stored in the EMIS. During this period an inventory of existing maps and data is conducted. For the City Consultation, the EMIS can be used to prepare a map exhibition. These maps will help to identify, clarify and prioritise the environmental issues facing the city. The EMIS also supports and interacts with the Issue-Specific Working Groups. Information already compiled during the inventory period can be shared and new information from the members of the working groups can be collected for inclusion of the system. It is advisable to establish a Mapping Group (see section B1.4) during the early stage of the first phase

in order to have the first mapping outputs ready for the Environmental Profile (EP) and the City Consultation.

The project's **Second Phase** (*Strategy & Action Planning*) is a 15 to 24 month period of intensive analysis, discussion and negotiation within the Issue-Specific Working Groups. The number, focus and membership of these Working Groups will change and evolve as the project proceeds, but they will remain the principal working mechanisms of the SCP Project. (See The SCP Source Book Series, Volume 3 - *Establishing and Supporting the Working Group Process*.) During this period, each of the agreed priority issues is further elaborated and developed, in order to reach a consensus on appropriate strategies for that issue. The strategies are then developed into action plans which are agreed by the organisations and groups involved in implementation. (See The SCP Source Book Series, Volume 4 - *Formulating Issue-Specific Strategies and Action Plans.)*

It is likely that small-scale 'demonstration' projects will be undertaken to test the approaches developed and to show what can be done through the SCP process. In addition, some of the first action plans will produce investment and/or technical assistance proposals which will be developed into properly formulated and 'bankable' proposals. All of these Phase Two Working Group activities will be gradual, pragmatic and co-operative, reflecting the real-world conditions for strategy formulation and implementation. During this Second Phase, the main project activities aimed at institutional capacity-building and human resource development will also be carried out.

During the Second Phase the EMIS supports the participatory decision-making process in a number of ways. The Working Groups will formulate their needs for specific maps and generate the data for new maps. During this stage a great deal of maps and data will accumulate and the EMIS will evolve rapidly as a functional tool. The system can produce many outputs, such as identifying environmentally sensitive areas ('hot spots'), can help to select sites for specific projects and can support project design for a specific site. With the help of the EMIS detailed strategies can be formulated and action plans prepared and illustrated with maps. The Mapping Group and the Issue-Specific Working Groups will interact closely with each other in order to ensure genuinely participatory mapping.

The **Third Phase** of work (*Follow-up & Consolidation*) is an open-ended follow-up and implementation period, which begins towards the end of Phase Two and carries on for an extended time afterwards. The strategies and action plans coming out of the Working Groups are further elaborated, building towards an over-all citywide environmental management and urban development strategy. Investment proposals are worked out in detail, subjected to rigorous analysis, and pursued vigorously with funding sources. The task of institutionalising the environmental planning and management (EPM) process, initiated during Phase Two, is undertaken in earnest (see The SCP Source Book Series, Volume 5 - *Institutionalising the EPM Process*). In addition, the remaining training and institutional development activities are implemented. Finally, there will be regional and/or national workshops and meetings to explore ways of extending SCP activities into other cities, building upon the experience gained in the project.

This is the stage where the EMIS is fully functional. A considerable amount of data has been gathered, allowing further analysis of the data, and the production of outputs such as a development pattern map, issue specific strategy maps and an environmental management framework. The system still needs continuous input to stay up to date and increasingly comprehensive in order that it remains a powerful urban management decision-making tool in the future. In addition, an EMIS can support the monitoring of the environment situation and the evaluation of the achievements of the EPM approach.

A3

Specific applications of EMIS

Different levels of city administration require different information about their city. For example, the city assessor needs a detailed, large-scale land information system to improve the collection of property taxes. The water department requires precise spatial information on the water utilities for better operation, maintenance and revenue collection. The forward planning department is concerned about the expansion of the city, while the environment department needs to manage environmental resources and hazards better. Equally important is the issue of information outreach: for example, the mayor presents a self-explanatory "snapshot" of the city's environment and development situation at a conference in order to attract tourism, investors etc.

The EMIS can support various requirements mentioned above. Colourful attractive maps draw attention and can quick-start discussions. The EMIS supports different tasks in urban management decision-making such as project design, site selection or investment planning. It can be further used to attract donors and investors by providing maps which show the best locations for investment in the city.

The need for a new urban management approach

During the last decade it was recognised that traditional planning practices did not sufficiently address the urban management problems cities faced. The Charter of Athens considers the city as a "masterpiece of architecture" to which functions can be attached on the drawing board. Reality has shown that this approach is unworkable, especially in cities with growth rates of five per cent and above. An open planning tool, however is able to react quickly to rapid changes in city development. The EMIS complements (but does not necessarily replace) existing planning tools, such as Landuse Plans, Master Plans, Zoning Plans and so on. The strength of the system lies in its capacity for cross-sectoral analysis and the facility it offers for the overlay of multiple environment and development information sets. This approach also supports better urban governance, because it incorporates issues and norms into the decision-making process which will be otherwise ignored. The information stored in the EMIS is a consensus interpretation of information, gathered and discussed in the working group process. The participatory nature of the EMIS responds to a gender responsive EPM by, for example, collecting data and information in a gender disaggregated way where applicable and necessary. However the decision-making process is transparent and traceable through the map layers and through the documentation of the working group meetings. EMIS also helps better disaster prevention by providing policy makers with early warnings about hazardous situations regarding the environment.

Which projects to design for a specific site?

For **project design,** information from several maps is combined and the analysis will provide options for selecting a site or area of interest. A table of information will show the information available about that site including the findings of the working groups about 'rules and conditions' regarding the environmental and development conditions for this specific site. The next step is to prepare a report listing all the information and regulations, making suggestions for the best uses of this plot. If a project document already exists, the information gathered can be used to refine the project design according to the findings. With the inclusion of some more information it is even possible to estimate the costs of different investments at this specific site. Based on the report, the investor can decide on the type of investment she or he will make, or whether the design of the project has to be changed.

Which sites to select for a particular project?

Site selection requires some advance considerations and decisions. This is best explained with an example: A site suitable for a sewage plant is needed. The rules applying to a suitable site for a sewage plant are that it is best placed downwind from settlements, but still near housing areas. The site should be accessible by road and the area must have suitable soil conditions and a low water table. To find sites fitting these requirements, several EMIS maps the will be queried to find all the areas with suitable soil conditions, a low water table and good access to roads. From these areas, sites will which lie downwind from settlements but not too far from them will be selected. There will be several sites matching this query. Not all of them will be available. The ones available will have different obstacles. A report will be prepared describing the advantages and disadvantages of the different available sites.

A city wide view: The Environmental Management Framework (EMF)

A major EMIS output is the Environmental Management Framework (EMF). An Environmental Management Framework has three major components: one, spatial analysis; two, project and investment requirements; and three, a management framework for effective implementation of strategies. The spatial component refers to the geographic interpretation of competing interests in the use of space and the aggregation of potential strategies for solving those competing interests. By mapping and overlaying the geographic distribution of the critical environmental resources, areas can be classified or ranked by their degree of exposure to environmental risks, and sensitivities to particular development activities. This ranking or categorisation of areas helps to determine which development activity is compatible to specific areas, and to articulates rules and principles applicable to development taking place in the different areas. Such rules and principles may not necessarily exclude certain areas from development; they rather enable the incorporation of the long-term costs necessary in investment decisions.

The spatial analysis component of an EMF would allow the determination and prioritisation of potential development areas for city expansion and growth. The selection of areas for future urban expansion will depend on the interaction between push factors (growth deterring), pull factors (growth stimulating) and the environmental sensitivities prevailing in the different areas of the city. The exercise results in the selection of areas with least foregone opportunities (say in terms of loss of agricultural land), benign environmental risks, higher carrying capacity, least infrastructure development cost and high economic efficiency. The spatial analysis component of the EMF makes extensive use of maps and Geographic Information Systems (GIS).

The EMIS can directly link into existing GIS applications such as Land Information Systems (LIS) or Utility Management Systems, provided, the different systems are compatible to each other. Those systems contain information about each plot in the city, such as details on houses, tenants, and owner. This information can then be used for property taxation and water and power supply charges.

Figure 2: The difference between EMIS, GIS and LIS

EMIS	GIS	LIS
An **Environmental Management Information System** is a participatory tool for urban environmental planning and management, concentrating on the interaction between environment and development activities	A **Geographic Information System** helps to store and manage large amounts of spatially referenced data. It provides analysis tools and therefore helps a better understanding of the activities on the earth's surface	A **Land Information System** focuses on land parcels as the primary unit of information. It maintains, analyses and disseminates information about land registration, land assessment and land evaluation
Whole city, including peri-urban areas Scale: 1:10,000 to 1:100,000	Depends on the issue Scale: all scales	Mainly built-up areas Scale: 1:500 or 1:5,000

EMIS and ISO 14001

The EMIS complements the voluntary environmental management system (EMS) defined through the ISO 14001 series. Used in conjunction with appropriate goals, and with the management commitment, the ISO 14001 helps to improve environmental performance and reduce negative impacts. They provide an objective basis for verifying claims about a local government's performance in its day-to-day operations. The ISO 14001 series addresses environmental management systems, environmental auditing, environmental labeling, environmental performance evaluation, and life cycle assessment. These international standards are voluntary standards for the establishment of a common world-wide approach to management systems that will lead to better urban environmental planning and management. Even though the standards do not prescribe performance levels, performance improvements will invariably be achieved by any entity if its commitment to environmental care is emphasised and employees are trained and are aware of the policies in place to protect the environment. The ISO 14001 voluntary environmental management standards and guidelines are intended to be practical, useful and usable for organisations of all sizes (Source: ANSI Online, link: http://www.soc.titech.ac.jp//uem/)

A4
How to introduce EMIS into the city

Establishing a fully functional EMIS can take several years. The system can be built incrementally from a low-cost set-up to a sophisticated and complex system without compromising the value of the outputs (a bicycle get you to your destination just as effectively as a luxury car!). The basic EMIS is essentially no more than a set of checklists of questions that should be asked when making decisions, with 'pigeonholes' to record and store the answers in simple formats that are directly usable, together with some advice on how to go about it.

After the initial stage certain amount of information will have been gathered and good outputs may have been produced to improve urban environmental management. However, it must be remembered that the EMIS can never be regarded as final, it has to be continuously updated and maintained. Any new investment will change the pattern of the city's fabric, and this has to be reflected in the EMIS. A city, therefore, has to commit itself to a long-term investment in the EMIS. This commitment includes not only providing the appropriate equipment, personnel and funding to run the system, but also providing clear policy guidelines for the purpose and the use of the results.

An EMIS works best if the following principles are accepted:

- An EMIS is a dynamic, learning system, so information has to be fed into the system continuously. "Rome was not built in a day". An information system does not have to be complete to be useful, and in any case takes significant time to assemble and fill. In the meantime, decisions on environmental issues will and have to be taken. Provided that attention focuses on the priorities of the users, even modest, incremental improvements in knowledge of an issue can be very useful. This tends to be especially valid in the environmental area, where the major problem is not necessarily a complete lack of information, but unawareness of its existence and whereabouts, its fragmentation and disposal a reflection of the fact that 'environment' is not generally recognised as a technical sector in its own right. Over time, as new issues crop up, the information system will increase its coverage and scope, through both 'passive' and 'active' collection efforts, provided that a framework is in place. In the beginning, the framework can be no more than a set of folders or 'message boxes' in which to 'pigeonhole' information under different headings. At an advanced stage, the framework can be a sophisticated computerised

GIS. The important is point is that the system receives regular maintenance and updating.

- An EMIS accepts the best information available. "*Better is the enemy of good*". It is tempting when defining 'systems' to be too ambitious, and attempt to be complete and all-encompassing. This, of course, can never be achieved, and is more often than not counter-productive, in that time and effort are diverted from content to form. The law of diminishing returns should be kept in mind; beyond a certain point additional information does not really contribute much to deciding one way or another on concrete actions and policies. Very often projects can be delayed or halted because essential information is missing, and time and resources do not allow in-depth research. In this case you may have to rely on estimated figures, common sense or community knowledge. The more the data is partial, missing, inconsistent etc, the more judgmental expertise is required to convert it into meaningful and reliable information. This is especially likely to be the case for environmental issues (indeed, it is one of the reasons for introducing an EPM process). 'Non-scientific' information may be used as long as the source is stated. There is usually a minimum 'critical mass' of information needed to support well-founded conclusions. The challenge is to find the right balance. Of course the aim will be to replace this kind of information in a later stage of the EMIS with more scientific data. But for the moment, what counts is that some information is better than none.
- One has to avoid falling into the '*data trap*', i.e. getting bogged down in a large, general purpose, open-ended and unfocused data collection exercise, almost invariably unsuccessful and therefore largely irrelevant. The purpose is not to substitute for general purpose or even sectoral statistical services or research institutions. Nor is 'information' synonymous with 'data'; only with analysis, interpretation and synthesis does data turn into information. An example to illustrate the difference: a list of sample results, for example values of 'BOD5' from testing of water quality, is data which is incomprehensible to the non-specialist but which, when interpreted, may state, for example, that the values exceed the legal health standards and render the water severely unfit for human consumption due to excessive organic contamination.
- An EMIS makes a clear distinction between *factual information and policy information*. Factual thematic maps show quantifiable or 'countable' data, for example geology maps, soil maps, population density maps, etc. Policy maps show information about certain policy decisions such as national acts, laws and by-laws, global environmental standards or rules and conditions developed by stakeholders during the working group process. Policy maps can be classified as Suitability and Sensitivity Maps. Suitability and Sensitivity Maps interpret information from factual maps and rank areas as 'more and less suitable', 'good' and 'bad', etc. according to specific rules and conditions. For example, a map on water pollution compares the chemical composition (facts) of the water and relates it to standards, rules and conditions (policies). If a certain chemical exceeds a certain level then we call it polluting. Policy maps are based on an intensive participatory process. They are subjective as they show policy aims and represent different opinions which have been negotiated during the working group process. These maps will be always disputed and discussed.
- An EMIS sticks to a consistent *mapping rationale*, so that the maps are easily to interpret. Many similar maps will be produced, showing, for example the suitability of areas for different development activities. It will be much easier for the user if all maps show the same pattern for very suitable land.
- Information in the EMIS has to be accessible for everyone in the public, private and popular sectors. This is an important principle, because an information system is derived from many users. The more people using the system, the more information

entering into the system. This principle addresses the typical *'data bank syndrome'*. The information system should not be viewed as static hoard of 'valuable' information, deposited by its owners to be carefully guarded from 'unauthorised' access, like in the vaults of a bank. Rather it should be seen as a continual flow, like a newspaper, where information is incessantly and actively sought out, quickly analysed and summarised, and rapidly distributed widely and without restriction. Information is like news, a perishable food that loses value over time. The usefulness and influence of a newspaper comes from immediately disseminating new information, not retaining it. An effective information outreach strategy is absolutely necessary for the success of the EMIS.

A5

EMIS Step by Step – an overview

Step 1: Setting up the EMIS

Setting up an EMIS unit takes quite some resources, and must be supported by an adequate number of personnel at least a GIS officer and one GIS assistant. An EMIS system can be built without computer equipment, but it is much easier to use a computer-based Geographic Information System (GIS) to handle the amount of data the system will contain. The standard EMIS set-up requires a high-end desk-top computer, an A0 inkjet printer and input devices such as a digitising board and a scanner. For fieldwork, a Global Positioning System (GPS) receiver will be essential. The office which contains the central EMIS set-up and the filing system (map filing cabinet) should be free of dust, cool and spacious enough to handle large printouts. A light table is essential for group discussions around particular maps printed on transparent material.

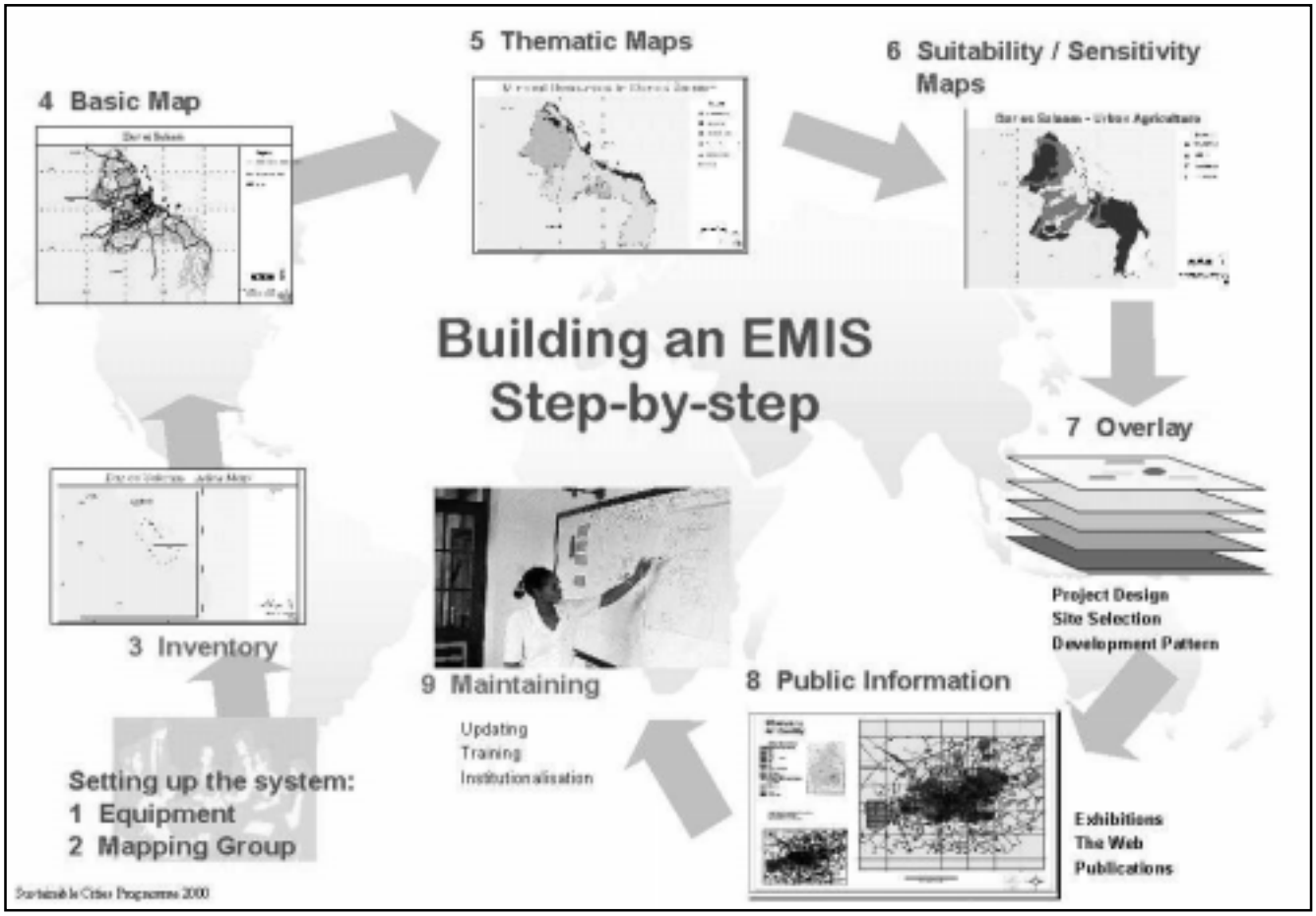


Figure 3: EMIS Step by Step

Step 2: Mapping Group

To link the EMIS with the stakeholders and users of the system, it is very useful to establish a Mapping Group. The major task of such a group is to backstop the EMIS unit and to make sure minimum mapping standards are kept. This group has to solve problems and decide many things during the EMIS-building exercise. In Step 1 they advise on purchasing equipment. For Step 3 they can provide information about existing maps and for Step 4 they can decide on the content and lay-out of the Basic Map. The Mapping Group facilitates the link between the Issue-Specific Working Groups and the EMIS unit, and it is this group which discusses the needs of Thematic Maps, the mapping rationale for Suitability and Sensitivity Map, and the overlay procedures. Finally, the Mapping Group provides training during Step 9.

Step 3: The Inventory

The EMIS inventory stage covers finding existing data and maps, setting up a filing system for hardcopies, developing a filing system for the digital data, and establishing a database of all relevant maps and data. It is frequently surprising how many maps already exist, often even in digital format. It is not necessary to reinvent the wheel; it is better to get hold of these maps. It is important to file hardcopies properly in a map filing cabinet. This makes the maps easy to find, and keeps them in good condition. It is even more important to create a logical filing system for the digital data. Otherwise it will be soon difficult to find the most recent maps and to know what kind of information is stored in a file named “lnsds.apr”. A well-designed database stores information on the location, date, status, scale, etc. on the maps.

Step 4: Basic Map

A Basic Map includes the main features of the city such as major rivers, main roads and basic landforms. These basic features should be used in each map created later on to give some guidance and orientation on the location. The layers of the Basic Map function as master layers, so rivers, roads or boundaries will never ever be digitised again unless they undergo physical change. When printing the first Basic Maps, it is essential to decide on a standard layout which can be used for all the EMIS maps.

Step 5: Thematic Maps

In the EMIS, Thematic Maps show strictly factual information. Thematic Maps, show, for example, height of water table level in metres underneath the ground, soil eroded each year in centimetres, population density per hectare for each administrative sub-unit, and so on. The input for these Thematic Maps will come from existing maps, scientific reports or existing data, which can be found in different city departments, research institutions or which is generated by the Issue-Specific Working Groups. The information in the Thematic Maps will be displayed as symbols (e.g. location of ground water wells), unique codes (e.g. administrative areas), class ranges (e.g. population density) or charts (e.g. content of chemical substances in water).

Step 6: Suitability and Sensitivity Maps

The Suitability and Sensitivity Maps are usually the main outputs of the Issue-Specific Working Groups as regards mapping. The creation of a Suitability and Sensitivity Map includes the interpretation of factual data found in Thematic Maps and the evaluation of these findings. This focuses on drawing conclusions about conditions in specific areas and defining and applying ‘rules and conditions’ according to these conditions. The Issue-Specific Working Groups will assign ranks to these ‘rules and conditions’ according to the environmental impact on development or the impact of development on the environment. A Sensitivity Map shows areas which are highly, moderately, less or not sensitive to an environmental issue, whereas a Suitability Map shows areas highly, moderately or less suitable for a development activity. The most

crucial point at this point is to link the areas of the maps to the rules and conditions established by the working groups. Storing the 'rule and condition' information in a database and linking the maps to it makes this possible.

Step 7: Overlaying of fact and policy maps

For some outputs of the EMIS it is necessary to combine information from several maps. The interaction between environment and development issues, meaning the identification of crucial 'hotspots', will be simulated by overlaying a variety of maps. Meaningful combinations of overlays will generate the necessary outputs which are crucial for urban environmental management. Typical outputs include strategy maps, landuse maps, zoning maps, and spatial management frameworks such as the Environmental Management Framework (EMF). These outputs help to answer routine questions in urban environmental planning and management.

Step 8: Information Outreach

Like the Environmental Planning and Management (EPM) process, the EMIS uses a participatory approach. Therefore public information activities are an important part of the system. This brings new information into the system, and can be very effectively supported by the EMIS itself. Methods to promote the system and the SCP process include exhibitions, the world-wide-web, printed publications, and interactive map publication on CD-ROM.

Step 9: Maintaining the System

An EMIS is a learning system. Thus, even though the design of the system is completed, the data content will grow and change continuously over time. In order to maintain the system it is vital to anchor the system in the most appropriate department or institution, ensure public involvement and acquire a regular budget on a long-term basis. The anchoring department has to commit itself to continuously up-date the system (undertaking the costs involved) and must provide a continuous training programme for the EMIS users and operators.

Part B

The Guide: Building an Environmental Management Information System (EMIS) Step by Step

B1 Setting up the EMIS

B2 Creating a Basic Map

B3 Applying mapping to analysis of environmental issues

B4 Applying mapping to decision-making: Outputs through overlaying

B5 Promoting public information

B6 Maintaining the EMIS

Building an Environmental Management Information System step by step

In conformity with the overall focus of EPM as described earlier, the information collected in an EMIS is concerned with natural resource systems, development activities, issues and actions. However, it is not the information system as such that defines the specific resources, issues etc. to cover; these are defined through the EPM/SCP process. The basic EMIS can be defined as a checklist to support this process. The checklists are defined with the EPM organising framework in mind, and cover basic knowledge and background information, issues, actions/development activities, instruments, stakeholders, resource persons, and spatial presentation (maps).

This section of the handbook presents a step-by-step guide to establishing, developing, using and maintaining an EMIS. The guide is aimed at the immediate user of the system. It concentrates mainly on the spatial presentation (maps) of the EMIS, and it is assumed that the reader has good mapping and cartography skills, computer knowledge and a basic understanding of GIS. This section gives a complete overview of the EMIS process and it is important that you read it all closely. Later on you can refer to the individual steps. In the text you will find many references to the toolkit, which is at the back of the book. These are additional tools on the CD-ROM. These tools are designed to help you to implement each step.

Here are again some key points on the EMIS to keep in mind while you are reading the more technical descriptions:

- The EMIS is part of the EPM process and it is designed to support every phase of the SCP project cycle.
- It is, in itself, a tool for better urban management, because it ensures that data is collected and analysed in a participatory and gender responsive way.
- The spatial scope of the EMIS can differ widely. It can cover the whole city, giving a more or less comprehensive picture of urban development. However, an EMIS, by its very nature, aims at connectivity rather than comprehensiveness. Therefore it is more often used to examine smaller “pilot” areas or specific issues from a cross-cutting perspective. It can focus on specific issues such as petty trading, or on specific locations, such as dealing with a lake within a city.
- Although the EMIS does not attempt to be comprehensive, it must have a basic set of data which includes information on the natural setting of the city, landuse, ongoing development activities and the state of the environment.
- The power of the EMIS lies in its outputs. Pinning large, colourful maps on the walls helps tremendously to deliver messages. Saving on printouts jeopardises the usefulness of the EMIS.

B1

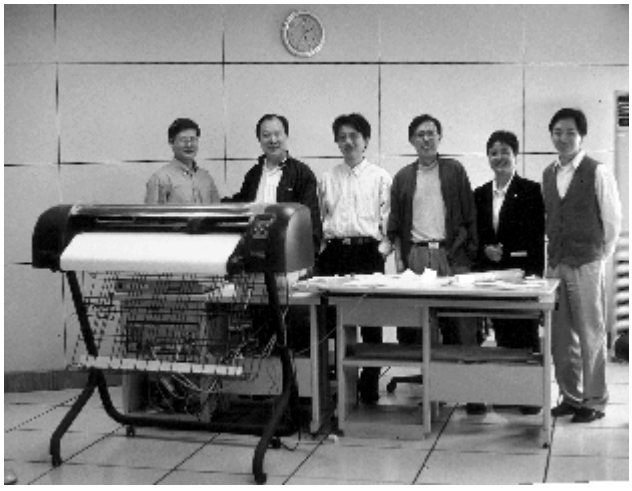
Setting up the EMIS

The spatial element is of course of prime importance in any urban setting. Mapping of information is an important part of the EPM concept. However, before you start drawing your maps you have to do some preparatory work first. The EMIS function has to be placed in a suitable location, you need committed staff to operate, you need to purchase equipment and software and you have to clarify on what data to collect and where to find it.

B1.1 Finding a place

Finding the right location for the EMIS is not an easy task. It depends entirely on the situation in the individual cities: is there already a GIS unit somewhere or an office or department with people who can support the EMIS? Initially, the EMIS unit is best located within the EPM unit or Technical Support Unit (TSU). While, the EMIS unit and the EPM unit do not necessarily have to be put in the same department, most cities start with this structure so that it is closely linked to the EPM Working Group process. If the EMIS unit is located separately from the EPM unit or TSU, because a GIS unit already exists in another department, or it has been decided to place the EMIS function in a particular department, it is still necessary to make sure that the system is linked closely to the SCP process cycle. At the very least the SCP project has to be able to both use and input data into the EMIS. The final location of the EMIS unit is best discussed in connection with the institutionalisation phase of the EPM unit. You could also consider the option of locating the EMIS function within the private sector. In some cases this can work out better, taking the efficiency of the private sector into consideration. But such a solution can also have serious pitfalls because the private sector is usually profit oriented and not interested to feed into the existing EPM structure and you might get little return for your investment. For further discussion of this topic refer to section B6.3 'Making the system routine'.

Just a few remarks about the office environment: the equipment for the EMIS needs to be kept in a clean, dust-free, dry and cool place. The technical equipment needs quite some space – and also you have to handle large sheets of paper - therefore you should choose a spacious office. The office should be easily accessible to the relevant stakeholders, and should not be a laboratory used only by few specialised technicians. As well as typical office equipment, such as chairs and desks, it is useful to have at least one additional table, preferable a light table to make overlays manually, and a map filing cabinet.



Wuhan, China

B1.2 Placing and engaging staff

The functions of the EMIS unit includes setting up, operating and maintaining the technical equipment, acquiring and analysing data, creating maps, maintaining the data, co-ordinating the process with the Issue-Specific Working Groups and the Mapping Group, and providing or organising sensitisation and training course in EMIS.

Professional people are needed with technical background and knowledge in GIS and urban environmental management. They have to have good communication and organisational skills because they will be dealing closely with stakeholders not only government departments and other institutions but also in the field at community level. Experiences in document design and layout and information outreach strategies are also essential.

People who combine all those qualifications are not so easy to find. However, most cities have at least one department where a GIS has been established, so there are people available within the municipal offices with some experience. Additionally, many universities provide basic training in GIS technology and applications. The resource persons from training institutions or from the private sector can often help to find the right candidates and provide training to fill existing gaps.

How many staff members will you need to make the EMIS work? The answer to this question will depend on the size of your city and the scope which you expect the EMIS to cover. The more Issue-Specific Working Groups are established, the more comprehensive the EMIS will be, and therefore the more personnel are needed. In most places it will be fine to have two staff members for the EMIS unit: an EMIS officer and an EMIS assistant. If you have to do a lot of map digitising, then it might be useful to employ a second assistant – maybe on a short-term basis. The tasks of the EMIS unit staff are described in detail in the terms of reference given in Tool 1. Briefly, the EMIS officer is responsible for the progress of the EMIS. His other tasks include acquiring analysing data and the design of the databases. Additionally she or he functions as an important focal point to ensure genuinely participatory mapping: she or he will be the link to the decision-makers and politicians as well as to the Issue-Specific Working Groups. The EMIS officer will report directly to the EPM Unit Co-ordinator. The EMIS assistant deals with the technical parts of the system such as digitising, inputting data and laying out maps and posters.

see Tool 1 - EMIS Employees

All staff working in the EMIS unit should have -or be given- a thorough training in the EMIS concept in using the selected GIS software packages. They should also have a general overview of the functionality of a GIS and the most common applications. The EMIS officer will preferably have some working experience with GIS. You should consider carefully the salary for your EMIS officer, because their skills are in high demand, and it happens quite often that private sector employment is more financially attractive. If it is not possible to pay the same salary as in the private sector, other incentives such as training and duty travel could help to keep staff in position.

B1.3 Selecting and putting in place the hardware and software

In places where computer technology and expertise is not available you should consider a manual EMIS set-up. Most of the functions of an EMIS described in this handbook can be performed manually and it is not worth investing in inappropriate technology which may rot away idly in a storage corner. However, since computers have now found their way into traditional paper-based government offices, this handbook describes the computerised set-up of the EMIS.

Hardware

The key hardware for the EMIS is the data input/output computer (the examples are based on IBM type personal computers). The specifications of desktop computers are changing rapidly. Therefore it is difficult to recommend a certain type of computer since the capacity of an average desktop computer doubles every two years. You are advised to review the market carefully and to purchase top-end equipment. The computer should have sufficient memory, a big hard disk, preferably fast SCSI interfaces, a reliable back-up system and a big monitor, preferably 19 or even 21-inch size. Today, computers are usually equipped with processors up to 1000 MHz speed, 128 MB RAM, a hard disk of 10 GB and above, and integrated CD-ROM writers. If you use more than one ‘EMIS computer’ in your unit you will have to network the computers in order to minimise ‘data confusion’ by storing it in different places (“which was the latest file version again?”).

The second important part of the EMIS equipment is an A0 size inkjet plotter. It is essential to the SCP project cycle and the EPM process that you have good quality map displays. Traditional pen plotters are no longer suitable for producing full-colour thematic maps. The inkjet plotter should have enough internal memory to process complex maps, which can use up to several dozen megabytes of memory. The plotter should also be able to process Postscript files since it will be used not only for maps but also for the production of high-quality, large scale posters.

If you can not purchase digitised data or if there are no other digitising facilities around, it is recommended that you purchase a digitising board of a size from A3 to A0. Please note that the cost of a digitising board is considerably high. It is worth assessing how much the 'real' digitising work has to be done. In many cases you only need to digitise a few layers from scratch, such as basic land forms, boundaries and utility networks. Much of the digitising of thematic maps is better done onscreen. In smaller cities you may consider just buying a A3 digitiser which costs only a few hundreds US dollars.

Scanners can help to quickly produce overview maps or to update existing maps. For example, aerial photographs can be scanned and digitised on-screen. A4 size scanners are cheap and reliable. Do not consider purchasing scanners bigger than A3 size. The cost of those scanners is very high and the technology in terms of storage and computer processing capacities still lags behind. A Global Positioning System (GPS) helps for quick surveys in the field and is essential for up-dating maps. A GPS is an inexpensive and useful tool. For specifications, costs and details about hardware please refer to Tool 2 'EMIS Equipment'.

see Tool 2 - EMIS Equipment

Figure 4: EMIS hardware

Data collection	Processing	Output device
• Digitiser A3 to A0 • Scanner A4 or A3 • Field survey equipment such as a GPS receiver • Light table	Two state of the art office computers, networked 1993 – 4/86 66-2 Mhz 1995 – Pentium I, 90 MHz 1997 – Pentium II, 200 MHz 2000 – Pentium IV, 1000 MHz	• A0 plotter for large scale maps and posters • Tape- or CD-writer for archiving of data • LCD projector for PowerPoint presentations

Software

In the last few years, many software companies have developed mapping and GIS software packages. They range from very simple mapping programmes with limited analysis tools to highly complex and powerful GIS programmes. Today, most of the software packages work on a windows-based platform and therefore most of them are quite easy to operate. The most common programmes are ArcInfo, ArcView GIS, Atlas GIS, MapInfo Professional, Idrissi, Map Maker Pro, TNT Mips, or Intergraph. It is difficult to recommend a particular software package since each one has its advantages and disadvantages, and, of course, its price. Experience has shown that in many cities certain programmes are better known and therefore more user support is available. Traditionally, many institutions have built capacities and produced data in, for example, ArcInfo format or AutoCad. Today, the data produced in the various software packages are increasingly interchangeable so that what to choose is becoming less of an issue. But still, before you decide which software package to order, you should check what GIS packages other institutions in your city are using. Maybe it makes sense to use the same one, in order to exchange experiences and know-how.

Most SCP partner cities are using ArcView GIS as a good compromise between capabilities, expandability and cost. Therefore it is helpful for other SCP Projects to use the same package, so that lessons of experiences can be easily exchanged. ArcView GIS can directly process ArcInfo and AutoCad data. It is a powerful tool, and it operates on the user-friendly MS Windows platform. ArcView GIS has a modular structure and new 'extensions' for more complex analysis requirements can be programmed, freely downloaded from the web, or commercially purchased. However, this programme is still rather complex, and requires powerful computers and a good knowledge and training in GIS in general. Alternatively, for small municipalities, NGOs or community organisations lighter products such as Map Maker Pro could be the better choice. This product was developed in close co-operation with Asian and African municipalities and is therefore more adapted to the particular needs of users in developing countries (instead of the North American business oriented application bias of the 'big' brands). Map Maker Pro is a cheap but powerful tool, which runs on small computers and is easy to learn and to understand. Because of MapMaker Pro's ability to convert many data formats and its extensive analysis capabilities it complements the use of ArcView GIS. It is not recommended to use architectural or designer packages such as AutoCad or Micro Station. Those programmes are not real GIS programmes and do not allow certain analysis methods necessary for the EMIS. However, AutoCad, for example offers a module which can expand the programme into a GIS (AutoCad Map). For a detailed comparison of these two software packages refer to Tool 2 'EMIS Equipment'.

see Tool 2 - EMIS Equipment

This handbook does not go into the details of image processing. Most GIS programmes have basic image processing functions which will allow you to use scanned aerial photographs or satellite imagery for your existing maps. The use of images, including satellite images will be described in section B2.2.

The data management structure of the GIS programmes mentioned above is compatible with common data base programmes and spreadsheets (such as dbase, Lotus, MS Excel, or MS Access). If you plan to process huge amounts of data network-server-based products such as Oracle or Sybase may be more appropriate. As well as the GIS software and a database programme, you should also consider using desktop publishing programmes such as Adobe Photoshop and Illustrator. For the preparation of presentations you will need word-processing (e.g. MS Word), slide presentation (e.g. MS Power Point) and web publishing (HTML editor, JAVA programming) software.

Figure 5: EMIS software

EMIS/ GIS/ Mapping	Image Processing	Database	Publication	Network
• ArcView GIS • MapMaker Pro • ArcInfo • MapInfo • Atlas GIS • Idrisi • AutoCAD Map etc.	• ILWIS • TNTmips • Erdas/Imagine • ArcView Image • Analyst etc.	• Oracle • MS Access • Dbase etc.	• Adobe Photoshop Adobe • Illustrator • Adobe Pagemaker • MS Powerpoint • HTML editor etc.	• Novell • Windows NT • UNIX etc.

B1.4 Linking to stakeholders, users and producers: the Mapping Group

If the EMIS is to be fully successful, it is very important to link it to its users right from the very beginning. The key users of the system are the stakeholders, both women and men, involved in the Issue-Specific Working Groups, who include of decision-makers,

citizens affected or concerned with the issue, professionals, experts and scientists and the project team. In order to keep all these groups informed on the progress of the EMIS, and to get their input it has proven to be useful to establish a Mapping Group.

The main purpose of establishing a Mapping Group is to ensure the smooth flow of information between the providers and the users of the information in the EMIS. The EMIS is a major data repository of the Issue-Specific Working Groups and the Mapping Group serves as a linking advisory body between the technicians and the users. Furthermore, the Mapping Group makes sure that the inputs into the system are sufficient and relevant to the EPM process and that the outputs of the EMIS are well understood and accepted, for example, that they follow certain required mapping standards. The Mapping Group also plays a role in providing the EMIS Unit with technical support.

The Mapping Group can be an informal gathering of 'mapping people', or better still, a formalised group with the status of an Issue-Specific Working Group. The Mapping Group is best established when initialising the Environmental Profile. The Environmental Profile is the first data repository of the SCP project cycle. Overview maps will have to be produced for it and certain data, such as population growth, extent of environmental deterioration, soil quality, etc., will be collected and displayed, usually in table format. The Mapping Group will consist of members from various institutions which have a connection to mapping: mapping and survey departments, local authority departments,

Mapping Working Group: THE SUSTAINABLE IBADAN PROJECT EXPERIENCE

As part of its effort to support the ever increasing stakeholder quest for up-to-date data and spatial information on the natural resources and environment of Ibadan-land (Nigeria) the Sustainable Ibadan Project Mapping Working group was inaugurated on the 23rd November, 1995.

Its goal was to sensitise the community, including government agencies and the public at large, on the usefulness of map data for sustainable development, and also to work towards the establishment of Environmental Management Information System (EMIS).

The tasks of the group were to identify and locate all available maps on Ibadan and to keep an inventory of map situation in Ibadan. They had to disseminate information on available maps to members of the community and other working groups. Another task was to increase networking and build capacities in mapping and GIS.

Summary of Activities:

- Supervise the execution of the map inventory in Ibadan, supported by UNCHS (Habitat).
- Organise, with assistance of a consultant, two sensitisation workshops on GIS and one workshop on EMIS.
- Create Thematic Maps of various land uses in Ibadan.
- Supervise the consultant executing the production of the Basic Map of Ibadan, supported and funded by UNCHS Habitat).
- Organise, with the assistance of consultant, the development of measurable indicators for solid waste management in Ibadan.

Membership of the mapping group is cross-sectoral, and includes map makers, map users, experts (training institutions) and those with political clout. The Mapping Group is anchored in the Survey Department, Ministry of Lands, which is responsible for map-making in Oyo State. The chairperson is appointed within the group. The chairperson is the Surveyor-General of State who also happens to be the Head of the Mapping Division of the Ministry of Lands, Housing and Survey. The Working Group members are not paid.

The Mapping Group meets twice every month. There were three sub-committees within the group: the map inventory committee, the map information network committee and the training committee. The Technical Support Unit (TSU) of the Sustainable Ibadan Project (SIP) provides the necessary technical advice and back up support services and facilitates the group meetings.

The composition of the Mapping Group is not static; it is adjusted from time to time to ensure that the group maintains the right mix of expertise and competence. Changes in membership occur due to the changing nature of the expertise required.

planning and geography departments of research institutions, the private sector, working group co-ordinators, and, of course, the staff of the EMIS unit. Please refer to Tool 3 'Mapping Group'.

see Tool 3 - Mapping Group

At each stage of building the EMIS, the Mapping Group can give advice and support in the following areas:

- Overview of Mapping Activities – The mapping group can provide an overview of all mapping activities in the city/town and can explore possibilities for sharing information, data and certain hardware, such as digitising boards.
- Inventory - All members of the Mapping Group can provide information on existing maps and their location for the Inventory. The members of the Mapping Group know best about the quality and usability of different maps.
- Community Sensitisation - Sensitisation and building capacities of community groups regarding data production and map reading is best organised by the Mapping Group (remember, the Mapping Group will contain representatives of community groups).
- Basic Map Preparation - This group will advise on the scale, the data, the layout and the layers to use for the Basic Maps. The group will also help the EMIS unit to formulate the right Terms of Reference when outsourcing specific work.
- Thematic Map Production - The Mapping Group will help to structure the major exercise of preparing Thematic Maps. They will discuss which maps will be needed and how they can best be produced with the working groups.
- Suitability and Sensitivity Maps -The members of the Mapping Group will be involved in the development of the mapping rationale for Suitability and Sensitivity maps. They can also give some comments on how to link specific rules and conditions with the maps.
- Overlaying – The Mapping Group will discuss the overlay procedures and will advise on which layers on environment and development issues are best combined in order to get meaningful results.
- Training - Some members of the Mapping Group are potential trainers for other EMIS users. Mapping Group members also know of suitable training facilities.

B1.5 Getting Information and Taking the Inventory

Inventorying information in a meaningful way is key to transparency in the flow of information and it avoids unnecessary duplication of work. Many offices have already a system in place for inventorying books, reports, maps and other documents. However, many also store their maps rolled up in a heap in the corner or on top of a shelf, or in piles on an office desk. A very important task - even though it might seem dull – is to start a filing structure that will let you find your maps and related information easily. Inventorying includes (a) finding and purchasing existing data and maps, (b) arranging and filing them, (c) setting up a database, and (d) creating an index map or an atlas. You should take this task seriously and follow the instructions carefully. Several tools are available which will help you to do your inventory.

What to collect

There is no set minimum level of information detail or disaggregation; the idea is to refine and develop information only as needed (according to priority issues). Nor is there an obligation to be complete and 'fill in blanks'; a major purpose of the EMIS checklist approach is precisely to make clear any lack of potentially relevant data. You must then decide if the missing information (or level of detail, coverage etc) is really critical and if the effort of generating it is worthwhile.

There are two limitations on the scope of your information collection, area and time. Regarding area, "everything" concerning what happens in or affects the city in question

is of potential interest, but it only becomes of actual interest if it is related to an issue under consideration. Nation-wide, outside the city, information related to any issues of city concern are of secondary interest, to explore commonalties or experiences. The definition of what exactly constitutes the 'city area' for the purpose of SCP is decided at the outset.

As a general rule, information, reports and so on that are older than about five years are of very limited value. It is better to concentrate on the last three years. The only exceptions to this rule concern basic fundamental compilations and studies such as census reports, master plans, and topographic maps, which may not be updated more often than every five to ten years, but are still valid as a basis for extrapolation and for seeing longer term trends. With these provisions in mind, you should always try to assemble information about trends and changes during over several years wherever possible, rather than just from one particular period (i.e. it is just as important to know that water quality is decreasing as the absolute level of pollution at a given time).

Please note: The EPM process takes gender concerns into consideration. It is important to ensure that data collection is not gender blind, and that is does not ignore gender sensitivity or relevance. In some cases it is necessary to disaggregate information according to issues with which the different genders are concerned.

Finding existing data and maps

From the point of view of those responsible for maintaining the information system, there are basically two methods of obtaining information. You could call these 'wholesale' and 'retail'. 'Wholesale' is basically commissioning a study or report from resource persons (experts, consultants, researchers etc), according to set formats, which are defined as part of the information system (e.g. the Environmental Profile). 'Retail' is the day-to-day collection and recording of bits and pieces of information, that are either useful in themselves or that may serve as inputs for other purposes (e.g. for working groups). In the 'wholesale' case, the practical difficulties of obtaining information are left to the expert; in the 'retail' case they have to be confronted directly. While there is no universal recipe, a systematic approach helps. This is all the more important when there is a strong tradition of bureaucratic 'secrecy' and a reluctance to volunteer anything spontaneously.

First of all, you cannot wait for information, but have to actively and repeatedly search for it, preferably through personal visits. Secondly, all channels should be used, official and informal, direct and indirect; the important thing is to get hold of the necessary information, not how and in what form. In particular, you should make every effort to utilise personal relations or introductions. Many times it is easier to get hold of something in another institution rather than at the source. It may often be impossible to physically get a copy of, for example, a report, but it may be easier just to find out what exists and/or study it on the spot. In general, people are less reluctant to talk about what is available and show it in the security of their office, than to hand out a document without 'authorisation', particularly if it has not been officially finalised but is a 'draft' (which is often the key version, as finals tend to come out too late, if ever, to be really useful).

The same principles described above also apply when you are looking for maps. Before you start preparing your own maps it is important to take stock of the maps which already exist in paper form and/or in digital format. You will be surprised how many maps have been produced by others already. You should collect as many of these maps as you can. If it is not possible to get hold of a map, note where it can be found and what information it gives. The following list provides you with an idea of where you can go looking for maps (Refer also to Tool 4 'Finding Maps'):

see Tool 4 - Finding Maps

- Mapping and survey departments will provide you with topographical maps.
- Many ministries and central/local government departments have thematic maps regarding their particular field of work.
- You can find many maps on the internet
- And never forget to contact your university's Geography or Cartography Department.

Purchase of data and maps

Always note down additional information about the maps that you obtain, such as for example, the date of the map, the quality of the map, the scale and the source of the data. Sometimes you may have to pay for the maps; you have to pay for digital data most of the time. Before you start spending money you should discuss with the mapping group if these maps are worth the money (also refer to Tool 5 'Purchasing Maps').

see Tool 5 - Purchasing Maps

Example: A SCP partner city purchased a digital basemap in the scale of 1:2500 for US dollars 60 per square kilometre. The total area covered was 500 square kilometres, so the total cost was US dollars 30,000 for the whole set. Only a small portion of about 80 square kilometres was relevant for the work of the issue specific working groups and the remaining data now sits quietly in a well locked drawer. The EMIS Unit could have saved US dollars 25,000 to be utilised for other purposes.

Arranging and filing maps

While you are visiting offices dealing with planning and mapping, you may notice a tendency to pile up maps everywhere. The people working there will know perfectly well where to find each map – at least most of the time – but for a newcomer it is a mess. And obviously, it is not the best way to store maps over a long period of time. In order to be able to find your maps and to keep them in good condition it is essential to file all hardcopy maps properly in a map filing cabinet. They should be labelled and ordered meaningfully before being put away. (to do this, see Tool 6 'Coding and Filing Maps')

see Tool 6 - Coding and Filing Maps

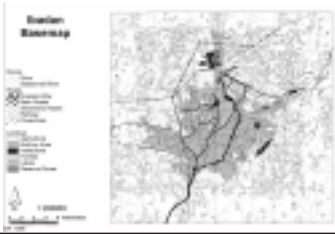
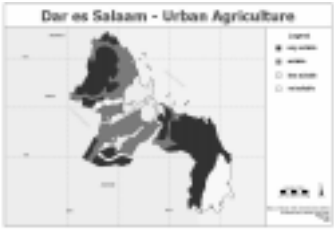
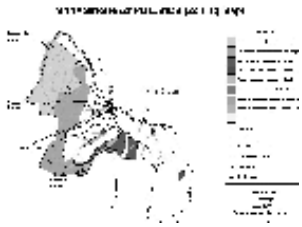
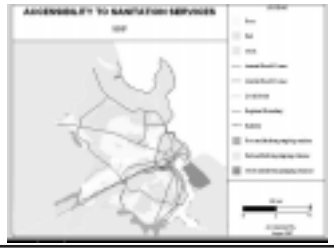
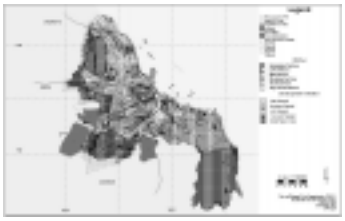
There are of course several possibilities for creating a coding system for all maps. The basic classification of all information is by topic (by which is meant the sections of the socio-economic/environmental profile and by 'issue' which is a cross-cutting environmental and/or developmental problem areas identified for analysis and action). However, many institutions and departments already use a standard coding system for any document produced and published; you should ask your local mapping and survey department about their system. Offices which do not have an appropriate filing system in place could use the structure proposed in this Handbook (see Tool 6 'Coding and Filing Maps'). This coding system follows the steps for creating maps for the EMIS. You prepare a code for Basic Maps, Thematic Maps, Suitability and Sensitivity Maps.

see Tool 6 - Coding and Filing Maps

Whatever coding system you choose, you should always apply this coding to digital maps as well as to your hardcopy maps. If you have ever tried to find a specific file on somebody else's computer you will know how difficult they can be to locate. Before you even start to put any digital data on to your EMIS hard disc, you should prepare a filing structure. There are two examples of a filing structure shown in Tool 7 'Filing Digital Data'. One strictly follows the coding mentioned in Tool 6 'Coding and Filing Maps'. The other one uses a coding rationale with meaningfully named folders. You can establish either system on your disc, but you have to remember to adjust each one according to your local setting, for example preparing folders for each Working Group active in your city. You will find two main directories in the structure: a folder called 'Working' and a folder called 'Archive'. Use the 'Working' folder for any current projects under development. Once these are finished, make sure to transfer your digital maps to the appropriate folders in the 'Archive'. Only finalised layers and maps are stored in the 'Archive'. The 'Archive' will allow you to open a well-designed, ready-

see Tool 7 - Filing Digital Data

Figure 6: Definitions of the different maps used in the EMIS

Definition	Source of data	Example
A Basic Map includes the main features of a city, such as major rivers, main roads, basic landforms and administrative boundaries.	Use a topographical map with a scale of 1:20000, 1:50000 or 1:100000.	
A Thematic Map map focuses on a specific topic. Thematic Maps in the EMIS will strictly show facts.	Information is provided by institutions or derived from research, and the Working Group process.	
Suitability Maps show evaluated information or policy rules and regulations for development issues. A Suitability Map might show areas which are highly, moderately, less or not suitable for a development activity like agriculture.	Information is mainly generated through the Issue-Specific Working Groups and the Mapping Group. It includes national & international standards.	
Sensitivity Maps show evaluated information or policy rules and regulations for an environmental issue. They show areas which are highly, moderately, less and not sensitive to an environmental issue like erosion.	Information is mainly generated through the Issue-Specific Working Groups and the Mapping Group. It includes national and international standards.	
A Service Delivery Map shows the extent and type of infrastructure and services in the different parts in the city such as water, sewerage, solid waste, energy and transport.	Data on water distribution, types of sewerage, road conditions, public transport, management of solid waste, areas serviced by power	
An Environmental Management Framework (EMF) refers to the geographic interpretation and aggregation of strategies. By mapping and overlaying the geographic distribution of critical environmental resources, areas can be classified or ranked by their degree of exposure to environmental risks, and their sensitivities to particular development activities. This ranking or categorisation of areas allows the determination of development activities compatible with specific areas, and the articulation of rules and principles applicable to development taking place in the different areas.	Suitability and Sensitivity Maps, refined by Service Delivery Maps	
Hot spots - The higher the ranking value in an overlay is the higher the competition is for development activities on that spot.		
An Action Plan Map shows the site where a demonstration project is planned which is intended to improve the environmental situation at this particular 'hot spot'. These maps show clearly the existing situation of a particular site.	Large scale maps in 1:2500	

made map with just a couple of mouse clicks. Potential investors requesting a map on soil suitability for a certain area may not have the patience to watch you searching for files and building up the requested map. Whenever you need to update a 'final' map or layer, copy the particular map or layer back into the 'Working' directory, make your changes and bring it into the 'Archive' once again.

A major exercise during the inventory stage is to set up a meta-data database. Meta-data refers to information about your maps and digital data. Such a database consists of data about the title of a map, the scale or the location where that particular map is stored. You should also try to add information on the source of the map, the reliability of the information used to prepare this map and the physical condition of the hardcopy. This database can be built using a spreadsheet or database program. On the CD-ROM you will find a ready-to-use MS Access database that you can use. You will have to adjust it to your particular needs. With this database it is possible to keep track of existing maps and their origin. This will allow non-EMIS people to come to the EMIS office and to query the database on existing maps in a specific area of the city, or for a specific topic such as waste management. The database has to be updated regularly. You can either do it on a weekly basis or the information can be added each time you finish a new map. In any case, you should decide on the time schedule and the responsibility for the database right now.

Index map and Atlas

There are two other things which will be helpful for your inventory: an Index Map and an Atlas of the City. An Index Map shows the entire spatial area covered by the EMIS. You just draw boxes on it indicating the areas covered by different maps. You note the map's code and the scale. If anyone wants to have some information about a specific area of your city, she or he just has to have a glance at this Index Map to find out which specific map she or he needs. An Atlas of the city is another way of collating the maps you have prepared. This will then provide an easy and accessible reference document for many institutions. You can even sell the Atlas in bookstores. For more information refer to section B5.3 'Publications'.

After these initial steps you are ready to produce your own maps for the EMIS. In the table below you find a brief description of the seven typical maps of the EMIS: Basic Map, Thematic Maps, Suitability Maps, Sensitivity Maps, Service Delivery Map, Environmental Management Framework (EMF) and Action Plan Maps. There is a short definition of this kind of map, some details of the maps or data needed to prepare them and a small example, of how they will look. Preparing the maps is described in detail in the following chapters.

B2

Creating a Basic Map

Large Scale – Small Scale

The scale shows how many times smaller the map is compared to the feature it represents. This difference is expressed by two numbers. The first number represents the units on the map and the second one shows the real size. On a map with a scale of 1:2500, one centimetre represents 2500 centimetre (or 25 m) in reality. Or you can look at this the other way round: On a map you can measure the distance between two points, which is, let's say, 10 mm. Outside on the street the same two points are 500 meters apart. The scale of the map is 1:50000, because 10 mm goes 50000 times into 500 meters. So large-scale maps, which show small areas in detail, have small numbers (representing larger areas) whereby small-scale maps, which show large areas but with less detail, have bigger numbers (1:200000 and beyond).

It is important to plan before you start:

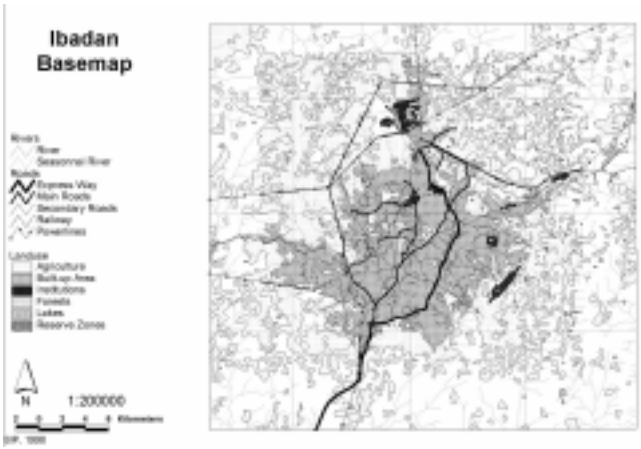
Any map you produce is a small project in itself. You need to go through a carefully structured planning process in order to avoid surprises while producing maps. The planning process for the Basic Map should be undertaken very carefully since all other maps in your EMIS will depend on it.

The project planning steps in Arc View GIS are as follows (see Figure 7):

1. Give your ArcView Project a meaningful name (e.g. basicmap.apr)
2. Make a clear decision of what the project will contain in terms of views, tables, charts, layouts and scripts
3. Do not overload your project, keep it simple and clear
4. Produce views and layouts both in colour and in black & white

The first map you will create in your EMIS is a Basic Map of your city. The Basic Map, as the name indicates, serve as a basis for any further map developed in the EMIS. A Basic Map includes the main features such as major rivers, main roads, basic landforms and administrative boundaries. As you can see a Basic Map is a kind of a topographical map, with only the main features shown. The EMIS Basic Map should not be confused with the term 'base map'. In many countries, the term 'base map' means a very particular map, for example in Anglophone countries, planners identify the term with large scale topographical maps (e.g. 1:2500). On the contrary, the scale of the Basic Map will probably be much smaller (1:10000 up to 1:50000) depending on the area the EMIS will cover.

The features digitised for your basic maps represent landmarks, such as a coastline, rivers, or major roads and administrative boundaries which do not change very often. Those layers are your master-layers which are used to create other maps. The master-layers are fixed and will only be updated and changed very carefully. Therefore you never ever digitise a river, a road, the coastline or the boundaries of the city a second time. If you need a certain section of a river for a different map you will take a copy of your master-layer which contains the river network and you delete all the rivers which you do not want in the new layer. This approach ensures that your features match exactly in every map. Or another example: you have finalised digitising the river network of your city. You start digitising the layer which contains administrative boundaries. One boundary follows a river which you have digitised before. You want to make sure that both lines match exactly ('tidy boundaries'). Either you copy the river stretch into the boundary layer and you continue digitising from there, or you use the tracing and snap functions of your GIS software.



Ibadan, Nigeria

Before the Basic Map is digitised or purchased, you have to make several important decisions. First of all you should check on the existing national mapping standards which should be applied for the EMIS. Then you have to decide which area the system should cover and therefore what scale should be used. Many environmental issues are related to the surroundings of the city, the source of the problem might be lying outside. Therefore the area covered by the system has to be greater than the city extension. Also, the features of the Basic Map do not stop at the administrative boundaries as rivers and roads extend beyond.

Figure 7: Starting an ArcView GIS project

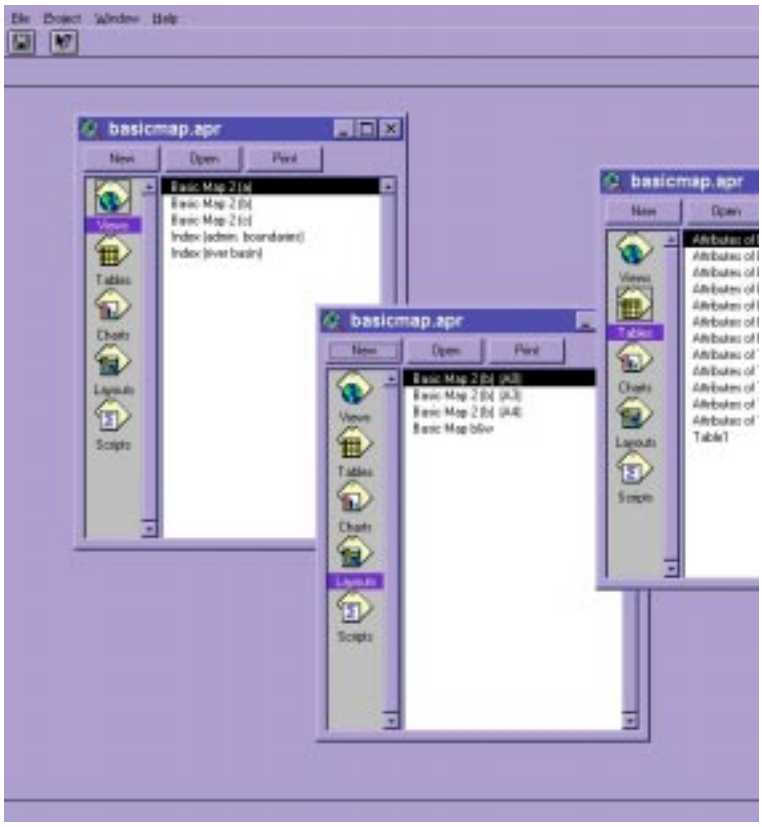
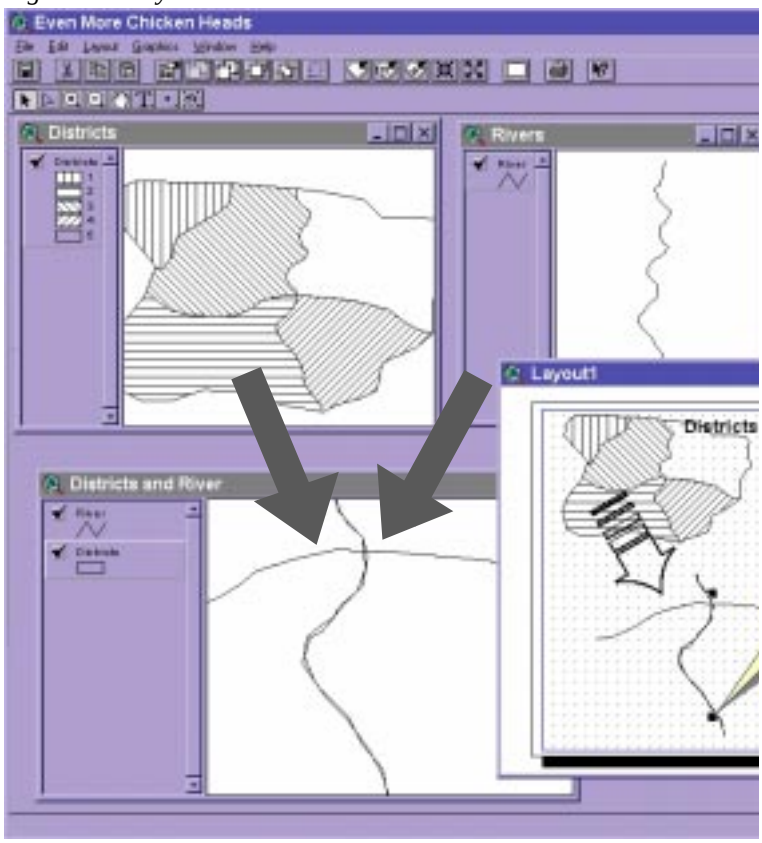


Figure 8: 'Tidy Boundaries'



What is a Map Projection?

Since the earth is a three-dimensional sphere (more or less) and maps are two-dimensional and flat, special techniques are required to represent the curved surface on a flat sheet. These techniques are called map projections. Map projections provide rules for converting the numeric values of latitude and longitude to the x and y co-ordinates of a rectangular grid. In this way the precise position of features on the Earth's surface can be obtained from the map. All map projections necessarily make compromises, and distort shape, area, distance or direction to some extent. The impact of this distortion on your work depends on what you will be using your map for, and its scale:

On large-scale maps, such as street maps, the distortion caused by the map projection being used may be negligible because your map will typically cover only a small part of the Earth's surface.

On smaller scale maps, such as regional and world maps, where a small distance on the map may represent a considerable distance on the Earth, this distortion may have a bigger impact.

Each national Government uses a particular projection for its official maps. A good topographic map contains the following information:

Grid:	UTM Zone 37
Projection:	Transverse Mercator
Spheroid:	Clarke 1880 (modified)
Unit of measurement:	metre
Meridian of origin:	39°00' East of Greenwich
Latitude of origin:	Equator
Scale factor at origin:	0.9996
False co-ords of origin:	500,000 m Easting
	10,000,000 m Northing
Datum:	New (1960) Arc

Universal Transverse Mercator System (UTM)

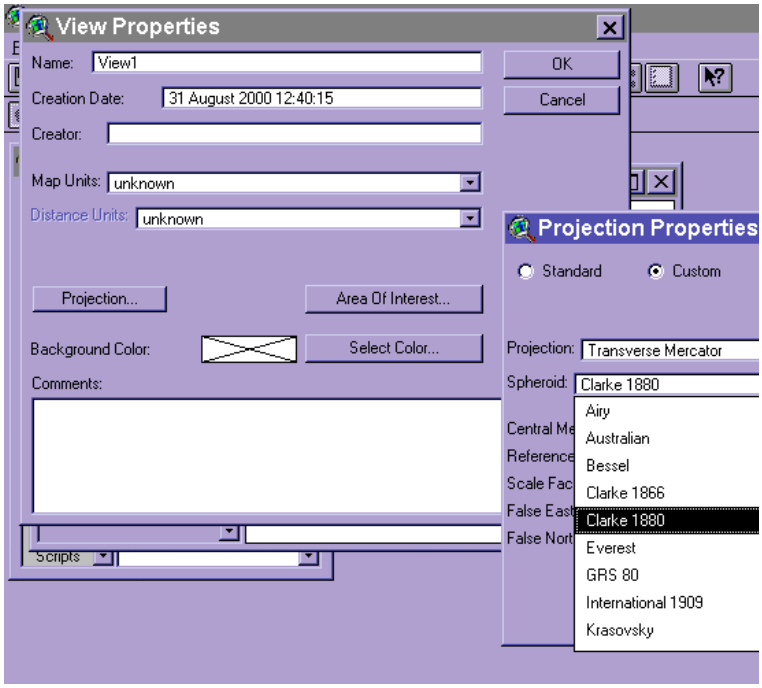
Universal Transverse Mercator (UTM) is a projection which tries to balance the distortion of shape, area, direction and distance with an accurate representation of small shapes and minimal distortion of larger shapes within the zone, while for the areas the distortion within each UTM zone is minimal. Local angles are true and the scale is constant along the central meridian, but at a scale factor of 0.9996 to reduce lateral distortion within each zone. UTM is designed for a scale error not exceeding 0.1 percent within each zone.

The Universal Transverse Mercator System divides the globe into sixty zones, each spanning six degrees of longitude. Each zone has its own central meridian from which it spans 3 degrees west and 3 degrees east of that central meridian. X and Y co-ordinates are recorded in meters. To eliminate negative co-ordinates, the projection alters the co-ordinate values at the origin. The value given to the central meridian is the false easting, and the value assigned to the Equator is the false northing. For locations in the Northern Hemisphere, the origin is assigned a false easting of 500,000, and a false northing of 0. For locations in the Southern Hemisphere, the origin is assigned a false easting of 500,000 and a false northing of 10,000,000.

Projecting your Basic Map

You will have to ensure the right projection for your maps, because otherwise you will have problems when you combine data later on from other sources, such as other maps or GPS data. If you purchase your Basic Map from a survey and mapping department make sure the digital data is projected. Very often digital data is provided with UTM co-ordinates, but without a projection. If this is the case, find out which original projection was used and replicate the projection in your map using conversion tools of e.g. ArcInfo or ArcView GIS. Please read the chapter on map projections in the handbook that comes with your GIS software carefully.

Figure 9: Projection in ArcView GIS

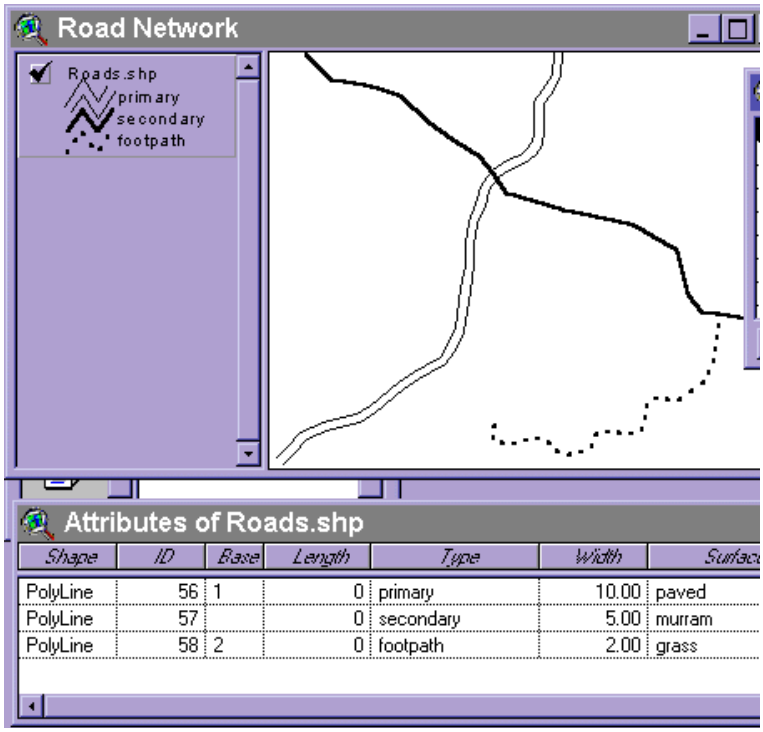


Features of your Basic Map

The Mapping Group will decide on which features are important and must be included in the Basic Map. As a rule of thumb, you should include all the features which are necessary for general orientation in the city: coastline, rivers, roads, landmarks, etc. Even a footpath in the outskirts of the city might be helpful, if there are no other features for orientation. On the other hand do not add too much information, because this might cover up your additional thematic information.

You have to distinguish between a Basic Map (which will be printed and put on the wall or used for reports) and the digital data for a Basic Map. Only some selected features will be used for a printed Basic Map, but of course you should digitise all features e.g. all roads onto one layer. To achieve this you have to add attribute information about the roads which you are digitising. The attribute table in Figure 10 shows several columns with information about the roads in your maps. The information about width, surface and condition can be used to prepare Thematic Maps (also refer to section B3.1 'Thematic Maps'). There is an additional column called 'Base' in the table. This refers to your Basic Map. All features with a number in this column will be shown the Basic Map. The different numbers indicate different line-symbols. In this case all the major roads will be shown, but in the outskirts of the city some footpaths will also be added for a better orientation in sparsely populated areas.

Figure 10: Basic Map layer with attribute data table and information window



Shape	ID	Base	Length	Type	Width	Surfac
PolyLine	56	1	0	primary	10.00	paved
PolyLine	57		0	secondary	5.00	murram
PolyLine	58	2	0	footpath	2.00	grass

The layout of your Basic Map

Another important thing to decide on now is the appearance of your maps. Most maps you produce and print should have the same appearance. Making sure that your maps have a consistent 'look' has several benefits. First of all people will recognise these maps as coming from the EMIS Unit. Secondly it helps you not to forget any cartographic element. Last but not least you will save quite some time, because you will not have to adjust your layout every time you prepare a map. In Figure 11 you see a typical map layout:

see Tool 8 - Creating a Basic Map

see Tool 9 - Standard Layout

To help you to keep track of your decisions for your Basic Maps, see Tool 8 'Creating a Basic Map'. On the CD-ROM you also find templates for a standard maps layout in ArcView GIS. You can adjust these templates to your needs by referring to Tool 9 'Standard Layout'.

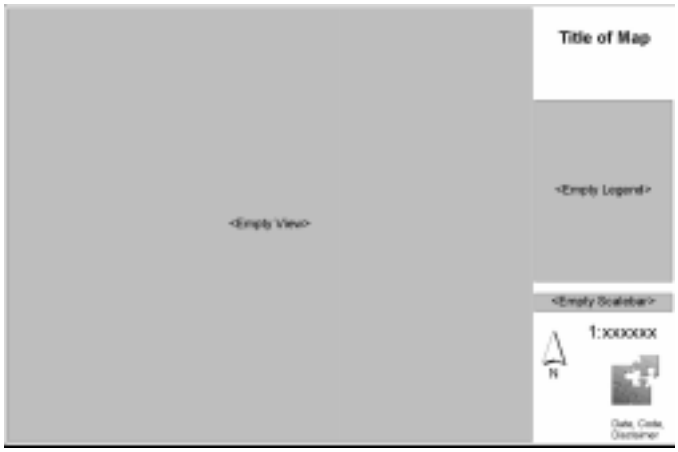


Figure 11: Typical map layout

B2.1 Creating a Basic Map using existing topographical maps

To create basic layers for your city, most of the time it is best initially to stick to existing topographical maps, even though some information might be outdated. These errors you can fix at a later stage (refer to section B2.2 'Updating a Basic Map with Images'). Once you have decided on the scale you will use you should acquire the topographical map sheets of your city, ideally on 'textile' or on film. Paper copies should be in perfect condition, not torn or folded. Just roll them for transporting them over short distances. But before you start digitising, check if you can get the maps already in digital format. It might seem more costly, but you will save quite some time.

If you decided to digitise the maps yourself, there are two ways to go about it:

- You can either use a digitising board, or
- you can scan your sheets and digitise on screen.

Of course there are advantages and disadvantages to both methods (some are listed in Figure 12). The choice you make depends mostly on the equipment you have available.

Digitising using a board

To use a topographical map sheet directly on your digitising board or screen will be confusing. After two hours of digitising you may encounter difficulties in distinguishing clearly between contour lines, roads, rivers, utility lines and administrative boundaries, and the possibility of digitising errors increases. Therefore, you have to separate the different features by tracing them. For each layer you prepare a new sheet – again best using film – showing only the features you need for that layer e.g. all rivers and streams or all streets. Marking your features according to the type e.g. all major rivers are marked with 1, all perennial rivers get a 2 and the seasonal rivers a 3 and so on, will ease the step of attaching attribute data to your drawings. Once you have prepared your sheet you put it on the digitising board using masking tape. You select at least four geographic reference points (which should be the same for all layers) for registering the map with the respective geographic co-ordinates. For registering your map you have to refer to the handbook of your GIS software.

Now you can start digitising. Tool 10 'Digitising with a Digitising Board', gives instructions for digitising using ArcView GIS.

see Tool 10 - Digitising with a Digitising Board

Onscreen digitising

To digitise onscreen you first have to scan the map sheets with a resolution of at least 150 dpi (dots per inch), or, even better, 300 dpi. You can easily use an A4 or A3 scanner, and scan the maps in several sections. The next step is to attach geographical co-ordinates to your scanned maps. You open the scanned map with your GIS software and select the tool for geographically referencing maps. Usually, you will select at least three points on your map to which you attach the correct geographical co-ordinates. The image will be adjusted according to the correct geographic co-ordinates. Map Maker provides an additional tool, Rubber Map, which allows a basic rectification of your scanned images in order to fit them together with your existing layers.

This procedure depends on the GIS software: with certain GIS software this procedure may be more difficult than it sounds, and errors, such as shifting of the co-ordinates, can occur. The Mapping Group will have to decide whether the errors are within the

Figure 12: Advantages and disadvantages of different methods of digitising

	PROS	CONS
DIGITISING BOARD	• Allows highly accurate digitising • You can place the entire map sheet on the board for a better overview	• You need expensive equipment and space • You always have to cross-check between the digitising board & screen • Takes more time to prepare • With some GIS software the set-up of a digitising board is difficult or even impossible
ON-SCREEN DIGITISING	• Allows fast digitising and the production of "quick & dirty" maps • You see your output immediately	• You need a lot of RAM, because the scanned files are extremely large • Scanning can distort information • It requires more effort to geographically reference the map

acceptable limits or whether other digitising tools, such as using a digitising board, have to be used. Please note: A perfect map is not always the most useful map. If a perfect map comes too late for a decision on a certain issue, it is useless.

see Tool 11 - Digitising with Scanned Maps

After preparations you can start to trace the features for each layer. For the specific steps, please refer to Tool 11 'Digitising with Scanned Maps'.

It has already been mentioned that it is important to keep track of additional information. If you have for example digitised all the rivers in your city, all you can see on your screen are connected lines. This is called the 'geometry'. To make sure all users will recognise these lines as rivers you have to add this information to a database table that is connected to your geometry. This is called attribute data (see also Figure 10 'Basic Map layer with attribute data table and information window').

There are two reasons for adding attribute data. First, you have to be able to query your data. If you click on a geometry line on your screen you should be able to read all information on this specific river in a pop-up window.

The second reason for adding attribute data is to be able to prepare attractive maps with different line symbols for different types of rivers (see picture above). For more information on this, please read section B3.1 'Mapping facts: Thematic Map'.

see Tool 5 - Purchasing Maps

see Tool 12 - Data Conversion

Depending on the size of your city or town you probably have to use several sheets of topographical maps. If you create, for example, six layers for each of the sheets, you have to digitise quite a large number of maps. As you can imagine, this will take quite some time and effort, especially if you are working on your own. In a smaller municipality things will be different. The whole area will probably be covered by one topographical map sheet. If you decide to outsource the task of digitising to an institution or to a private company, you have to follow the progress of digitising closely to make sure you get the expected output. In the annex you find an example of a consultancy contract (Tool 5 'Purchasing Maps').

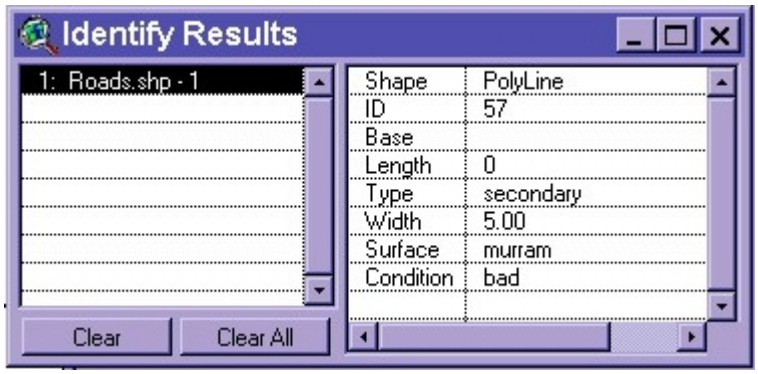


Figure 13: Information Pop-up window (ArcView GIS)

As mentioned before, you may be lucky enough to find that somebody else already has done the basic digitising exercise. However, this data probably needs refining and processing. Mapping and Survey Departments usually store the digital data in an AutoCad like digital exchange format (dxf). The different layers are separated by colours (as they are used for printing plates in order to produce topographic maps) rather than by theme, so you need to separate these layers. The data has to be transferred to another digital format suitable for your GIS software. For these tasks refer to Tool 12 'Data Conversion'.

B2.2 Updating a Basic Map with Images

Using 'imagery' in a EMIS has a broad range of application. Some references of these applications are made in section C2. In EMIS, imagery is mainly used for updating your maps. Using images allows you to add recently built-up areas, roads or the change in a river's course.

Two different types of images are used for this task. **Aerial photographs** are taken by planes flying at a specific height. From aerial photographs you will get very detailed pictures in a high resolution. A single aerial photograph is inexpensive, but you might need quite a lot of them to cover your city. In many places, aerial photographs are out-dated and the municipality does not have the resources to arrange for taking and

processing their own aerial photographs. **Satellite images** can be a cheaper solution. Satellite images are taken from earth-orbital satellites. One 'scene' will normally cover a whole city. It is very useful to purchase satellite images on a regular basis every few years. This means that you can update your maps regularly and also that you can use the satellite images to detect changes. To process satellite data you should consult an expert, or, better still, purchase imagery customised according to your specifications, which you provide when you order the images. Up till recently, the two major satellites for imagery were SPOT and LANDSAT TM. During last few years, however, the availability of satellite images from different sources has increased. Very suitable for urban management purpose are images from SPOT and ICONOS. Finding the right image for your city may take some time. In Tool 13 'Purchasing Images', you will find some addresses to start looking. Most images can be ordered using the Web, but you can also write to the companies. Today, a single satellite image (covering up to 500 sqkm) costs around 5,000 US Dollars.

see Tool 13 - Purchasing Images

Kibera, Nairobi

You can use satellite images and aerial photographs in a similar way to scanned topographical maps. It is possible to purchase a satellite image which is already geo-processed. If you don't get geo-processed images, you have to identify accurate locations to adjust your image to known co-ordinates. On a topographical map you find points marked around the map itself, which refer to the co-ordinates used. With images this is different. You have to identify suitable spots on the image such as road crossings, specific buildings, airports etc. These spots should be locations that will not change in the near future, which are easily to locate on the satellite image and whose co-ordinates are available on a topographical map. After georeferencing your images you can add new streets to your street layer, define the build-up area in your city and even distinguish between different types of settlements. You can also use former digitised layers to adjust your images. However, you have to take into account that georeferencing a picture has its drawbacks. The picture might be distorted and not match entirely with your digital maps. For more specific instructions refer to your GIS software handbook.

B3

Applying mapping to analysis of environmental issues

The Issue-Specific Working Groups gather a large amount of information about the environmental issue they are dealing with. Using maps can help them to come to a better understanding of the issue. Maps can clearly indicate areas where the situation for a particular environmental issue is hazardous. Analysing maps which show the development activities of the city can help to identify the activities causing or affecting the issue. With all these maps at hand, the working group can specify which areas are the best location to start improving the environmental situation in the city.

EMIS and the Environmental Profile

The establishment of an EMIS and the preparation of the Environmental Profile take place (ideally) at the same time. The EMIS can provide maps to illustrate the EP and make visible the current environmental and development situation and problems. On the other hand the EP provides a great deal of factual information for the EMIS. If you refer to the SCP Source Book Series: Volume 1; Preparing the SCP Environmental Profile; pg 28, a typical outline for an EP is given.

Generally the four main chapters of the EP can be illustrated with maps. Basic maps are used in the introduction to give an idea of the general city setting. Chapter 2 deals with development activities, and their location can be shown in maps. Their interaction can provide some ideas about the growth pattern of the city. In Chapter 3 maps can be used to illustrate the natural setting of the city, highlighting natural resources and hazards. Even Chapter 4, which talks about the main actors in the urban management, can be illustrated by maps e.g. showing the location of community based organisations (CBOs). In fact, a map can be prepared for each subchapter. This sounds like a lot of work, but it means that you build an initial library of Thematic Maps for the EMIS and the working group process which follows.

An interesting example of an Environmental Profile which uses maps is the "Environmental Profile of Zanzibar Municipality". The EP is 80 pages long and includes 21 maps. All maps are printed on one A4 page either in scale 1:100000 or 1:15000. The whole EP is printed in black and white, so that it can be copied. Therefore the maps are also in black and white, and use patterns to distinguish the different areas. The Basic Maps shows the settlement pattern and the different administrative boundaries. The Thematic Maps include topics such as population density, city expansion, tourist attractions, trade activities, fishing, the transport network, road conditions, drainage and sewer systems, the sanitary situation, waste collection points and open spaces. Regarding natural resources and hazards, there are maps showing marine resources, water distribution, landuse and flood-prone areas.

Wuhan, China

B3.1 Mapping facts: Thematic Maps

In general a thematic map is defined as a map focusing on one specific topic, rather than simply representing the earth's surface. Unlike a topographical map, a thematic map shows issues such as traffic or population density. In the EMIS, thematic maps are divided in two types: Thematic Maps and Suitability or Sensitivity Maps. Thematic Maps in the EMIS show only facts, while Suitability or Sensitivity Maps show evaluated information or policy rules and conditions. During the Working Group process this separation of map types is useful to distinguish the decisions and evaluations of the Working Group from facts derived from other sources. It is useful to clearly identify policy options.

Just to give you a feeling what Thematic Maps can be about, they can cover topics such as the amount of waste generated in different communities, the height of water level in metres beneath the ground, soil eroded each year in centimetres, types of crops planted 1997, city land use, population density per district, and so on (you should also refer to Tool 14 'Standard Set of Thematic Maps').

see Tool 14 - Standard Set of Thematic Maps

Thematic Maps are built on existing maps, existing data, research and fieldwork. Thematic Maps already exist in many government departments and research institutions, for example, geology maps or soil maps. Remember that factual information is often mixed with policy information in these maps. You will have to separate the relevant information and features from these maps and digitise them into new thematic layers.

Where to find data for Thematic Maps

Often, huge amounts of digital data is stored in centrally located database servers. These data are often collected through and refer to monitoring activities, such as air quality monitoring stations, cadastral information, or utility management. Other socio-economic data are collected and stored in statistical institutions. This data is often related to existing administrative boundaries (districts, wards, arrondissmonts, etc.) and can easily be linked to the basic administrative boundary layer in your system. Remember that administrative boundaries only have to be digitised once. Afterwards you can prepare several Thematic Maps by linking this layer to the relevant database or spreadsheet. The attribute data of the administrative areas and the information from the database server require a matching column each. The information in these columns must match, either using names for areas or districts or special codes for them. This is normally either an ID or the name of the feature (a ward, a street, or a river). Just make sure that both columns are defined identically, either being Integer or Text.

If you use text columns, the names should be spelled correctly. How to connect a database or spreadsheet with a map is explained in Tool 15 'Attribute Data'.

see Tool 15 - Attribute Data

Information for a Thematic Map can also be drawn from an Issue-Specific Working Group. A great deal of 'common sense' information can be gathered just by querying the Working Group members, who are experts in that particular environmental issue in the city. As explained earlier, it is more important for the EMIS to have some information than no information. This Handbook encourages you to include non-scientific information in the EMIS; information derived by rule of thumb. Of course you always have to mention this source in your inventory database and also, which is even more important, on the printed map. If there is some lack of information, always try to gather it in close co-operation with the Issue-Specific Working Group.

If, however, the Working Group does not agree on borders between different areas, it can be necessary to go and check in the field. This kind of fieldwork must be done carefully, to ensure that the results can be used in the EMIS. To make sure the information gathered can be translated into maps, some preparation is needed (see also Tool 22 'Overlaying Maps'):

see Tool 22- Overlaying Maps

- The EMIS unit prepares 'working maps' to trace and update the findings in the field. The 'working map' will have clearly indicated the specific survey areas and allocates the individual surveying teams accordingly. This way it will be much easier to add this information into the system.
- The data types to be collected should be defined in advance. The best way is to prepare a model spreadsheet and print out some sheets for the researchers to fill in. This way the data will be consistent, and you will only have to type in the information later on.
- A Global Positioning System (GPS) is useful, especially in remote areas. The researchers can keep track of their position while collecting data.

To co-ordinate the work of data collection you will probably have to call at least three meetings with the Working Group members who will collect the data. The first one will take place to find out which area the research will cover, what kind of data will be collected, and so on. The agenda of the second meeting is to hand over the research maps and sheets and to explain how to use a GPS. For complex surveys you should

What is a Global Positioning System (GPS)?

A GPS is a satellite navigation system. Today, 24 satellites orbit the earth and send back radio signals. A GPS receiver captures these signals. The signals are recalculated and translated into position and time. Since the 'Selective Availability' has been lifted (since May 2000) your position can be calculated with 99% accuracy (the differential GPS is not anymore necessary). To calculate your position you need to connect to at least four satellites, and thereafter, each additional satellite will improve your accuracy. Your position is usually provided in geodetic datum (longitude/ latitude), but most receivers will give you the possibility of seeing your position in other projection formats. Be careful though - position offsets of several hundred meters can result from using the wrong datum (see also Map Projections). Source: Dana, P.H. (1999): http://wwwhost.cc.utexas.edu/ftp/pub/grg/grcraft/notes/gps/gps.html

consider a test survey and adjust the questionnaires according to the problems encountered. The last meeting will take place after the research to discuss the findings and to note any unexpected problems in data acquisition. Obviously, this type of data collection requires resources in terms of time, transport, and even fees. Therefore it is important to budget for this kind of activity well in advance.

We distinguish four types of active search for specific information:

1. 'Hunting': inquire about particular information of interest (e.g. water quality study of a particular lake).
2. 'Fishing': ask what other information they have related to any of the specific issues or topics of concern (e.g. on water quality in general).

These first two could be called the elements of the active, specific search, i.e. the contact is made for these purposes. In this context, one should not take anything for granted, but try to physically see what exists (e.g. the allegedly 'complete' file of industrial polluters may in fact only contain an odd, outdated notice). The following two elements can be called passive, incidental search, which would not justify a visit per se but might by chance turn up something worth pursuing.

3. 'Extending the chain': asking if they know of or could suggest anybody else worth contacting about the issues or topics raise.
4. 'Widening the net': asking about what the organisation has done, is doing or is planning to do in general and/or in the area of concern (the city).

see Tool 16 - Preparing Thematic Maps

Once the information has been collected and put into the system, you can select from a number of different ways to prepare a Thematic Map, depending on the type of data you have (there is a step by step description in Tool 16 'Preparing Thematic Maps'):

- Symbols: The simplest way to display thematic information in a map is by using descriptive symbols, showing waste collection points, mining pits, ground water wells, museums, hotels, and so on. This provides useful basic information. In an EMIS, those points also need to be converted into areas of extent (e.g. the accessibility of waste collection points, etc.)
- Codes: Certain areas or polygons in your map show different types of a topic representing unique values. Typical examples of this kind of Thematic Maps are landuse maps, vegetation maps, soil maps or geological maps.
- Classes: Certain areas or polygons in your map show a numerical figure for each area. The data is represented in classes using specific graduated ranges. Typical maps of this sort are population density maps, traffic flow maps, chemical contents in water, air and soil, etc. Most of the Suitability and Sensitivity Maps represent classes.

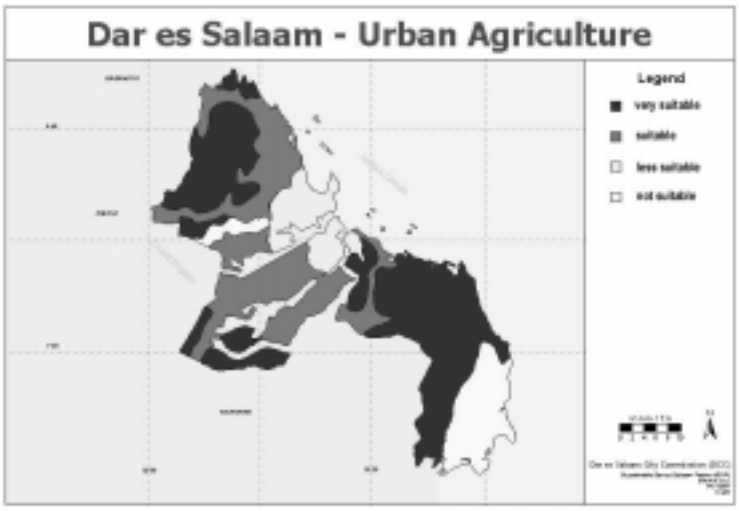
- Charts: These maps show complex information such as changes over time or different chemical concentrations in water or air.

A typical Thematic Map, which will probably be prepared in every EMIS, shows city expansion over a period of time. This map can be used for further analysis. You can examine why the city expanded in the directions it did. Analysing the growth pattern together with a map showing hazards or other environmental situations, will show some areas will where further expansion is unsuitable or even dangerous, and other parts where it is safe.

B3.2 Mapping policies: Suitability Maps and Sensitivity Maps

In an EMIS, factual data should be strictly separated from policy information. To prepare a policy map you have to interpret factual data, evaluate your findings and come to a conclusion about conditions in different areas. Then rules and decisions about regulations for these areas according to the situation there have to be added.

For development issues, policy maps are called **Suitability Maps**. A Suitability Map might show areas which are highly, moderately, less or not suitable for a development activity such as agriculture. For environmental issues these maps are called **Sensitivity Maps**. They show areas which are highly, moderately, less and not sensitive to an environmental issue, such as erosion. Policy maps can also show existing regulations and rules such as minimum distance for housing areas from dumpsites or water reserves. The suitable or sensitive areas will be given ranking numbers according to the level of the rule or condition for each area. The more suitable an area is for development or the more environmentally sensitive it is, the higher the number.



Dar es Salaam, Tanzania

The buffer function of your EMIS software is useful when creating policy maps. Many bylaws exist which refer to required distances to features such as points or lines. With the buffer function you can create maps showing these restricted areas. For example: A bylaw exists prohibiting building underneath a power line. If you have created a map showing all the power lines you can create buffers around these lines which show the restricted building areas.

In an EMIS, preparing Suitability or Sensitivity Maps is an even more important activity of the Working Group process than the preparation of Thematic Maps. Suitability and Sensitivity Maps synthesise the results of a Working Group process on a specific environmental issue in the form of a map. Developing and applying rules and conditions to the different areas on maps will support the Issue-Specific Working Groups to develop issue specific strategies and 'bankable' investment projects. To get

Factual Thematic Maps and Policy Thematic Maps in brief

Air quality Monitoring Stations measure the concentration of various chemicals in the surrounding air (e.g. 150 µ SO per cubic metre air). The factual Thematic Map will show areas with ranges of, for example 0-49 µ/m3, 50-99µ/m3, 100-149 µ/m3 and 150 and above µ/m3. This map does not show 'pollution' yet. A pollution map, which is an environmental Sensitivity Map, is the interpretation of the factual Thematic Map. For example, the chemical concentration can be compared to international or national standards. If a concentration exceeds a certain value, then we call it 'polluted'. If there are no official standards or rules, the issue specific working group will have to come up with standards, e.g. acceptable levels of air pollution.

the right data for your Suitability and Sensitivity Maps you have to work closely with the Issue-Specific Working Groups. They will provide you with essential information about existing rules, conditions and laws. Using a light table will be the easiest way to create and discuss Suitability and Sensitivity Maps. Prepare printouts of all the Thematic Maps related to a specific topic, and the Working Group can trace the different areas by overlaying the relevant maps on the light table.

see Tools 19 and 20 - Preparing a Sutability map, Preparing a Sensitivity Map

To create Suitability and Sensitivity Maps a few things should be kept in mind.

- Decide on the number of ranks (e.g. four types of areas like highly, moderately, less and not suitable) and the intervals according to importance (e.g. 1 = good, 2 = moderate, 3 = less, 4 = not suitable or 1 = good, 3 = moderate, 5 = less, 7 = not suitable). Please refer to the text box on ranking and hotspots in section B4.3 and to Tools 19 and 20 on preparing Suitability and Sensitivity Maps.
- Keep to the one mapping rationale: always use the same pattern or level of brightness for the same type of areas across all issues (highly suitable or sensitive areas use a dark pattern, and areas not suitable or not sensitive use the lightest pattern), this makes overlaying easier.
- Even though there may be several areas which are less suitable for agriculture, the reasons for these areas to be less suitable are different. So therefore the attached rules and conditions are also different; make this clear in your database.

Map 1 Soils Stability	Map 2 Catchment Areas Water Supply	Map 3 Agriculture	Map 4 Air Pollution
	in floodplain near intake		exceeding standards x times
	in floodplain	very suitable	
serious constraint		suitable	above acceptable standards
soils constraint	in critical catchment		below acceptable standards
		less suitable	
no constraint	outside catchment	not suitable	no pollution

Ranks	
Values	Symbols
5	
4	
3	
2	
1	
0	

Figure 14: Ranking

If you haven't done so yet, it is high time to consolidate the Working Group results in a concise database. The various rules and conditions are mostly documented either using word processing software or by keeping them in a memo field in your database. For example, in MS Access the field type Memo can store up to 64,000 letters. This is equal to 16 pages of text. You need to apply an ID coding to connect the data with your map. This ID number will allow you to link the different areas to the rules and conditions agreed upon by the working group. How to connect your map to this database is explained in Tool 15 'Attribute Data'. After you have linked the map to the database, clicking on an area on the map will show all information related to it.

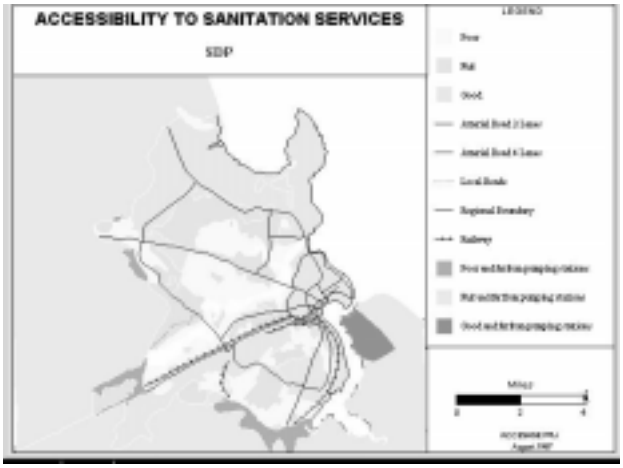
see Tool 15 - Atribute Data

How to create a Suitability Map

A Working Group on water quality in the rivers and lakes of the city uses some of the following Thematic Maps: watercourses and lakes, sanitation situation, solid waste situation, built up areas, landuse, agricultural areas, drinking water availability, chemical elements in a water body. With these maps the current situation regarding water quality can be captured and evaluated. The Working Group discussions on these maps is a way to find out if your information is valid. The Working Group members also provide information about existing rules and standards and create new maps showing river pollution, water reserves with restricted landuse or areas along the rivers which have to be kept free from buildings. To ensure a participatory way of map development, the overlays of the various maps are best done on a light table. This way you find conflicting uses of the water network, can trace sources for water pollution, and see hazardous areas. They trace the different areas, looking for areas with similar situations. Then they will discuss what has to be changed in these areas to improve the situation of the rivers and lakes, or which uses can be allowed which use existing environmental resources sustainably. During this discussion, the Working Group members can also decide where to start demonstration projects, bearing their decision both on the degree to which the situation is threatening and on the level of support from inhabitants and community based organisations. This process leads to the preparation of action plans (see also B4.4 'Further use of the system: Maps for demonstration-replication').

A special type of a Suitability Map is a Service Delivery Map (see Tool 21 'Preparing a Service Delivery Map'). This map combines Thematic Maps such as infrastructure maps with power lines, sewerage system, water pipes and waste collection system, with the Suitability Maps for accessibility, sanitation, and drinking water. This combined map therefore shows the overall situation of infrastructure and services in the city.

see Tool 21 - preparing a Service Delivery Map



Dar es Salaam, Tanzania

Important note: you need to check with the Working Group representative of the particular utility department or company regarding their own 'utility master plan' in terms of a particular utility extension or improvement. This information will be crucial for developing strategies for possible areas of city expansion.

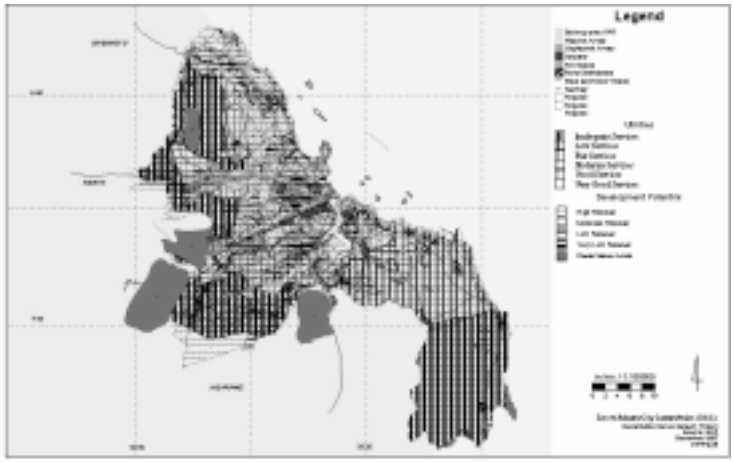
B4
Applying mapping to decision making: Outputs through overlaying

An overlay is – to describe it simply – putting two sheets of paper with different maps on top of each other, analysing the interaction of the features and summarising the ranks from the individual Suitability or Sensitivity Maps. This is exactly the way overlays were done before digital mapping existed. It is still a good idea to do overlays manually if you want to involve all the relevant stakeholders in this exercise: you prepare printouts of the maps and everyone gathers around a light-table; overlaying the maps and discussing the outcomes. The results can be traced on a new sheet and can even be digitised again. The same participatory principle must be applied when you use the computer for the overlays. The GIS software packages provide you with tools for overlays. Please see also Tool 22 for a further description. Certain overlay functions are quite powerful and several layers can be easily combined into one new layer with all the information from the overlaid layers. The map will probably look very scattered but you will be able to query one map to get all the necessary information about a specific site.

see Tool 22 - Overlaying Maps

An overlay only makes sense if you use the right layers for it. The Mapping Group will help in the decision. Only use polygon or area maps to overlay. Of course you can also overlay line or point features, but you will not be able to intersect other polygons with points and lines in order to get new polygons with certain characteristics. For an example refer to Tool 22. The procedure of overlaying maps results into the main outputs of the EMIS.

The outputs of an EMIS will differ from city to city according to their focus - area-wide or area-specific, issue specific or more comprehensive. Therefore this chapter should be read carefully, and the descriptions taken as examples. You have to relate the different analysis tools of the EMIS to your own database. If your EMIS focuses mainly on specific areas or covers only some environmental issues, the outputs proposed in this Handbook are less. It is, for example, not relevant for every city to prepare, for example, a city-wide Environmental Management Framework.



Dar es Salaam, Tanzania

The EMIS, containing a great deal of data and information, is now powerful enough to provide multifaceted answers to complex questions. At the same time, it will be able to provide decision-makers with 'simple' maps, so that they can defend their strategies and proposals by convincing the constituency with crisp and clear arguments. In order to provide maps for both demands, the system calls upon the professional cartographic skills of the EMIS Officer to "tailor" and simplify complexity to produce clear and readable outputs. A highly sophisticated map which tries to give the ultimate answers to problems is useless if it is not easily understood. Remember that the Mapping Group plays an important role in advising on the readability of a map.

To answer more complicated questions, the EMIS uses your GIS software to provide you with a number of sophisticated spatial analysing tools. Some of them you have already used for preparing Thematic Maps (e.g. querying the tables and buffering features). Other tools of the GIS will help you to split areas, make complex queries and overlay maps. But before you start to use any of these tools you should analyse the type of problem you wish to address. Decide which data you need to answer the questions related to the problem and define the steps you will take.

Possible queries

- Example 1: An investor has bought a plot and wants to build a car repair centre. What consequences can be expected?
- Example 2: The city needs to build a sewage treatment plant. Where is the best site?
- Example 3: Data on population growth shows that new housing estates are needed. What areas of the city are available for expansion or densification?

B4.1 Project Design and investment at a specific site

This is the easiest type of querying an overlay map. After you have overlaid several Suitability and Sensitivity Maps, all you have to do is to query the site or area for which you plan an investment. The table of information will show you the links to all the rules and conditions for the different environmental and development issues. The next step is to prepare a report listing all these regulations and make to suggestions for the best use for this plot.

If a project document for the use of this site already exists the information gathered can be used to refine the project design according to the findings. In a later stage, when you have built up a more comprehensive database, it will even be possible to estimate the costs of different investments at this specific site. The report will help decision-makers to present well-prepared proposals to interested investors. Based on the report the investor can decide on the type of his investment, and whether it might be better to change the design of the project in order to avoid additional external costs.

B4.2 Site Selection

This type of querying an overlay map requires some consideration in advance. This is best explained with an example: Your task could be to find a site suitable for a sewage plant. To answer this question you have to go through different steps.

What are the rules for a site suitable for a sewage plant?

- Downwind from a settlement in order to minimise negative effects (smell) on residents;
- Near to the built-up area in order to reduce infrastructure costs;

- Good access by road for supply and maintenance;
- Low environmental sensitivity of the soil and geology in order to protect the groundwater table;
- 'Downhill' in order to reduce the need for pumping stations.

What kind of data do you therefore need?

- Built-up area and buffered map for distance;
- Service Delivery Map (accessibility areas of the utility system);
- Landuse map for determining conflicting areas;
- Sensitivity Maps on ground water table, soil, geology and terrain;
- Contour line map

How do you query your overlay of these maps?

- Select all areas with low ground water table and least sensitive areas in terms of soil and geology;
- From these areas select all areas in low terrain;
- From these areas select all areas with high or moderate access to roads
- From these search areas downwind from housing areas
- From these, select sites in areas with no sewage treatment system, and there you are!

You will find several sites matching this query. Not all of them are available. The ones available have different obstacles. Your last step will be to prepare a report on the different sites, explaining their advantages and disadvantages, and the level of restrictions which will affect the cost of building a sewage plant there. Once given these sound technical arguments, it is now up to the decision-makers to choose a site.

B4.3 Development Pattern, Environmental Management Framework and Zoning

The main focus of the EMIS, as said earlier, is to synthesise outcomes from the Issue-Specific Working Groups into a database structure and to provide relevant maps in order to support the EPM process. Therefore the outputs expected from the EMIS will differ as the EPM process differs in every city. Consequently, this handbook does not provide a standard set of EMIS outputs but provides you with some synthesised lessons of experiences from cities applying the EMIS. Your EMIS will be focused and adjusted to the expectation of those who take part in the EPM process and city management. Remember that the EMIS does not aim to be comprehensive, but connective.

The simplest analysis of the overlays is a city-wide landuse pattern of the existing uses and their impact on the environment. This map will give you a good overview of the status quo at a fixed time. It is the basis for a framework for managing your city's environment-development interaction.

Many city administration planning departments have an office concerned with 'forward-planning'. Traditionally, forward-planning has been done using a master planning approach. Nowadays, however, the drawbacks of the master planning approach have led to new developments in planning practices, such as Strategic Development Plans, 'Open Planning' and other concepts. The Environmental Management Framework (EMF), one output of the EMIS, is an alternative to traditional planning approaches. The participatory nature of the EMIS gives the EMF a strongly participatory character and therefore builds a high sense of ownership among the stakeholders.

If you decide to develop a city-wide EMF, you have to make sure that your data and maps cover the entire city area, and that at the same time they cover a broad number of environmental and development issues. Before you feel overwhelmed by the amount of the work to be done and the complexity of the preparation, please check whether an

The Drawbacks of a Master Plan

Although a master plan can provide a useful spatial framework for guiding the future growth and development of a city, its implementation is easily frustrated and limited by a number of issues. These include:

- its seemingly comprehensive nature, which results in idealistic but unaffordable infrastructure, social services and development proposals, often with no clear relation between planning, implementation options and resource availability;
- its control orientation, with rigid standards and conditions which are very difficult to enforce in a context of rapid urbanisation;
- its sectoral approach to development issues, which concentrates on land use activities and thereby undermines the need to strengthen management capacity through cross-sectoral co-ordinating arrangements;
- its almost invariable dependence on expatriate preparation with limited national and local participation, thereby reducing the understanding of local conditions and lessening the commitment to implementation by the key agencies involved;
- its limited strategic focus on operationalisation and implementation of its various proposals; and
- its indifferent attention to environmental issues and the need for sustainable utilisation of natural resources and management of hazard-prone lands.

EMF is needed, supported and will be implemented later. Otherwise it is not worth spending time on it. Some SCP partner cities, such as Wuhan and Shenyang in China, focus on a few carefully chosen environmental issues, such as air quality management. Other cities, among them Dar es Salaam, have decided on city-wide strategies for a variety of issues. Dar es Salaam has prepared an EMF, called the 'Strategic Urban Development Plan', which substitutes for the traditional master plan.

The local EPM Unit is the main driving force for the management and co-ordination of the preparation of the EMF. The Mapping Group has a strong advisory role. It is important to regularly inform key decision-makers, such as the director of the planning department and the city executive, on the progress of the EMF. With their commitment and their constructive inputs the EMF will become a powerful decision-making tool.

The EMF can be used to compile all the strategies and investment opportunities drawn up by the Issue-Specific Working Groups. Working Group findings can be compared, and contradicting strategies can be adjusted. Finally, a broad strategy for city growth and expansion can be developed.

An Environmental Management Framework (EMF) has three major parts: (a) spatial analysis; (b) projects and investment requirements; and (c) a management framework for effective implementation of strategies.

(a) The **spatial component** refers to the geographic interpretation and aggregation of strategies. By mapping and overlaying the geographic distribution of critical natural resources, areas can be classified by their degree of exposure to environmental risks and ranked by their sensitivities to particular development activities. This ranking of areas allows the determination of which development activities are compatible with specific areas and, additionally, supports the articulation of rules and principles applicable to the development taking place in the different areas. Such rules and principles do not necessarily exclude certain areas from development, but they do enable the incorporation of the necessary long-term costs in investment decisions.

The spatial analysis part of the EMF allows potential development areas for city expansion and growth to be determined and prioritised. The selection of areas for future urban expansion will be the result of the interaction between push factors (growth deterring), the pull factors (growth stimulating) and the environmental sensitivities prevailing in the different areas of the city. The exercise results in the selection of areas with least foregone opportunities, with benign environmental

risks, with a higher carrying capacity, with least infrastructure development cost and with high economic efficiency.

(b) The section on **projects and investment requirements** includes the list of priority investment projects, with brief descriptions or profiles attached, and their estimated costs, including an estimation of investments required to up-scale successful demonstration projects. It also includes the list of potential sources of investment, and strategies for mobilising resources.

(c) As an aggregation of issue-specific strategies negotiated by the stakeholders concerned, the EMF provides a broad **management framework** which builds on the experience and achievements gained in creating a better understanding of issues, in co-ordinating implementation, and in establishing stronger linkages and connectivity between the different sectors and stakeholders. Based on this, the preparation of the EMF will be used:

- to summarise the roles of the major stakeholders in implementing the proposed strategies;
- to highlight co-ordination and implementation mechanisms that have been tested and proven to work effectively; and
- to synthesise the lessons of experience gained and principles developed through the implementation of demonstration projects, and from there, to develop a management framework and strategies which allow further consolidation and up-scaling.

Using Ranking to identify Hotspots

The higher the ranking value in an overlay is, the higher the competition is for development activities on that spot. We call these areas 'hotspots'. It is necessary to sort out overlapping, conflicting strategies and competing issues in order to find the most optimal pattern of development and to reconcile the strategies pertaining to the different issues. This can be done through overlaying the relevant strategy maps of the different issues. For example, the land determined as most suitable for urban agriculture may fall on the land determined as most suitable for mining, making further prioritisation of activities necessary. Or some of the land suitable for urban agriculture may overlap with hazardous land, making it necessary to qualify the type of agricultural practices permissible in such areas. To make the exercise straightforward and to get a sensible result out of it, the overlaying should proceed step-by-step, overlaying no more than two topics at a time, and should be confined to the issues and strategies whose combined interpretation is required to project an overall growth pattern. This step is best done on a light table, so that everybody involved in the negotiations can take part. The results can later be transferred back to digital format.

From this exercise, area-specific rules and principles for each 'hotspot' will evolve. Addressing the 'hotspots' and resolving conflicting strategies requires an in-depth analysis of area-specific rules and principles. Strategies that were meant for a specific issue and area may need to be modified or modulated through a series of rules and development conditions to ensure the compatibility of different development activities in the different geographic areas. Overlaying a sewage network development strategy map over a ground water management strategy map may for example, highlight areas characterised by a lack of sewage network and a high water table. Such areas need further prioritisation in sewage network development and to specify the type of sewage technologies which are appropriate for such areas.

After all these maps have been overlaid, the results will be aggregated into one map. This is like overlaying the overlaid maps, including key service delivery maps, so as to generate an aggregate picture of suitability or development priority areas. In a situation where many variables or spatial attributes are involved in determining such an overall suitability map, it might be necessary to attach weight to each of the attributes on a given scale, so as to allow the generation of a composite. Areas with many rules or conflicting issues will pose many constraints to development and rank lowest among the potential development areas and vice versa.

As maps capturing different issues and strategies are overlaid on each other, areas where conflicts are sharp, or where actions to remedy environmental damages are needed, will come into sharp focus immediately. These are the 'hotspots', which need to be addressed through immediate action plans and investment projects.

The aggregated map can also be used for preparing different scenario maps, focusing on different political aims such as, for example, what are the development opportunities if all the environmentally sensitive areas are protected? Or, what if new housing estates are needed, but densification has priority to prevent further spreading of the city? These maps can evolve into **Zoning Plans**, but should not be promoted as final solutions (remember, the EMIS is an open-ended system). They can help to clarify the impact of different policy and strategy decisions.

see Tools 19 and 20 - Preparing a Suitability Map, Preparing a Sensitivity Map

see Tool 23 - Environmental Management Frameworks

Technically, the EMF is an aggregate of relevant Suitability and Sensitivity Maps and makes intensive use of the ranking mechanism (see Tools 19 and 20 on preparing Suitability and Sensitivity Maps'). Tool 23 'Environmental Management Frameworks' will give you examples of how environmental management frameworks have been developed in other cities.

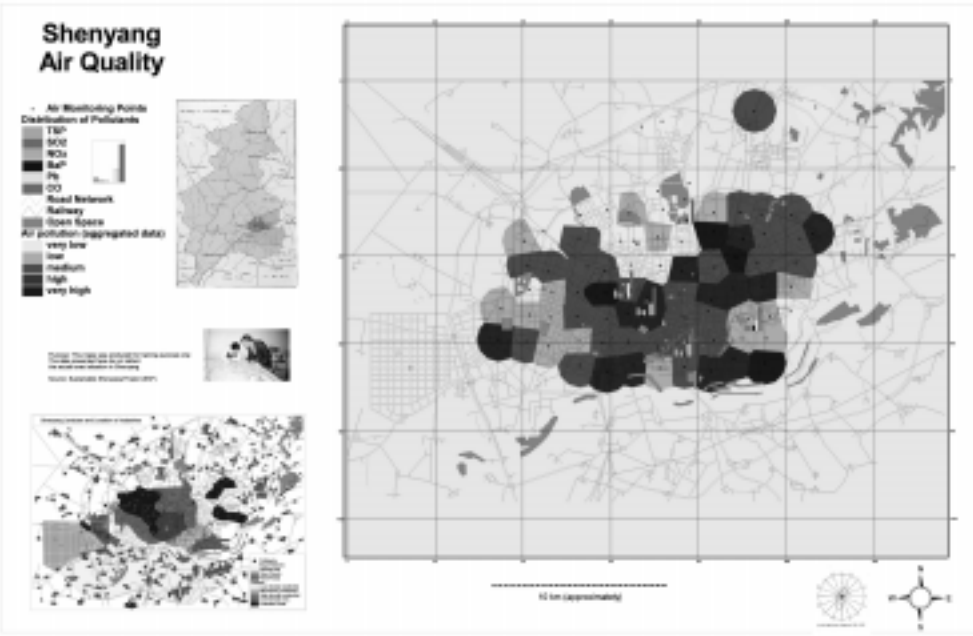
B4.4 Further use of the system: Maps for demonstration-replication

Once the 'hotspots' are identified, action is needed. The Issue-Specific Working Groups will discuss the strategies for a bankable investment project. Demonstration projects to improve the environmental situation at this 'hotspot' will be planned. The EMIS will be able to present a number 'hotspots' with similar characteristics. The Working Group's aim is to start a demonstration project on a site where it will have the optimum impact at minimum cost. The EMIS will help you to identify this particular site. It also identifies similar sites for replication of the demonstration project.

This might also be the right time for a change of scale in your system. Up to now you have probably used a scale of 1:25000 or 1:50000. If you have started to prepare the first action plans, the scale you had to use was 1:1000 or 1:2500. You can build on these first maps in this latter scale to add more and more maps in this scale. This, over time, can link into a type of Land Information System, storing data on plots and houses (if this is not already done by a different department). Such detailed maps will show clearly the existing situation, and you can simulate the situation as it will look after the demonstration project has been implemented. The maps will also help to describe the necessary steps to implement the strategy.

Some examples for typical action plans are:

Figure 15: Poster showing the Air Quality situation in Shenyang



- Network of new solid waste collection chambers;
- River Basin Action Plan - How to improve polluted rivers;
- Protection of the cultural heritage in the city centre;
- Revitalisation of a neighbourhood, etc.

EMIS for monitoring and evaluation

The EMIS can also be used as monitoring and evaluation tool for measuring progress in EPM. Information about the status of different environmental issues and ongoing development activities should be fed into the system regularly. This gives you the opportunity to show how the situation is changing - for better or worse - over a certain period of time. Thematic Maps can be prepared showing the current status of the situation and the change over the last few months. It is very useful to make this kind of information available to the Working Group co-ordinators, maybe by pinning the maps on a wall that everybody passes regularly. In this way, the information is publicly available and taken into consideration in making decisions on urban development. See Tool 24 'Cities State of the Environment' for an example of a map based monitoring and evaluation system.

see Tool 24 - Cities State of the Environment

B5
Promoting public information

Public information outreach activities are an important part of the EPM process and subsequently of the SCP project cycle, and the EMIS can be used to support this. It is often said that a picture speaks a thousand words. A maps can be very eye-catching and they will add immensely to any information outreach activity. Whenever you plan a public information campaign (exhibition, publications, lectures, conferences) think of which maps can be used to support the topic. A map allows you to show complex interactions on one sheet of paper. To explain a map's content in words will probably result in several pages of text. However, even though some things may look obvious on a map, you always have to bear in mind that reading a map needs some skill. Not everybody is used to reading a map. It is always an interpretation of the features shown. Therefore maps should be kept clear and simple. Most of the time it is better to show several maps instead of one overloaded one.

Here are some rules you should be aware of when publishing a map whether as a printed or digital image:

- Always make sure that the map includes all the information necessary to read it, including cartographic elements like the scale, scalebar, north arrow, a clear legend, geographic co-ordinates and the source of the information.
- The layout should be make visual sense:
- The area covered by the EMIS goes beyond administrative boundaries which means that there is a hinterland. For example, rivers or environmental issues do not stop at boundaries. Don't produce maps which make the city look like an island.
- Colours should be easy to tell apart (see nice colour circle)
- Always check if the colours print out as you intend. Just a tip: Prepare a small printout with samples of all the colours you are using, so you can check how they are going to look.
- In general show only one topic on each map.

Besides being eye-catching, there is another purpose to showing maps in public. The EMIS follows a participatory approach, so maps should be used and checked by as many stakeholders as possible. Perhaps the condition of a road changed during the last rainy season. The people who can confirm that are the people living in the neighbourhood of that particular road. As the EMIS includes maps derived from the Working Group process or from estimated data, feedback from the public is necessary. People have to verify the information. The process of publishing information will certainly improve your data.

B5.1 Exhibitions

During the SCP process cycle several special events take place. An exhibition can be prepared to support the launching of the project, the City Consultation and Working Group meetings. For public information outreach it is also useful to held small exhibitions in your office building or in other public buildings e.g. libraries or city hall. These exhibitions can be prepared as posters or panels and/or with a computer slide presentation such as MS PowerPoint.

To prepare a poster you can either use desktop publishing software or your GIS software package. In ArcView GIS it is fairly easy to prepare a poster using the layout mode. You can use several maps on your poster as well as add pictures and text. The Shenyang Air Quality poster gives you an overview of the possibilities:

If you prepare a poster with desktop publishing software (MS PowerPoint, Adobe PageMaker, Photoshop or Illustrator) you have to save your maps (including the cartographic elements) as a graphic file. Most of the GIS software packages allow different formats for exporting graphic files. The pure bitmap format (BMP) or Windows Metafile formats (WMF) are usually not used because of their big file sizes. A full colour, high-resolution image in screen size may exceed 10 MB. Because bitmap images require so much storage, many techniques have been developed for compressing image data. The most popular graphic formats are the Graphics Interchange Format (GIF) and the Joint Photographic Experts Group (JPEG) which can compress in a ratio of 1:10 compared to bitmaps. The GIF89a format is a lossless compression technique (it compresses images without removing details), the JPEG format is a lossy compression technique (it compresses images by removing detail). GIF is mainly used for graphics with flat colours such as maps, and JPEG is used for photographic images with graduated colours. Encapsulated Postscript formats (EPS) are also lossless formats which work best with Adobe Illustrator and a Postscript printer/plotter. For different file formats see also Tool 26 ‘Posters’.

see Tool 26 - Posters

Using a computer slide show gives you many possibilities for a presentation. The slides can be used to underline the main points of somebody’s speech or the slide show can run by itself. In any case each slide should be understandable without further explanations. When showing maps in MS PowerPoint you can reduce the resolution of the JPEG considerably (and save storage space), because most screens only have a resolution of 72 dpi.

B5.2 The Web

There are several different ways to present your city’s EMIS through a website. The easiest way is to explain the EMIS briefly, to describe recent projects and to add some maps as images in JPEG format to illustrate the site.

A more sophisticated website can use clickable maps. These maps are saved as pictures, and contain several links, for example, one to each area. These links will access to further information, such as pictures, other maps, and written information. You could use, your index map as your clickable map. If somebody clicks on one of the boxes on the index map a list with all existing maps in this area will be shown. Or you could show a Thematic Map with information popping up for each selected area. If you intend to give details about ongoing projects, a map showing the hotspots and demonstration projects would work well with pictures and project descriptions attached. Of course it is not possible to prepare all your maps in this way. You can only show some examples in the form of clickable maps. Tool 22 gives you an example of how a webpage might look.

The most sophisticated way for presenting an EMIS on a website is to give users access to your database for querying and viewing the maps. This is a quite difficult

task which requires additional resources and specialised expertise. Some GIS software developers provide web publishing tool of different levels of sophistication (e.g. ArcView Internet Map Server (IMS) of ESRI).

B5.3 Publications

Several publications derive from the SCP project cycle, including the Environmental Profile, reports from Consultations, Working Group reports, Urban Development Frameworks and investment plans. You will probably have to include several maps in these publications, ranging from the Basic Map which gives an overview of the city to Thematic Maps and Overlays. For many publications it is wise to use black and white maps instead of coloured ones:

- Black and white maps can be as neat as coloured ones. It is better to have sharp black and white maps rather than smeared coloured printouts.
- A black and white layout forces you to prepare simple maps.
- A black and white layout is much cheaper to have printed.

Another publication output of the EMIS is a Sustainable City Atlas, which we have already mentioned in section B1.5 'Getting Information and Taking the Inventory'. A Sustainable City Atlas can be used in public and private institutions and it can be sold in bookshops. A short version is useful to give to investors. The Atlas should combine maps with written information about the city. For example on one page a soil map of the city can be shown and on the opposite page the text gives information on mining activities and agricultural usage.

Interactive Map Publication is a different approach which gives people, in this case particularly decision-makers, access to your database. All you need to do is to transfer your data, maps and related tables to selected individual's computers. You install map viewing software e.g. the free ArcExplorer on their computers and save the data in a separate folder. The recipients are given a short introduction on how to use the software and access the maps. They can then explore the data by themselves to find out more about the city. This data should be updated regularly every second month. Interactive Map Publication makes the progress of the system very visible, therefore this is a good way to promote the EMIS among high-level decision-makers.

Urban Atlas of Ismailia

The Sustainable Ismailia Governorate Project established a unit to produce maps for its different working groups. A Basic Map of Ismailia was produced with the help of a satellite image and aerial photographs. AutoCAD was then used to make the Thematic Maps from this Basic Map for the working groups. However, it was not helpful to present the information in this form to decision-makers as it was too difficult to understand. Therefore, the EMIS officer used Corel Draw to prepare meaningful, but colourful maps and to present the results of the working group in a simple way. All these maps were compiled in an Atlas of Ismailia, which is very easy to understand. It uses impressive self-explanatory symbols such as differently sized farmhouses or bees and fish to illustrate urban agriculture or fisheries. The Atlas includes seventeen maps showing population density, development activities and the natural set-up of Ismailia. It is printed in A4 landscape and in full colour. The Atlas has been very useful in informing the public about the environmental situation in Ismailia.

For more information, please contact the Sustainable Ismailia Governorate Project at sigp@thewayout.net

B6
Maintaining the EMIS

To maintain an information system like the EMIS there are several things to consider. First of all, the EMIS is a learning system, so it will never be 'finished'. Of course after you have taken all steps described, the major part of the work is done. The tasks will change. Whereas before the most important task was to gather data, it will now be to analyse the data. Staff are still needed to update the data, fill gaps, analyse the information and prepare different outputs. This chapter deals with the process of institutionalising the EMIS. This process includes updating the information of the system, training staff and users and fitting the system to the city structure.

B6.1 Updating the information in the EMIS

Preparing the Thematic Maps, Suitability and Sensitivity Maps needed by the working groups provide the first opportunity to up-date the information in the EMIS. Of course, new development activities are taking place all the time, and the environment-development interaction changes. Each new road or sewerage plant will change the pattern of the EMF. An EMF is not static and will never be a 'finished' document. Keeping track of the changes and up-dating the system will be the main challenge facing the mapping unit in the years following its establishment. For example, some information may go out of date or your system still contain estimated data because of a previous lack of exact scientific data. This information will have to be incrementally replaced by more accurate and up to date information.

One way to acquire new information is to work closely with your local university. You can make an arrangement whereby they can use your data for free, as long as they give you their results in exchange. It is probable that there will be many theses prepared by students regarding all kinds of issues in your city. Therefore you should always keep in touch with them. Students will probably be as interested as you are in this relationship, for it is always an asset if scientific findings are used.

Another source for updating your maps might be investors or donors who do not agree with the findings of the EMIS. They might argue that some of the information is not scientific. If this is the case, they are very welcome to provide additional information or funds for conducting detailed research, so make sure that your system is attractive enough for them to feed into it.

It is important to save a back-up version of the EMIS regularly. There are a variety of different ways to do this: CD-ROM writers, tape drives, zip-drives or another hard disc. These devices have to be stored in a secure place, preferably not in the same office as your computer. For some suggestions about a back-up system, see Tool 27 'Backing up the EMIS'.

see Tool 27 - Backing Up the EMIS

B6.2 Building and maintaining skills

Training is one of the main prerequisites for making the EMIS work. It is essential to provide sensitisation courses and training in the overall EPM process to all EMIS users. These training sessions should not focus on particular GIS software, but should emphasise the general use of the EMIS, and how it can support the work of the trainees. It is more important to learn how an EMIS works and the possible applications of a GIS for urban planning purposes than to learn commands and software package menus.

The EMIS has different users: decision-makers, planners and GIS administrators. All these users need to know about the EPM process, the principles of EMIS and how they can use it effectively in their day-to-day business. The type and the extent of information needed about the system differs from user to user:

- The GIS administrator need a broad knowledge of GIS and EMIS and its possible applications as well as detailed technical knowledge about the hard- and software. Because GIS applications and software are changing rapidly the staff of the EMIS unit need regular training sessions and intensive exposure to information through relevant magazines/publications and Internet access.
- Planners and other users of the data need training in GIS and applications, as well as basic knowledge in using the GIS software package for analysing data.
- Decision-makers and other interested people need a basic knowledge of the possibilities of the EMIS and outputs, so they can support the system politically, while also being aware of its limits.

A good example of a training agenda which takes different needs into consideration is the case example of Ibadan, Nigeria.

Training of the EMIS staff in Ibadan, Nigeria

The introduction of Geographic Information Systems to management practices requires a training programme that is comprehensive. The workshops and training for sensitisation and for initial capacity building targeted two broad classes of persons. The first class of persons was senior level government officials who needed an awareness of the role of GIS. The second group of persons consisted of persons for whom a GIS facility might actually be setup.

First Sensitisation Workshop

Duration: One-day event

Participants: Sixty participants drawn from a cross-section of the stakeholders

Objectives: The aim of the Workshop was to sensitise the top level management of government offices and international donor agencies on the role of GIS in the management of the urban environment. Therefore, the workshop was designed to provide a down-to-earth description of what GIS is and to show the relationship between the formulation of action plans and the attainment of sustainable management of the urban environment, and to demonstrate potential uses of GIS at the local level.

Second Sensitisation Workshop

Duration: A two-day workshop, as a follow-up to the previous workshop.

Participants: 54 participants consisting mainly of people selected from the staff of the eleven Local Governments in Ibadan Metropolis.

Objectives: The workshop aimed to demonstrate the GIS facility and to stimulate the interests of potential operators and users. It was also necessary to teach basic principles of using GIS for the purposes of map production, illustration and decision-making. The approach adopted by the Workshop involved plenary sessions and smaller group meetings. In order to facilitate the interaction of participants with the facilitators and GIS equipment, four computers were provided, all of them equipped with GIS peripherals such as digitisers, printers and different GIS software.

It is very important to prepare a long-term training strategy. First of all GIS is changing rapidly, so there is always something new to learn. Secondly the 'brain-drain' of well-trained personnel is a very common problem for public administration. Several SCP partner cities have experienced the loss of well-trained staff members. Often, when people are well trained and have the opportunity, they will move to the private sector, most of the time this is a better paid area. The mapping group must develop a pool of potential EMIS experts in order to avoid a break-down in the EMIS operations if the EMIS officer leaves. You will find a list of possible training institutions in Tool 28 'Training'.

see Tool 28 - Training

B6.3 Making the system routine

The institutionalisation of the EMIS unit is an essential part of the institutionalisation of the SCP process. The unit needs an appropriate permanent location, preferably, integrated in an existing department. There are three things to be considered: the main focus of the EMIS, the key persons for the system and the existing structure of institutions in the city. Often, the system will be located in the planning department. The advantage of this solution is that it provides a pool of staff knowledgeable in urban planning and management and probably also skilled in using GIS. The linkage to the planning department can change the planning procedures in the long term. However, experiences have shown that planning department can have a negative influence on the EMIS, using traditional static planning methods, or even replacing it with purely cadastral management, without implementing the EPM approach.

The EMIS unit works cross-sectorally, so it also makes sense to place it directly under the head of the city, as a sort of a central information office of the municipality. This location would underline the importance of the system and would give the staff the opportunity to have direct access to all relevant information. Additionally the system would be linked closely to the decision-making process and therefore provide strong arguments for the EPM in day-to-day politics. Being closely linked to the key decision-makers will also provide support to keep the system running. On the other hand, however, with the strong linkage to politics the system can be misused and priorities other than strengthening the EPM take over. Additionally, this positioning can be quite distancing, and the Working Groups, essential partners in the EMIS could lose touch with the system.

City	Dar	Ibadan	Ismailia	Wuhan
EMIS management	EMIS is with the Sustainable Dar es Salaam Project	EMIS is with the Technical Support Unit of the Sustainable Ibadan Project	EMIS is integrated in the Ismailia Governorate Administration	EMIS is with the GIS experts of the Environmental Protection Bureau
Office location	Office is located in the building of the Urban Authorities Support Unit; Being institutionalised into the new municipalities	Office is located in one of the local government offices	Office is located in the Ismailia governorate building	Office is located in an existing GIS Lab, separated from the EPM unit
Staffing	Employees are seconded from the DSM City Council	Employees are seconded from the municipality; Support through a mapping group	Employees are staff of the Governorate	Employees are part of the EPB office
Benefits	Closely linked to the EPM Process	Closely linked to the EPM Process through mapping group	Integrated in local administration	Full technical knowledge in running GIS
Drawbacks	Too much project set-up	Too much project set-up Brain-drain prone	Depends on interest of decision maker	Disconnected from the project, Sometimes difficult to gain access to the data

Some other possibilities as to where the EMIS could be placed in the existing structure of the city were already discussed in section B1 'Setting Up the EMIS'. Also refer to volume 5 of the SCP Source Book series 'Institutionalising the Environmental Planning and Management (EPM) Process'. Here you will find two examples of the many possible solutions and their advantages and disadvantages, presented with short descriptions of SCP city experiences.

What does the EMIS cost?

An EMIS consists of four components: hardware, software, data and users, and with each of these components the costs increase. A full-fledged EMIS set-up is expensive. If you have budget constraints, build your EMIS incrementally. The beauty of the system is that it allows different levels of sophistication without losing the quality of the end products. Purchasing the hardware is actually the cheapest part of the set-up. Software, including regular updates, which are necessary, can cost up to ten times more. Data acquisition is also expensive. The costs include buying maps, acquiring rights to digitise data and purchase of digital data. The most expensive part of the system, however, will be employee salaries and training for users of the system. This is something you should keep in mind, if you intend to generate money from your EMIS to recover its costs. Because of the high level of financial inputs necessary it is essential for the EMIS to have strong political backing.

Of course the costs for an EMIS can be lower. Most of the time software can be purchased at a cheaper rate for non-commercial projects. Also data cost will be considerably less, because a great deal of data can be provided free of charge by the different stakeholders from different government departments and ministries. It is in their own interest to provide the EMIS with data, because with better urban management all stakeholders will 'win' from the combined information. The Working Group process also generates free data for the EMIS. However, funds are still - as always - crucial for the success of the EMIS, so you should start to lobby for funding for the EMIS from the very beginning. Try to get a realistic picture of the costs of the system for each year, translating donations into true costs.

While the system should be kept open to the public, and everybody should have access to the data, this does not mean that the EMIS unit is obliged to give out printouts to everybody free of charge. Nor does it mean that the unit has to create maps or make changes to existing ones according to everybody's wishes, as this can become very time consuming.

It must be admitted that to run the EMIS as an open system is a real challenge. Accepting donated data carries with it the responsibility of providing access to this data for all users. Two things can help you to provide this access: a computer and a time schedule. You could make available a computer running ArcExplorer, be connected to the EMIS. Open access to this will allow all the users to view the data and make some queries. Maybe your budget even allows the users to make some black and white printouts of the maps. Of course, the people coming to query the data would need a short presentation on how to use ArcExplorer, but then they should be able to carry on by themselves. Another possibility to reduce pressure from outside visitors is to limit visits to specific times. The EMIS office could be open to the public perhaps two days a week.

Monitoring effectiveness of the EMIS

The ultimate effectiveness of the EMIS cannot be judged independently from the effectiveness of the EPM and working group as a whole. Furthermore, as EPM/SCP is a learning process and contents and scope are progressively evolving, one cannot automatically use the criteria of concrete impact on the handling of environmental issues in general.

To begin with, one can focus on the communication elements (particularly relevant to the EMIS): internally and subjectively through user satisfaction as expressed by the stakeholders: externally and 'objectively' (or perhaps 'normatively' might be more accurate) by evaluating whether the environmental and crosscutting nature of issues has been effectively made explicit.

For the EMIS, a priority starting point for monitoring might be the former aspect, through the following indicative questions:

- Are the EMIS contents updated regularly?
- How many times have decision-makers or other stakeholders requested or received information presented in the EPM framework formats?
- In these instances, did they:
  - find the information understandable?
  - find the information relevant and/or useful to their concerns/activities/decisions? If so, how?
  - gain a better comprehension of the issues in question?