

Building an Environmental Management Information System (EMIS)



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



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 EPM¹

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)

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Middle East: Ismailia (Egypt), Tunis (Tunisia)

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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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Part A

Introduction and Overview

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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:

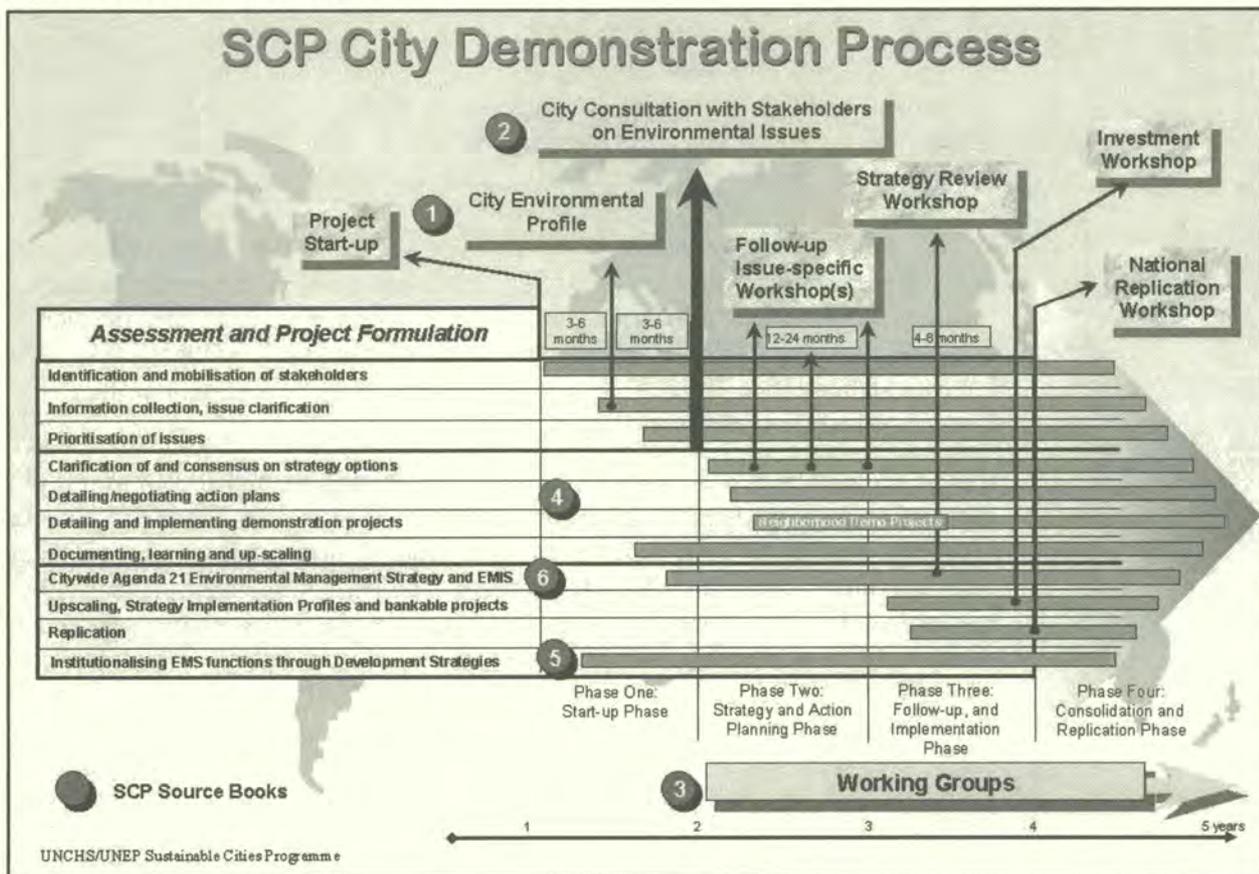
- central focus on environment-development interactions;
- broad-based participation by public, private and community sector groups;
- concern for inter-sectoral and inter-organisational aspects;
- reliance on bottom-up and demand-driven responses;
- focus on process: problem-solving and 'getting things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

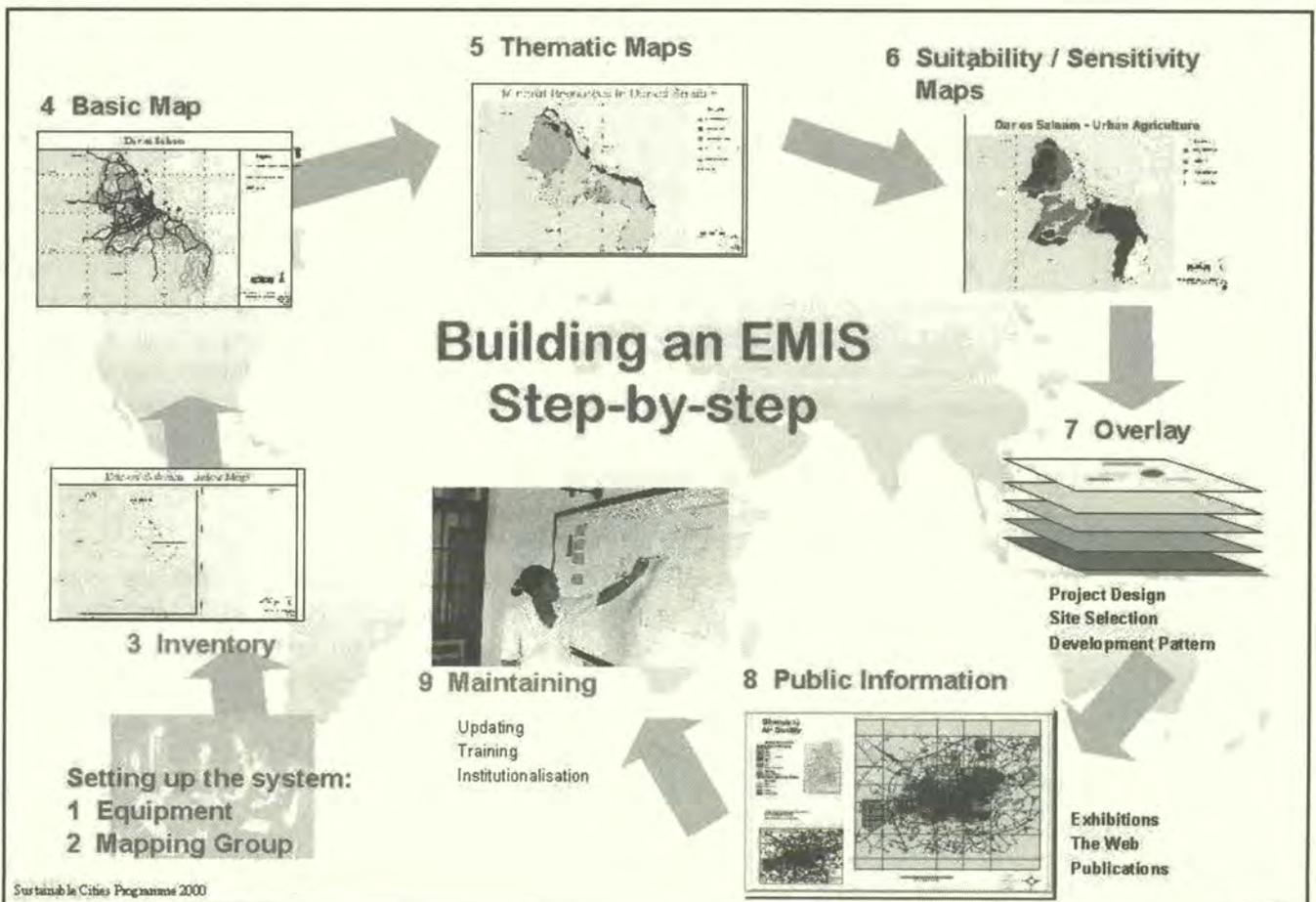


Figure 3: EMIS Step by Step

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 "Insds.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.

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.



Wuhan, China

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
<ul style="list-style-type: none"> ● 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	<ul style="list-style-type: none"> ● 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, 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
<ul style="list-style-type: none"> ● ArcView GIS ● MapMaker Pro ● ArcInfo ● MapInfo ● Atlas GIS ● Idrisi ● AutoCAD Map etc. 	<ul style="list-style-type: none"> ● ILWIS ● TNTmips ● Erdas/Imagine ● ArcView Image ● Analyst etc. 	<ul style="list-style-type: none"> ● Oracle ● MS Access ● Dbase etc. 	<ul style="list-style-type: none"> ● Adobe Photoshop Adobe ● Illustrator ● Adobe Pagemaker ● MS Powerpoint ● HTML editor etc. 	<ul style="list-style-type: none"> ● 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 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 commonalities 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 it 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'):

- 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').

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')

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.

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

see Tool 5 - Purchasing Maps

see Tool 6 - Coding and Filing Maps

see Tool 6 - Coding and Filing Maps

see Tool 7 - Filing Digital Data

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

Definition	Source of data	Example
<p>A Basic Map includes the main features of a city, such as major rivers, main roads, basic landforms and administrative boundaries.</p>	<p>Use a topographical map with a scale of 1:20000, 1:50000 or 1:100000.</p>	
<p>A Thematic Map map focuses on a specific topic. Thematic Maps in the EMIS will strictly show facts.</p>	<p>Information is provided by institutions or derived from research, and the Working Group process.</p>	
<p>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.</p>	<p>Information is mainly generated through the Issue-Specific Working Groups and the Mapping Group. It includes national & international standards.</p>	
<p>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.</p>	<p>Information is mainly generated through the Issue-Specific Working Groups and the Mapping Group. It includes national and international standards.</p>	
<p>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.</p>	<p>Data on water distribution, types of sewerage, road conditions, public transport, management of solid waste, areas serviced by power</p>	
<p>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.</p>	<p>Suitability and Sensitivity Maps, refined by Service Delivery Maps</p>	
<p>Hot spots - The higher the ranking value in an overlay is the higher the competition is for development activities on that spot.</p>		
<p>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.</p>	<p>Large scale maps in 1:2500</p>	

'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-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.

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 metres apart. The scale of the map is 1:50000, because 10 mm goes 50000 times into 500 metres. 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).

B2

Creating a Basic Map

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.

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.

Ibadan Basemap

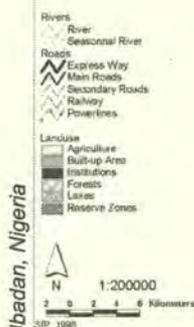


Figure 7: Starting an ArcView GIS project

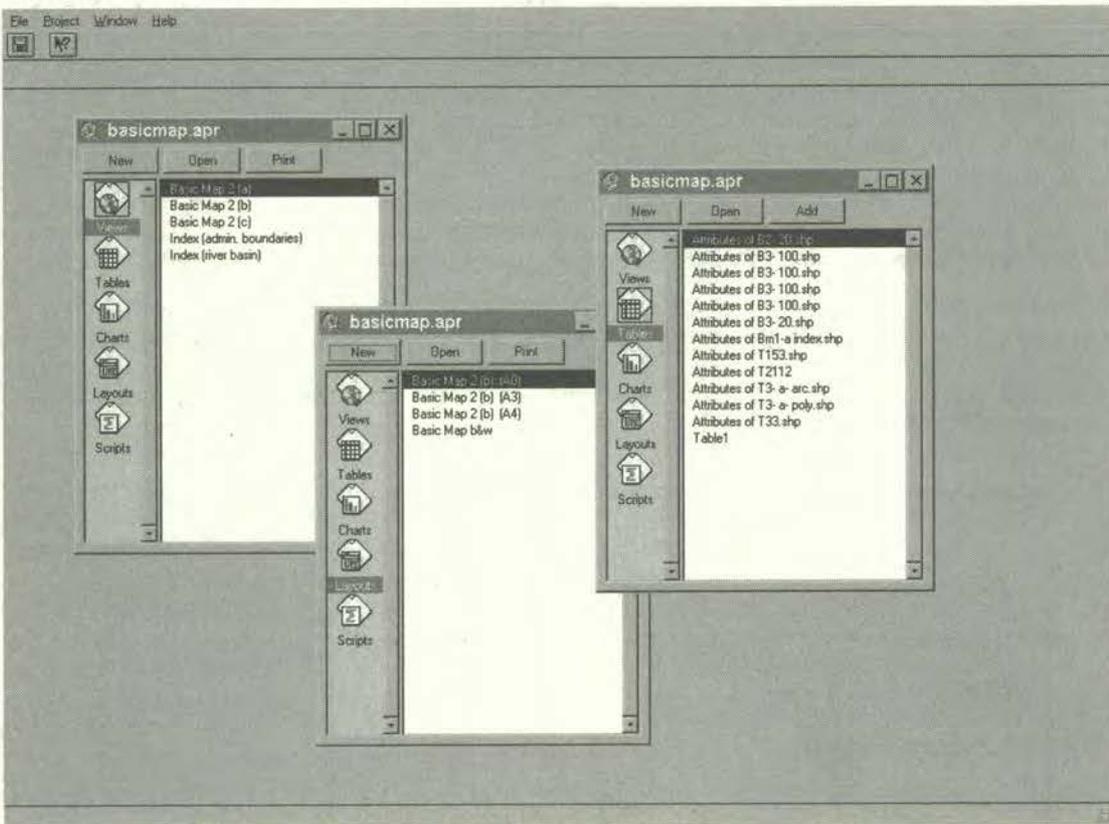
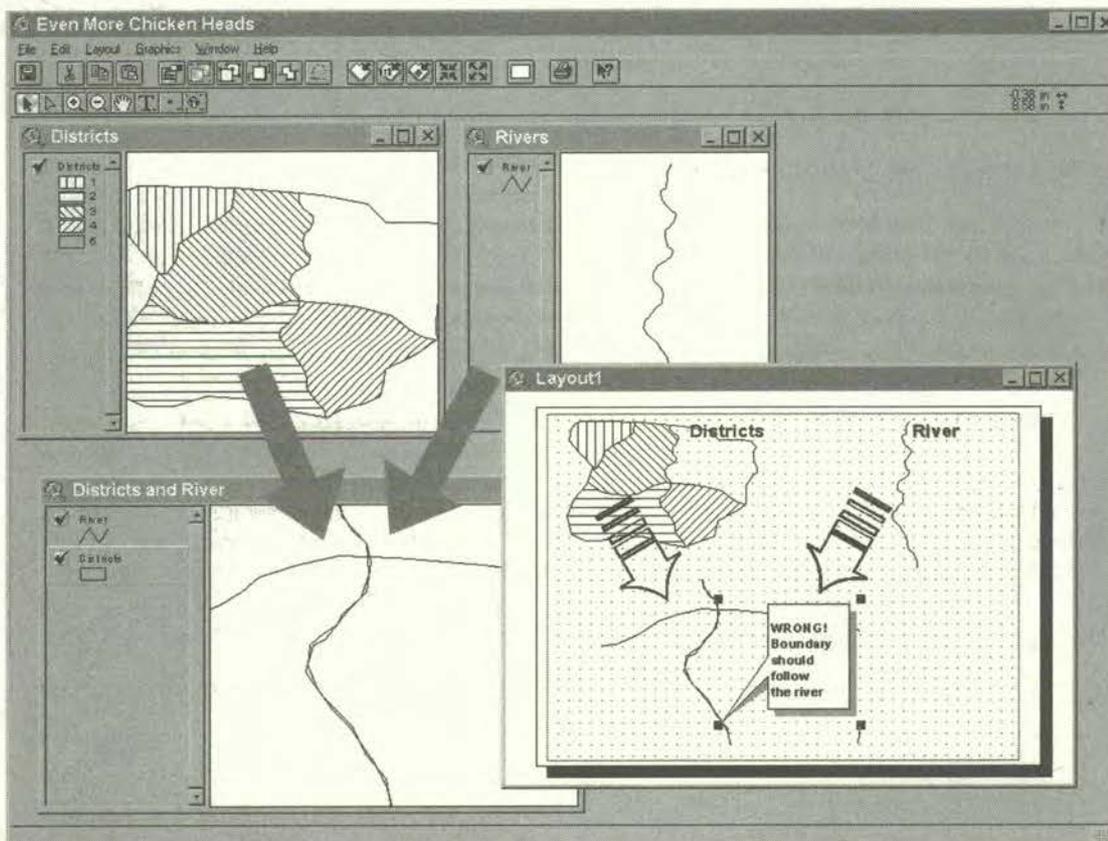


Figure 8: 'Tidy Boundaries'



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.

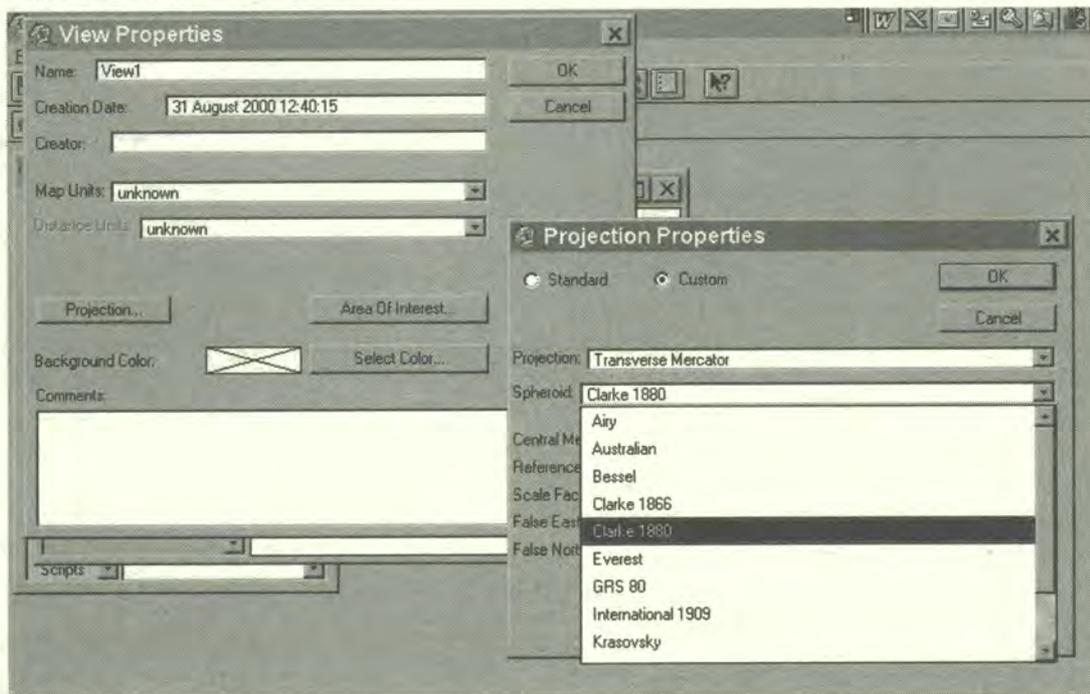
The Universal Transverse Mercator System divides the globe into sixty zones, each spanning six degrees of longitude. Each zone has its own central meridian from which it spans 3 degrees west and 3 degrees east of that central meridian. X and Y co-ordinates are recorded in metres. To eliminate negative 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.

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.

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

Figure 9: Projection in ArcView GIS



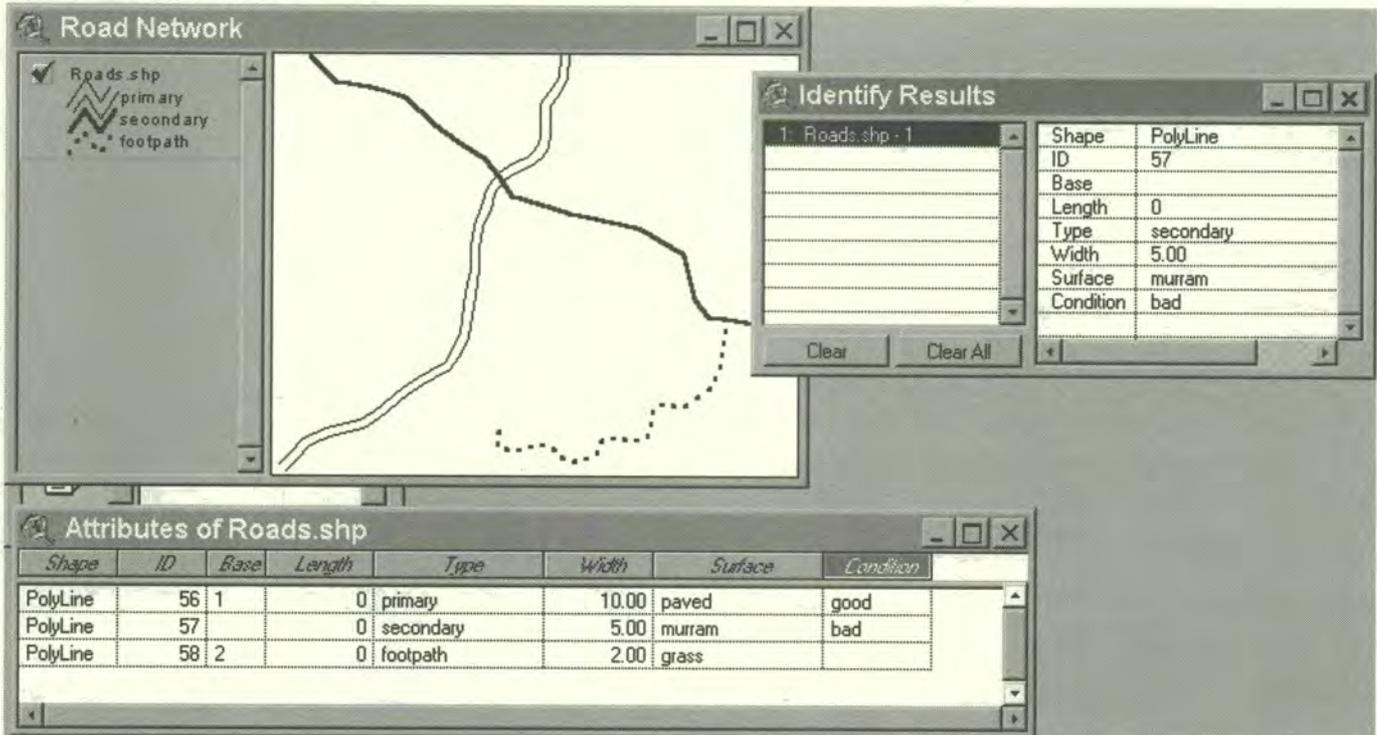
original projection was used and replicate the projection in your map using conversion tools of e.g. ArcInfo or ArcView GIS. Please read the chapter on map projections in the handbook that comes with your GIS software carefully.

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

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



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.

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 B.2.2 '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 decide 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.

see Tool 10 - Digitising with a Digitising Board

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

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.

Figure 12: Advantages and disadvantages of different methods of digitising

	PROS	CONS
DIGITISING BOARD	<ul style="list-style-type: none"> • Allows highly accurate digitising • You can place the entire map sheet on the board for a better overview 	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • Allows fast digitising and the production of “quick & dirty” maps • You see your output immediately 	<ul style="list-style-type: none"> • 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

see Tool 11 - Digitising with Scanned Maps

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 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.

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').

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'.

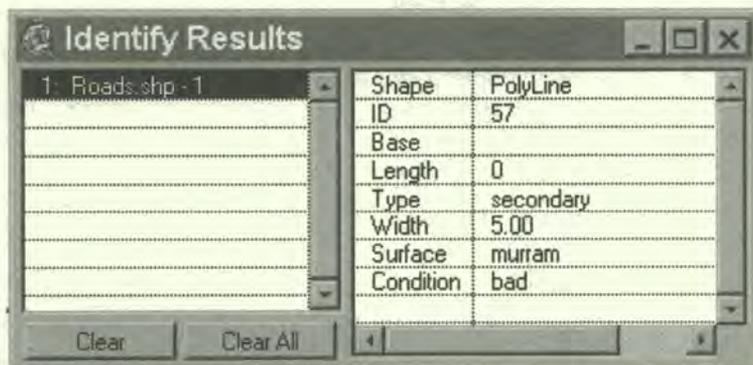


Figure 13: Information Pop-up window (ArcView GIS)

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 scan 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 easy 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 located 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, arrondissements, 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 metres 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).

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.

see Tool 16 - Preparing Thematic Maps

- **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 where further expansion is unsuitable or even dangerous, and other parts where it is safe.

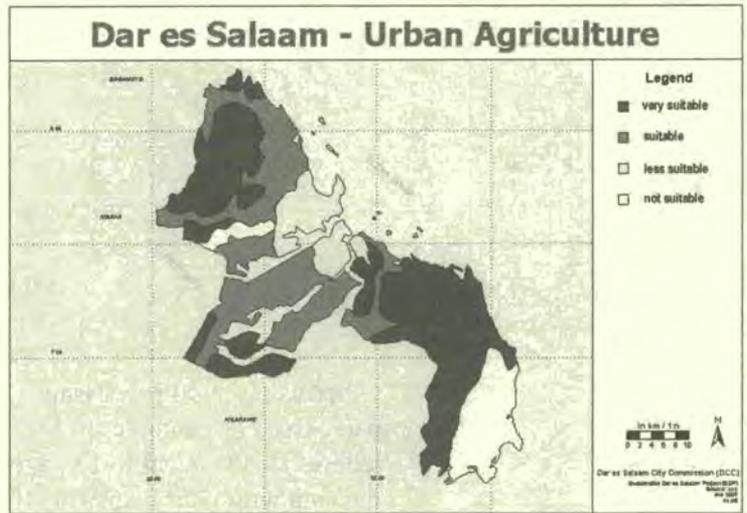
B3.2 Mapping policies: Suitability Maps and Sensitivity Maps

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.

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.



Dar es Salaam, Tanzania

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, 50-99 μ /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.

To get 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 Suitability
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.

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

- 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.

If you have not 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 - Attribute
Data**

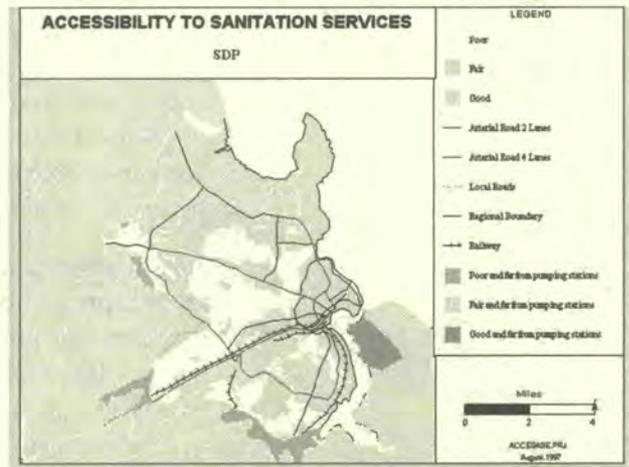
How to create a Suitability Map

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

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.



Dar es Salaam, Tanzania

B4

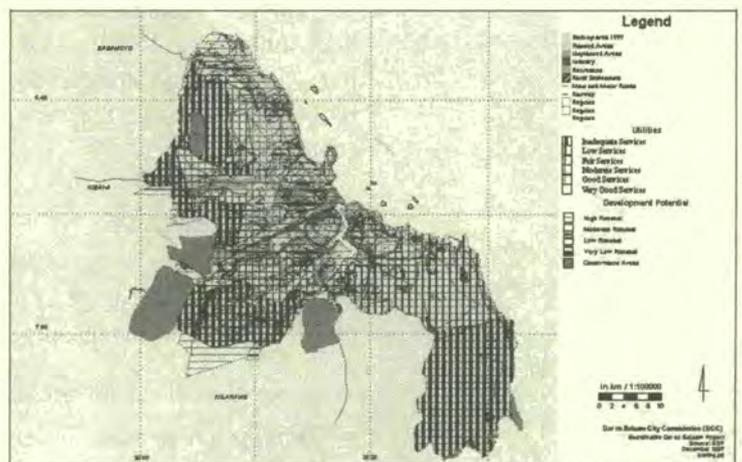
Applying mapping to decision making: Outputs through overlaying

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 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

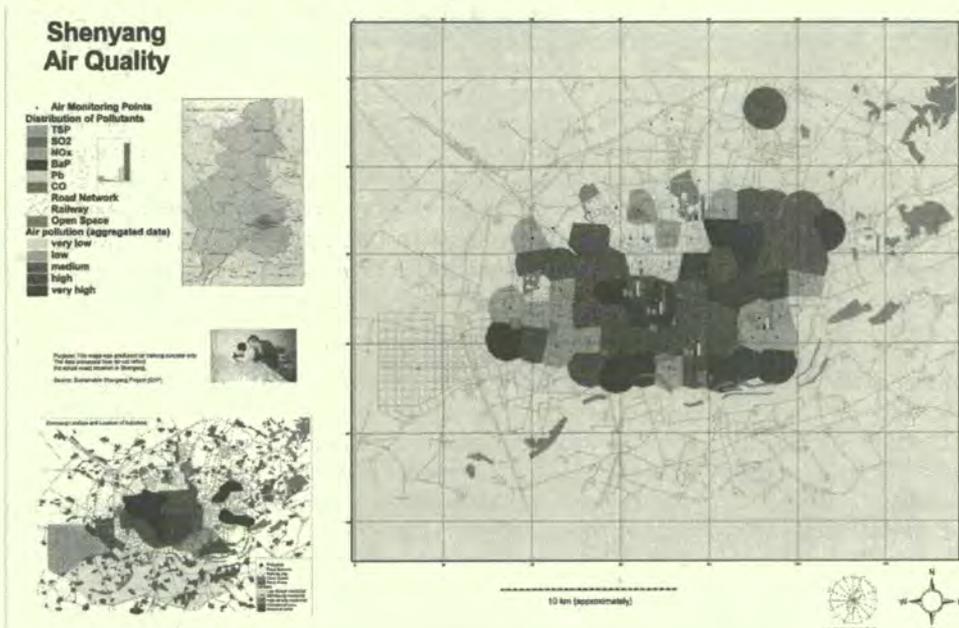
Technically, the EMF is an aggregate of relevant Suitability and Sensitivity Maps and makes intensive use of the ranking mechanism (see Tools 19 and 20 on preparing Suitability and Sensitivity Maps'). Tool 23 'Environmental Management Frameworks' will give you examples of how environmental management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

Figure 15: Poster showing the Air Quality situation in Shenyang



Some examples for typical action plans are:

- 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. 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 an 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 hold 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'.

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

see Tool 27 - Backing Up the EMIS

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.

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.

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

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

see Tool 28 - Training

if the EMIS officer leaves. You will find a list of possible training institutions in 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

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

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.

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?

Part C

The Toolkit: Key Steps in Building an Environmental Management Information System (EMIS)

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Setting Up

- Tool 1** EMIS Employees
- Tool 2** EMIS Equipment
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- Tool 4** Finding Maps
- Tool 5** Purchase Maps
- Tool 6** Map Coding
- Tool 7** Data File System

Tool 1: EMIS Employees

Qualifications and tasks of the employees of the EMIS unit

Examples of Terms of Reference for the EMIS Officer and the EMIS Assistant

Terms of Reference

EMIS Officer

Post Title:	<i>EMIS Officer</i>
Duty Station:	<i>Sustainable Cities Project X</i>
Starting Date:	<i>immediately</i>
Duration:	<i>two years (with possible extension)</i>
Purpose:	<i>to support the establishment and consolidation of an Environmental Management Information System (EMIS) in city x and other cities/towns in country x.</i>

Context

An Environmental Management Information System (EMIS) is a fundamental tool for decision makers and planners in promoting sustainable urban development. EMIS supports effective urban environmental planning and management (EPM), including routine land use and investment decision-making, area specific action planning and overall monitoring of the state of and improvements in the physical environment. In the context of the Sustainable Cities Programme (SCP) EMIS is the system used for collecting, organising and applying information relevant to urban EPM in clarifying issues, formulating strategies, implementing action plans, monitoring progress and updating changes.

Broadly, the EMIS includes two components: (a) mapping and GIS applications and (b) managing the database and information modules related to environmental resources/hazards and cross cutting issues affecting the long term growth and development of the cities. The EMIS Officer will be responsible for both components, and for the overall functionality of the EMIS. The EMIS Officer will work under the supervision of the local EPM unit co-ordinator.

Activities

The EMIS Officer will assist the local EPM unit in the EPM process and ensure the step-by-step application of the EMIS within the process. The EMIS Officer will perform the following duties:

I. SCP/EPM Process

- to support the local EPM unit in the preparation and up-dating of the Environmental Profile in terms of information capture and maps;
- to support the local EMP unit in the preparation and conducting of the City Consultation, through, for example, exhibitions and illustrations;
- to provide Issue-Specific Working Groups with the relevant information for the development and implementation of strategies and action plans;

- to gather relevant information from Issue-Specific Working Groups and other stakeholders;
- to provide substantive support in the institutionalisation of the EMIS function within the local EPM unit and within the overall institutional structure.

2. EMIS step-by-step

- To supervise and to work closely with the EMIS Assistant;
- to procure the hardware and software for the EMIS, to install the equipment and keep it in good running condition;
- to link the different stakeholders, including people from the community level, in the mapping process and to create an enabling environment for constructive exchange of experiences;
- to take inventory of all institutions and specialised firms who have the relevant expertise in mapping, GIS, remote sensing and database management in the context of urban environmental planning and management;
- to set up and co-ordinate the EMIS Mapping Group;
- to develop a structure for the EMIS database and to develop an inventory of existing maps and non-spatial data on environment-development interaction and set up a meta-database;
- together with the Issue-Specific Working Group co-ordinators to view the information used for the EMIS and to develop a routine for regularly updating it;
- to acquire relevant data (spatial and non-spatial data on environment-development interaction) for the EMIS;
- to analyse the data in co-ordination with the issue-Specific Working Group co-ordinators and, if applicable, prepare an Environmental Management Framework;
- together with the local EPM unit team to develop an information outreach strategy and to contribute EMIS “products” to the various outputs of the local EPM unit including a website;
- to organise and conduct briefing sessions with decision-makers and stakeholders to familiarise them with the EMIS;
- to organise and, if necessary, to execute practical training programmes on the EMIS use of mapping including demonstrations on mapping analysis for urban development planning.

Qualifications

Expert with degree in geography, urban or regional planning (with background in social sciences) is required with extensive working experience (at least 3 years) in designing and operating participatory management information systems and in database management. General knowledge and experience at user level in GIS and experience in desktop publishing as well as web design is desirable. Knowledge of environmental management and familiarity with Environmental Planning and Management (EPM) and the SCP approach is an advantage. Experience with community work and participatory planning concepts is an asset.

Terms of Reference

EMIS Assistant

Post Title:	<i>EMIS Assistant</i>
Duty Station:	<i>Sustainable Cities Project X</i>
Starting Date:	<i>immediately</i>
Duration:	<i>one year (with possible extension)</i>
Purpose:	<i>to support the establishment and consolidation of an Environmental Management Information System (EMIS) in city x and other cities/towns in country x.</i>

Context

An Environmental Management Information System (EMIS) is a fundamental tool for decision makers and planners in promoting sustainable urban development. EMIS supports effective urban environmental planning and management (EPM), including routine land use and investment decision-making, area specific action planning and overall monitoring of the state of and improvements in the physical environment. In the context of the Sustainable Cities Programme (SCP) EMIS is the system used for collecting, organising and applying information relevant to urban EPM in clarifying issues, formulating strategies, implementing action plans, monitoring progress and updating changes.

Broadly, the EMIS includes two components: (a) mapping and GIS applications and (b) managing the database and information modules related to environmental resources/hazards and cross cutting issues affecting the long term growth and development of the cities. The EMIS Assistant will support both components. The EMIS Assistant will work under the direct supervision of the EMIS Officer.

Activities

The EMIS Assistant will assist the EMIS Officer in the step-by-step application of the EMIS within the environmental planning and management process. The EMIS Assistant will perform the following duties:

- to conduct an inventory of existing maps in close collaboration with the EMIS Officer. This task includes ordering, storing and labelling printout maps. The EMIS assistant will feed this information into the meta-database together with information on the digital data available, and will update this database regularly;
- to prepare the maps of the EMIS while digitising or updating. He or she will also be responsible for the preparation of Thematic Maps for the working groups;
- to enter data to the database on specific themes, in particular on the priority environmental issues; continuously update information of the system and use the new data to prepare additional maps;
- as part of the Information Outreach Strategy of the Sustainable Cities Project and especially the EMIS to prepare maps and posters for presentations and exhibitions; to layout the digital maps and to prepare printouts.

Qualifications

The EMIS Assistant should have a background as a cartographer, surveyor or a related field. Considerable work experience in mapping and database management is necessary. Knowledge of the use of GIS software packages would be an advantage.

Tool 2: EMIS Equipment

List of Hardware, Software, Office Equipment, List of addresses

Hardware

Computer hardware specifications change rapidly. The specifications given below reflect the situation in 2000. For international procurement you have to specify your local requirements such as voltage, frequency, plug type, etc.

1. Computer hardware:	Desktop, IBM compatible, computer
Processor:	800+ MHz Intel Pentium III processor
Memory:	minimum 128 MB RAM (expandable)
Graphics:	PCI local-bus 3D graphics accelerator with at least 32 MB RAM
Frontside Bus Speed:	minimum 100 MHz
Hard Drive:	minimum 20 GB IDE (or SCSI)
CD-ROM:	24-48 speed CD ROM and Internal CD-RW Drive (Writer)
Expansion slots:	At least 2 PCI available slots
Ports:	USB, Parallel, Serial
Monitor:	Colour SVAG, minimum size 19", preferably flat screen, e.g. Trinitron
Built-in Modem:	V.90 High-speed Modem (56K)
Other Cards:	Network Card (if network planned), Audio Card and speakers
Backup:	Internal Tape drive (optional) for regular backup
Operating system and office software:	MS Windows 98 (Windows NT, if networked), MS Office 2000 Professional
Costs:	approx. US\$ 2-3,000
2. Plotter:	A0 Inkjet colour plotter
	e.g. Hewlett Packard HP DesignJet 755CM, or the cheaper HP DesignJet 750C, or 500C
Size:	minimum A0 (36 inch wide) printable area
Resolution:	600 dpi (black)/300 dpi (colour)
Memory:	at least 32 MB
Language:	Adobe PostScript Level 2
Drivers	AutoCAD, Windows 98
Print Media:	sufficient ink cartridges (e.g. 5 each colour for first order);
Paper:	Heavy Weight Paper, Coated Paper, Clear Film (one roll each)
Cost:	from US\$ 4,000 (HP DesignJet 500C) to US\$ 8,000 (HP DesignJet 755CM)
3. Scanner:	A4 or A3 flatbed scanner
	A4 (or A3, if resources are available) flatbed, colour (32 bit) and greyscale, high resolution (1200 dpi optical), parallel and USB interface e.g. HP ScanJet 5300C Business Series
Cost:	US\$ 300 (A4)
3. Printer	A4 Inkjet colour printer
	e.g. HP DeskJet 840 Series
Price:	US\$ 200

4. Digitiser	A3 to A0
Size:	active area from 12 in x 18 in to 24 in x 36 in
Accuracy:	0.010 in (0.25 mm)
Device:	16-button pointing device (cordless)
Drivers:	Windows 98, WinTab compliant e.g. Calcomp, Summagraphics (e.g. Summagrid V SG5-48)
Stand:	Manual Lift/Manual Tilt Base Model for large scale digitiser
Cost:	A3: US\$ 600; A0: US\$ 3,000
5. Global Positioning System (GPS)	Hand held GPS receiver
	Compatible with PC mapping software, NMEA/DGPS data interface, with Combo PC Interface / Power Cable, with lighter adapter & 9 pin serial connector
	e.g. Magellan 315 GPS Receiver, Trimble, Garmin
Cost:	US\$ 200-500
6. Others	Backup
	Backup Power for each computer, e.g. UPS 1.000VA or equivalent To be checked locally

GIS Software

The typical software package for an EMIS consists of:

- GIS software (e.g. Map Maker Pro and ArcView GIS)
- Database software (e.g. MS ACCESS, part of MS Office Professional)
- Image processing software (e.g. MS Photo Editor or Adobe Photo Shop)
- Web editor (e.g. HTMLER) or Netscape Composer

For the purchase of Satellite Imagery and Aerial Photographs, please refer to Tool 13: Purchasing Images.

Comparison between Map Maker Pro and ArcView GIS:

	Map Maker Pro	ArcView GIS 3.2
Spreading	not so well known, developed for small scale applications in developing countries	widespread and well known
System Requirements	at least 386 processor and windows, 4 MB RAM, preferable 8MB	at least 486 processor and windows 12 MB RAM, preferable 16 MB
Purchasing	easy, cheap, Map Maker Basic fits on one diskette, can be obtained through internet	expensive, contact regional ESRI authorised dealer
User Interface	acceptable, menu is too extended	icons to click and menu, icons sometimes have unusual symbols
Handbook	handbook is easy to understand with additional information about mapping and surveying, basic online help with links	Tutorial is easy to follow and explains more or less all features of ArcView GIS, additional information about mapping and projections, extensive online help
Import	DXF (Autocad and Idrisi), Idrisi, ArcInfo, Tiger, Atlas GIS, MapInfo and more	ArcInfo, DXF, MapInfo Interchange Format, others are in development

Export	ArcInfo, ArcView, DXF and more	latest version exports shapefiles to DXF, otherwise in graphic output (jpg, bmp, eps)
Table Data	dBase, Access or edit in Map Maker Pro; limited connectivity to external databases (weakest point of Map Maker)	easy to handle, easy SQL connectivity to external databases;
Images, Raster Data	Tiff or Bitmap, can be used as background	BIP, Erdas, JPEG, Tiff's can be used and processed
Digitising	concept two possibilities: symbols, lines and polygons (can be drawn in one layer) or node and link drawing; very easy to change between both drawing modes after each new object, you have to indicate which lay-out; can change polygons to lines and vice versa	concept: point, line or polygons in one shapefile can use screen as well as digitising board
Overlays	minimal overlay functions	possible with different options (split, merge, intersect) also buffer option
Thematic maps	inheritance, data surface produce 3-D maps	easily done with legend editor
Lay-Out	different styles have to be saved in files, a little bit uncomfortable, but manageable	very easy to handle, possibility to create own symbols, can be a combination of several views, text and charts, but produces large files
Printing	can print large formats on an A4 printer; print-outs on several sheets possible (tiles)	requires plotter for large formats
Others	GPS can be used directly, programme can be customised	Avenue is the internal language to write scripts and design own symbols; good description
Strong	low system requirements, low price, double concept for geometric data, import/export facilities; image registration; some useful extensions (e.g. rubber map); software can be tested free of charge for a limited period	easy to use, many people know it, many additional extensions for specific uses (however expensive), good database connectivity
Weak	not a nice user interface, sometimes typing of commands, no overlay, no good database connectivity	expensive, sophisticated system requirements, no direct image registration

Office Equipment



Beside typical office furniture such as chairs and desks, it is useful to have at least one additional table, preferable a light table. Another additional item you have to purchase is a map filing cabinet. These filing cabinets cost around \$500. Vertical Plan Filing Cabinets are more space economical than horizontal cabinets. The size 52" in height x 35" in width x 20" in depth (for maximal 600 drawings size 40 in x 30 in) is the most appropriate (do not forget to order filing strips with it).



Light Table:

Light Tables Tops can be bought for \$150. A whole table will cost at least \$400. It is also fairly easy to get a light table locally built.

Addresses

For computer equipment:

Hewlett-Packard Corporate Headquarters; 3000 Hanover Street; Palo Alto, CA 94304-1185; Tel: +1-650-857 1501; Fax: +1-650-857 5518
Europe, Africa, Middle East; Route du Nant-d'Avril 150; CH-1217 Meyrin 2; Geneva, Switzerland; Tel: +41-22-780 8111
Asia Pacific: 17-21/F Shell Tower; Times Square, 1 Matheson Street; Causeway Bay, Hong Kong; Tel: +852-599 7777
<http://www.hp.com>

other sources:

<http://www.gateway.com>
<http://www.compaq.com>
<http://www.buymicro.com>
<http://www.circuitcity.com>

For Global Positioning Systems:

Magellan Corporation; 471 El Camino Real; Santa Clara, CA 95050-4300;
Tel: +1-408-615 5100; Fax: +1-408-615 5200
<http://www.magellangps.com/>

Trimble Navigation Limited, Corporate headquarters, 645 North Mary Avenue, Sunnyvale, CA 94086; Tel: 1-408-481 8940; Fax: +1-408-481 7744 www.trimble.com

other sources:

<http://www.thegpsstore.com/site/>
<http://www.globe-mart.com/gps/>
<http://www.garmin.com/>
<http://www.gpsworld.com>

For digitisers:

GTCO CalComp, Inc; US Headquarters: 14555 N. 82nd Street; Scottsdale, AZ 85260;
Tel: +1-800-458 5888; Fax: +1-480-948 5508
European Headquarters: World Trade Center; Top 165; A-100 Vienna Airport, Austria;
Tel: +43-1-70073 6455 Fax: +43-1-70073 6458
sales.gtcocalcomp@atnet.at

other inquiries:

office.gtcocalcomp@atnet.at
<http://www.gtcocalcomp.com/>

For GIS Software:

For ArcView GIS, ArcInfo, ArcExplorer
Environmental Systems Research Institute, Inc. ESRI; 380 New York Street; Redlands, CA 92373-8100; USA Tel: +1-800-447 9778.
Outside the United States, contact your local ESRI distributor.
webmaster@esri.com
<http://www.esri.com/>

MAP MAKER Ltd; The Pier, Carradale, Argyll, Scotland; PA28 6SQ, United Kingdom;
Tel: +44-1583 431 358; Fax: +44-1583-431 728
info@mapmaker.com
<http://www.mapmaker.com/>

other GIS software:

MapInfo: <http://mapinfo.com>
ERDAS: <http://www.erdas.com>
TNTmips: <http://www.microimages.com>
Intergraph: <http://www.intergraph.com/gis/gmwm>
IDRISI: <http://www.clarklabs.org>

Microsoft; One Microsoft Way; Redmond, WA 98052-6399; Tel: +1-425-882 8080
<http://www.microsoft.com/windows/default.asp>

Tool 3: Mapping Group

How to establish a Mapping Group

Checklist of Members, Terms of Reference for Mapping Group, Invitation Letter for Meeting

Checklist of Members of the Mapping Group

- **Survey and Mapping Institution/Department**
(or other institution which is responsible for mapping in the city or country)
Contact person and address:

 - **Planning Department**
(Department in city or country which is responsible for urban planning)
Contact person and address:

 - **Community Representatives**
(Relevant people who have a stake in participatory mapping and planning methods)
Contact person(s) and address(es):

 - **Representatives of the Issue-Specific Working Groups**
Contact person and address:

 - **University and other research institutions**
(Geography or cartography department)
Contact person and address:

 - **EMIS Unit**
(staff working to build up the EMIS)
-

Example of the Terms of Reference for a Mapping Group:

Mapping Group

<i>Project title:</i>	<i>Sustainable Ibadan Project</i>
<i>Post title:</i>	<i>Advisory Mapping Group</i>
<i>Expected start:</i>	<i>August 1998</i>
<i>Purpose:</i>	<i>To support the establishment of the EMIS (Environmental Management Information System) with expertise and knowledge. To coordinate the mapping task of the Sustainable Ibadan Project</i>

Expected Outputs

- EMIS is established with accepted national standards in mapping
- Knowledge of existing data is shared
- Training units are established

Duties and Tasks

- Regular (monthly) and exceptional meetings
- Advise on map coding (see Tool 6: Map Coding)
- Clarify basic map (content, accuracy, intervals between up-dates)
- Set standards for lay-out of maps produced by the EMIS Unit
- Set standards for data, both spatial and non-spatial
- Discuss maps with the Issue-Specific Working Groups
- Support participatory planning methods in demonstration areas
- Make recommendations in the use of international/national standards and rules and conditions developed by the Issue-Specific Working Groups
- Make recommendations for outsourcing of digitising, image interpretation, printing etc.

Qualification of Members

Members of the mapping group are conversant with mapping (producing and/or reading) and participatory planning methods, such as transects, Participatory Rapid/Urban Appraisals etc.

Example of an Invitation Letter:

To: Members of the Mapping Group
From: EMIS Officer
Date: 26 July 1999

**Subject: Invitation to Mapping Group Meeting, EMIS Unit,
Sustainable Ibadan Project, 15 September 1999, 16:00hrs.**

Dear Ms. Kamau,

The next Mapping Group meeting will take place (as planned) on 15 September 1999. We will meet in the EMIS office, Laikipia Road 15, room 12 at 16:00hrs. Please find attached the minutes of the last meeting.

The agenda will be as follows:

- 1) Approval of minutes of the last meeting
- 2) Report on progress since the last meeting
- 3) Data from Ministry of Water has arrived: how to transfer them into the EMIS using ArcView GIS
- 4) Discussion with Working Group on Waste Management
 - maps needed to be prepared
 - data collection
- 5) Exhibition for public library has to be prepared
- 6) Training on EMIS
- 7) a.o.b.

I will be glad to see you there. Please let me know if it is not possible for you to attend the meeting. I would also appreciate any notice about additional topics for the agenda.

Yours sincerely,

EMIS Officer

Tool 4: Finding Maps

Institutions where existing maps and/or digital data can be found

Checklist of institutions

- **Survey and Mapping Department/Institution**
(or other institution which is responsible for the survey and mapping function in the city or country).

Contact person and address:

- **Municipal Departments, such as the Planning Department**
(Department in city or country which is responsible for urban planning)

Contact person and address:

- **Ministry of Lands, Housing etc.**

Contact person and address:

- **Other Ministries, such as Energy, Water, Health, Environment**
(for specific thematic maps)

Contact person and address:

- **Universities and other research institutions**

Contact person and address:

- **Existing projects which might have relevant maps**

Contact person and address:

- **Atlas of the city, province, country**
-

- **Internet**

It is possible to locate maps on the internet. However, most of the maps are in small scale and serve as background and reference maps. A valuable source is the Digital Chart of the World (DCW) which was developed from satellite imagery in 1993. The base scale of the DCW is 1:1000000.

Global Resource Information Database:

GRID-Arendal's Online

Maps and Graphics Database: <http://www.grida.no/db/index.htm>

<http://www.gisdatadepot.com>

GISLinx - Over 1,700 Categorized GIS Links!:

<http://www.gislinx.com/>

Multimap:

<http://www.multimap.com/world/places.cgi>

Green Map System:

<http://www.greenmap.com/>

CGRER NetSurfing: Maps and References:

http://www.cgrer.uiowa.edu/servers/servers_references.html#mapforeign

Hart Environmental Data - Search the Indicator Database:

<http://www.subjectmatters.com/indicators/HTMLSrc/KeySearch.html>

World City Maps:

http://www.lib.utexas.edu/Libs/PCL/Map_collection/world_cities.html

Digital Chart of the World:

<http://www.maproom.psu.edu/dcw/>

Map Libraries:

http://www-map.lib.umn.edu/map_libraries.html

Maps and Cartography:

<http://www.lib.berkeley.edu/EART/MapCollections.html#web>

see also links on CD-ROM

Tool 5: Purchase Maps

How to outsource map production

Example Letter

To: Head of Department (e.g. local EPM Unit or Department in which the EPM Unit is located)
 From: EMIS Officer
 Date: 5 November 1999

Subject: Recruitment of a consultant for the preparation of the Basic Map

Further to discussions between the local EPM Unit and the Head of Department on the selection of the consulting firm, please find attached the terms of reference for the local consulting firm GEOMap Ltd. GEOMap Ltd. will support the preparation of a series of maps as an input to the preparation of the Environmental Management Framework (EMF).

GEOMap Ltd. is undertaking development activities in the field of rural and urban development, management and natural resources and has worked with organisations including UNDP, Danida, the Netherlands Embassy and the European Unity (EU).

The consultant(s) will undertake the following activities:

1. Digitising of 4 sheets (incl one final print)	US \$	2,600
2. Printing of 50 A0 sheets (to be identified later)	US \$	800
3. 10 days of technical backstopping to the EMIS Officer	US \$	2,000
Total	US \$	5,400

Kindly authorise Finance Office to spend US\$ 5,400, charging budget line xxx.

With best regards

EMIS Officer
 Local EPM Unit

Terms of Reference

- 1) The consultant(s) will produce a set of 6 digital maps (in ArcView GIS format) of the following topographical maps in scale 1:50.000:

Kawe, sheet 186/1 (1993); (full sheet)
Dar es Salaam, sheet 186/4 (1993); (full sheet)
Kisarawe, sheet 186/3 (1993); (full sheet)
Shungubweni, sheet 204/2 (1993); (full sheet)

All digital maps will show the status as shown on the above topographical maps. The maps will be prepared in the following sequence and contain the following layers:

- a) Digitise the coastline of sheets 186/1, 186/4 and 204/2 and prepare a map showing the coastline of Dar es Salaam region.
 - b) Prepare a map showing the traffic network including streets and railroad.
 - c) Prepare a map including the power lines and pipelines.
 - d) Digitise the river network and distinguish three types of rivers (perennial, seasonal, torrential). Prepare a map showing the land use. For the different types of land use see enclosed table.
 - e) Prepare a map showing the height above sea level by digitising the contours and the trigonometrical stations. Use only sheets 186/1, 186/4 and 186/3.
 - f) Use UTM grid, Transverse Mercator Projection, Clarke 1880 (modified) Spheroid and New (1960) Arc Datum (as on original map).
- 2) The consultant(s) will prepare a draft of the digital maps to discuss the finalisation of the maps with the EMIS Officer. The consultant(s) will provide 2 CD-ROMs with the data as well as one final print-outs per layer.
- 3) The consultant(s) will connect and set up the digitiser within the EMIS Unit using the available driver software.
- 4) The consultant(s) will print 50 supplementary colour sheets of maps (A0 size) to be identified later by the EMIS Unit.
- 5) The consultant(s) will provide technical support to the EMIS Unit for GIS techniques using the software used by the EMIS Unit. Programmes used by the EMIS Unit, are ArcView GIS and Map Maker Pro. The support will be undertaken on request of the EMIS Unit and will be not less than 10 days in minimum units of half a day, over a period of one year.

Tool 6: Map Coding

Coding and filing maps in an organised system

Storing hardcopies, structure of the EMIS maps inventory, structure for the EMIS layer inventory, updating the EMIS inventory structure, database driven inventory

Hardcopy-Map Filing System

You will need:

- a map filing cabinet for A0 maps (also see Tool 2: EMIS Equipment)
- a hanging file for A3 maps
- a wide back file for A4 maps
- decide on a coding system to label your maps, for example according to the following proposed system:

Images I - I

Base Map BM - I

Thematic Map TM - I

Suitability Map SM - I

Overlay Map OM - I

(for further details see structure of EMIS inventory)

- label all the map and layer files properly
e.g. Base Maps and Suitability Maps, A4 size
 - label the drawers of the mapping cabinet
e.g. Thematic Maps
 - put the A4 maps in clear plastic folders or poly-pockets
 - attach hanging registry to large maps
 - attach information and code to map and add this information to your Inventory Database
 - file the maps.
-

Overall Structure of the EMIS Inventory

This example of a coding structure, matching the proposed filing structure given in Tool 7: Data File System, is divided into two parts: Coding for maps and coding for layers. Many GIS software programmes - and in particular ArcView GIS - ask you to save your information in two different formats: layers (in ArcView GIS: themes or shape files), which contain the geographical information (also called the geometry), and maps or projects (in ArcView GIS: apr-files) which contain information on the layout of a map, the appearance of the colours, the placement of objects, etc. Because a layer can be used in several maps and a map normally contains several layers it is important to save these formats in different folders and to distinguish between them in the coding system. At the first glimpse the two coding lists appear to be identical, but there are some differences, e.g. there are more maps listed for TM61 Population than there are layers. This is because normally population maps are created using the layer of administrative boundaries. So one layer is used to produce several Thematic Maps.

Structure of the EMIS Map Inventory

Aerial Photographs and Satellite Imagery (AS)

- AS 1 Aerial Photographs
- AS 2 Air Photos
- AS 3 Satellite Images
- AS 4 Scanned Images (e.g. maps)
- AS 5 Site Records (e.g. photographs)

Basic Maps (BM)

- BM 1 Topographical Maps
- BM 2 Base Maps
- BM 3 Street Maps

Thematic Maps (TM)

The Environment Setting

TM I Natural Resources

TM 11 Geology

- TM 111 Minerals

TM 12 Marine Features

- TM 121 Corals
- TM 122 Islands

TM 13 Geomorphology

- TM 131 Landforms
- TM 132 Dynamics
- TM 133 Unstable Slopes

TM 14 Soil

- TM 141 Composition
- TM 142 Soil Types

TM 15 Climate

- TM 151 Rainfall
- TM 152 Temperature
- TM 153 Humidity
- TM 154 Wind

TM 16 Hydrology

- TM 161 Water Table
- TM 162 Rivers
- TM 163 Lakes
- TM 164 Swamps
- TM 165 Flood Plains

TM 17 Biodiversity

- TM 171 Vegetation (Flora)
- TM 172 Fauna
- TM 173 Ecological Areas - Ecotones

TM 2 Natural Hazards

TM 21 Degradation

- TM 211 Pollution
 - TM 2111 Air
 - TM 2112 Water
 - TM 2113 Soil
 - TM 2114 Noise
- TM 212 Erosion

TM 22 Depletion

- TM 221 Non-renewable Resources
- TM 222 Renewable Resources

TM 23 Disasters

- TM 231 Flooding

The Development Setting

TM 3 Administrative Boundaries

TM 31 Regional boundary

TM 32 District boundaries

TM 33 Ward boundaries

TM 4 Land Use

TM 41 Primary sector

- TM 411 Agriculture
- TM 412 Fishing
- TM 413 Mining

TM 42 Industry

- TM 421 Light Industry
 - TM 4211 Small Scale Industry
 - TM 4212 Crafts
- TM 422 Heavy Industry
- TM 423 Informal Industry

TM 43 Commercial

- TM 431 Central Business District
- TM 432 Consumer Services
 - TM 4321 Markets
 - TM 4322 Restaurants
 - TM 4323 Banks
- TM 433 Wholesale and Storage Warehouse
- TM 434 Informal Business

TM 44 Institutional

- TM 441 Public Administration Facilities
 - TM 4411 Government
 - TM 4412 Post Offices
 - TM 4413 Police
 - TM 4414 Military
- TM 442 Community Facilities
- TM 443 Health Facilities
- TM 444 Education Facilities
- TM 445 Cemeteries

TM 45 Housing

- TM 451 Housing System
 - TM 4511 Legal Residential
 - TM 4512 Semi-legal Residential
 - TM 4513 Illegal Residential
 - TM 4514 Co-operative Housing
- TM 452 Housing Density
- TM 453 Housing Condition
- TM 454 Housing under construction

TM 46 Recreation

- TM 461 Open spaces
 - TM 4611 Playgrounds
 - TM 4612 Public Parks
- TM 462 Sport Facilities
- TM 463 Entertainment
 - TM 4631 Cinema
 - TM 4632 Music Hall
- TM 464 Tourism Facilities
 - TM 4641 Hotels
 - TM 4642 Beaches

TM 5 Infrastructure

TM 51 Transport Systems

- TM 511 Road Network
- TM 512 Pedestrian and Cycle-ways
- TM 513 Railway
- TM 514 Harbour
- TM 515 Airport

TM 52 Public Transport

- TM 521 Bus routes
- TM 522 Bus stops

TM 53 Energy and Power

- TM531 Electricity
 - TM 5311 Generation
 - TM5312 Networks
- TM 532 Others (e.g. gas, kerosene, coal, charcoal, firewood)
 - TM 5321 Sources
 - TM 5322 Networks

- TM 533 Renewable Energy
 - TM 5331 Sources
 - TM 5332 Networks

TM 54 Water Supply

- TM 541 Water Distribution
- TM 542 Water Treatment

TM 55 Stormwater Drainage and Flood Control

TM 56 Waste Management

- TM 561 Liquid Waste
 - TM 5611 Sewerage Network
- TM 52 Solid Waste
 - TM 5621 Collection Points
 - TM 5622 Collection Pattern
 - TM 5623 Dump Sites

TM 57 Telecommunications

TM 6 Socio-economic Patterns

TM 61 Population

- TM 611 Absolute Population
- TM 612 Population Density
- TM 613 Population Growth
- TM 614 Age Distribution
- TM 615 Gender Distribution
- TM 616 Migration

TM 62 Education

- TM 621 Formal Education
- TM 622 Informal Education
- TM 623 Training

TM 63 Health

- TM 631 Diseases
- TM 632 Sanitation

TM 64 Land Issues

- TM 641 Ownership
- TM 642 Land Economics
- TM 643 Land Policy

TM 65 Economy

- TM 651 GDP
 - TM 6511 Primary Sector
 - TM 6512 Secondary Sector
 - TM 6513 Tertiary Sector
- TM 652 Employment
 - TM 6521 Primary Sector
 - TM 6522 Secondary Sector
 - TM 6523 Tertiary Sector

- TM 653 Income
 - TM 6531 Public Sector
 - TM 6532 Private Sector
 - TM 6533 Informal Sector
 - TM 6534 Self-employment
 - TM 6535 Income Distribution
- TM 654 Municipal Finance

TM 66 Organisations

- TM 661 CBOs
- TM 662 NGOs
- TM 663 Political Organisations
- TM 664 Religious Organisations

TM 67 Heritage / History

- TM 671 Cultural heritage
 - TM 6711 Ethnic groups
 - TM 6712 Religions
- TM 672 Natural heritage
 - TM 6721 Ethnobotany
 - TM 6722 Ethnozoology

Suitability and Sensitivity Maps (SM)

- SM 1 Environmental Issue One (e.g. Air quality)
- SM 11 Environmental Sub-issue (e.g. Heavy metal air pollution)
- SM 2 Environmental Issue Two (e.g. Water resources)
- SM 21 Environmental Sub-issue (e.g. Suitable areas for drinking water)

Overlay Maps (OM)

- OM 1 Environmental Management Framework
- OM 2 Service Delivery Map

Action Plans (AP)

- AP 1 Working Group Air Quality: One-Way Street System in CBD
- AP 2 Working Group Water Resources: Protection of Water Resources

Structure of the EMIS Inventory (Layers)

Aerial Photographs and Satellite Imagery (AS)

- AS 6 Aerial Photographs
- AS 7 Air Photos
- AS 8 Satellite Images
- AS 9 Scanned Images (e.g. maps)
- AS 10 Site Records (e.g. photographs)

Basic layers (B)

- B 1 Topography
 - B 1 1 Contour Lines
- B 2 Streets
- B 3 Rivers
- B 4 Background
- B 5 Administrative Boundaries

Thematic layers (T)

The Environment Setting

T 1 Natural Resources

T 1 1 Geology

- T 1 1 1 Minerals

T 1 2 Marine Features

- T 1 2 1 Corals
- T 1 2 2 Islands

T 1 3 Geomorphology

- T 1 3 1 Landforms
- T 1 3 2 Dynamics
- T 1 3 3 Unstable Slopes

T 1 4 Soil

- T 1 4 1 Composition
- T 1 4 2 Soil Types

T 1 5 Climate

- T 1 5 1 Rainfall
- T 1 5 2 Temperature
- T 1 5 3 Humidity
- T 1 5 4 Wind

T 1 6 Hydrology

- T 1 6 1 Water Table
- T 1 6 2 Rivers
- T 1 6 3 Lakes
- T 1 6 4 Swamps
- T 1 6 5 Flood Plain

T 1 7 Biodiversity

- T 1 7 1 Vegetation (Flora)
- T 1 7 2 Fauna
- T 1 7 3 Ecological Zones - Ecotones

T 2 Hazards

T 21 Degradation

- T 211 Pollution
 - T 2111 Air
 - T 2112 Water
 - T 2113 Soil
 - T 2114 Noise
 - T 2115 Erosion
- T 212 Over-use

T 22 Depletion

- T 221 Non-renewable Resources
- T 222 Renewable Resources

T 23 Disasters

- T 231 Flooding

The Development Setting

T 3 Administrative Boundaries

T 31 Regional Boundary

T 32 District Boundaries

T 33 Ward Boundaries

T 4 Land Use

T 41 Primary Sector

- T 411 Agriculture
- T 412 Fishing
- T 413 Mining

T 42 Industry

- T 421 Light Industry
- T 422 Small-scale Industry
- T 423 Crafts
- T 424 Heavy Industry
- T 425 Informal Industry

T 43 Commercial

- T 431 Central Business District
- T 432 Consumer Services
 - T 4321 Markets
 - T 4322 Restaurants
 - T 4323 Banks
- T 433 Wholesale and Storage Warehouses
- T 434 Informal Business

T 44 Institutional

- T 441 Public Administration Facilities
 - T 4411 Government
 - T 4412 Post Offices

- T 4413 Police
- T 4414 Military
- T 442 Community Facilities
- T 443 Health Facilities
- T 444 Education Facilities
- T 445 Cemeteries

T 45 Housing

- T 451 Housing System
 - T 4511 Legal Residential
 - T 4512 Semi-legal Residential
 - T 4513 Illegal Residential
 - T 4514 Co-operative Housing
- T 452 Housing Density
- T 453 Housing Condition
- T 454 Housing under construction

T 46 Recreation

- T 461 Open Spaces
 - T 4611 Playgrounds
 - T 4612 Public Parks
- T 462 Sport Facilities
- T 463 Entertainment
 - T 4631 Cinema
 - T 4632 Music Hall
- T 464 Tourism Facilities
 - T 4641 Hotels
 - T 4642 Beaches

T 5 Infrastructure

T 51 Transport Systems

- T 511 Road Network
- T 512 Pedestrian and Cycle-ways
- T 513 Railways
- T 514 Harbours
- T 515 Airports

T 52 Public Transport

- T 521 Bus routes

T 53 Energy and Power

- T 531 Electricity
 - T 5311 Generation
 - T 5312 Networks
- T 532 Others (e.g. gas, kerosene, coal, charcoal, firewood)
 - T 5321 Sources
 - T 5322 Networks
- T 533 Renewable Energy
 - T 5331 Sources
 - T 5332 Networks

T 54 Water Supply

- T 541 Water Distribution
- T 542 Water Treatment

T 55 Stormwater Drainage and Flood Control

T 56 Waste Management

- T 561 Liquid Waste
- T 562 Sewerage Network
- T 563 Solid Waste
 - T 5631 Collection Points
 - T 5632 Dump Sites
 - T 5633 Recycling

T 57 Telecommunications

T 6 Socio-economic Patterns

T 61 Population

T 62 Education

T 63 Health

- T 631 Diseases
- T 632 Sanitation

T 64 Land Issues

- T 641 Ownership
- T 642 Land Economics
- T 643 Land Policy

T 65 Economy

- T 651 GDP
- T 652 Employment
 - T 6521 Primary Sector
 - T 6522 Secondary Sector
 - T 6523 Tertiary Sector
 - T 6524 Informal Sector
 - T 6525 Self-employment
- T 653 Income Distribution
- T 654 Municipal Finance

T 66 Organisations

- T 661 CBOs
- T 662 NGOs
- T 663 Political Organisations
- T 664 Religious institutions/ organisations

T 67 Heritage / History

- T 671 Cultural Heritage
 - T 6711 Ethnic Heritage
 - T 6712 Religious Heritage

- T 672 Natural Heritage
- T 6721 Ethnobotany
- T 6722 Ethnozoology

Suitability layers (S)

S I Urban Renewal

- S 11 Up-grading
- S 12 Replacement

Instructions for Updating Your EMIS Inventory Structure

The structure of your EMIS inventory will depend on the particular needs and uses of your city or organisation. You may find that maps you are creating do not fit into any of the groupings provided (default), and so sub-categories may need to be added or new categories created. On the other hand you may find that some categories are redundant or simply unnecessary, such as 'Marine Resources' in an inland city.

For this reason the file (found on the CD-ROM) has been made in a way that is easily editable. The codes have been created as a numbering style and they should update automatically whenever you make a change.

On the other hand, if you wish to start designing an inventory structure from scratch, you can use the templates provided. These are also found in the CD-ROM.

One thing that can make such a classification system confusing is that all basic maps and layers are also thematic maps and layers. However, each individual map or layer should be given only one code, and should not be assigned to more than one category. For this reason you (as a team) should decide from the beginning what factors determine and distinguish between basic, thematic and suitability maps.

e.g. A Street layer that only shows the different kinds of streets or roads (highways, secondary roads, dirt roads, tracks, etc.) and their names, will fit as a Basic Layer. If more sophisticated attributes are then added to show the amount of traffic found on each road and the noise pollution resulting from it, then it would be categorised separately as a Thematic Layer.

For adding a category

- 1) At the end of the line below which you want to place the new category, press Enter;
- 2) Press the Tab key to go down a level, and Shift+Tab to go up a level until you reach the level you want to place your new category (note that the numbering changes automatically as you go up and down levels);

Instead of using the keyboard, you can use the following tool buttons of the Formatting toolbar: use “Increase Indent” instead of the Tab key and “Decrease Indent” instead of Shift+Tab.

3) Type in the name of your new category.

Adding spaces between categories

Although this is simple, it may not seem straightforward at first. This is because, a) when you press Enter once at the end of an existing code line, your new line will start with a code at its beginning (instead of being a blank space between lines), and b) when you press Enter one more time you will get two blank lines instead of one.

To add only one blank line between two category lines:

- 1) at the end of the line after which you want the space, press Enter once
- 2) press the Backspace key once to delete the code.

You should now have a blank line separating the two categories.

Changing the properties of the numbering format

- 1) You first need to highlight all the lines to which the relevant coding (or numbering) style applies – for instance, all of the lines with Thematic coding, or all the lines with Basic coding.
- 2) Then you can proceed to change the format of this coding section by going to Format menu > Bullets and Numbering > Outline Numbered > Customise where you can change the properties

You will have to change each level individually and the changes you make will be reflected in the preview window on the right. You do this by choosing the desired level from the list on the top left-hand side.

Changing code numbering

3) Under “Number Format”, type in the style of coding you desire for each level.

e.g. If you want to change the coding format from general style “BM | | |” to “bm l.l.l.”, you will type in the difference, but remembering to do so for all the relevant levels.

Changing indentation

4) For each level you will have to define the indentation of the ‘Number Position’ and the “Text Position” separately.

Changing the style of a code level

- 5) The More button on the right-hand-side reveals further properties at the bottom.
- 6) Here you can link any given level to an existing style. Choose any style from the list or keep as ‘no style’.

Using the Templates

Two templates are provided for creating your own inventory structures in MS Word. One is for classifying Layers ('Inventory Structure (layers).dot') and the other for Maps ('Inventory Structure (maps).dot').

Note: *that the extension *.dot designates an MS Word template.*

Here are two different ways in which you can produce new MS Word documents with these templates:

- A. Using Windows Explorer, double click on the appropriate template file (for layers or maps) and this will open a new Word document, based on the format given in the template; or
- B. Copying the template files to the Microsoft Office 'Templates' folder* will then make these templates available when you choose 'New...' under the File menu. This Templates folder is usually found under the following path: C:\Program Folders\Microsoft Office\Templates

Note: *that by opening the templates themselves in MS Word, through the 'Open...' command, you will be editing the templates and not a new document. What you want to do is to create a new document based on the templates. In this way you will conserve the basic format of the template for any future use.*

EMIS Inventory using MS Access Database

The best solution for keeping a sound inventory regarding maps and environmental information is to use a relational database structure, for example MS Access. A relational database allows you to make complex queries within a short time. The CD-ROM contains a sample database on the Nairobi River Basin and a template for developing a customised database. The database is best separated into two main sections: firstly, the map and layer database according to the above coding; and secondly, according to the environmental priority issues identified through the Environmental Profile and the City Consultation. Each Issue-Specific Working Group will have its own space to slot in information related to their priority issues. Much information can be extracted from the minutes of the working group meetings. Other tabular/numeric information can be directly linked to map layers.

Tool 7: Data File System

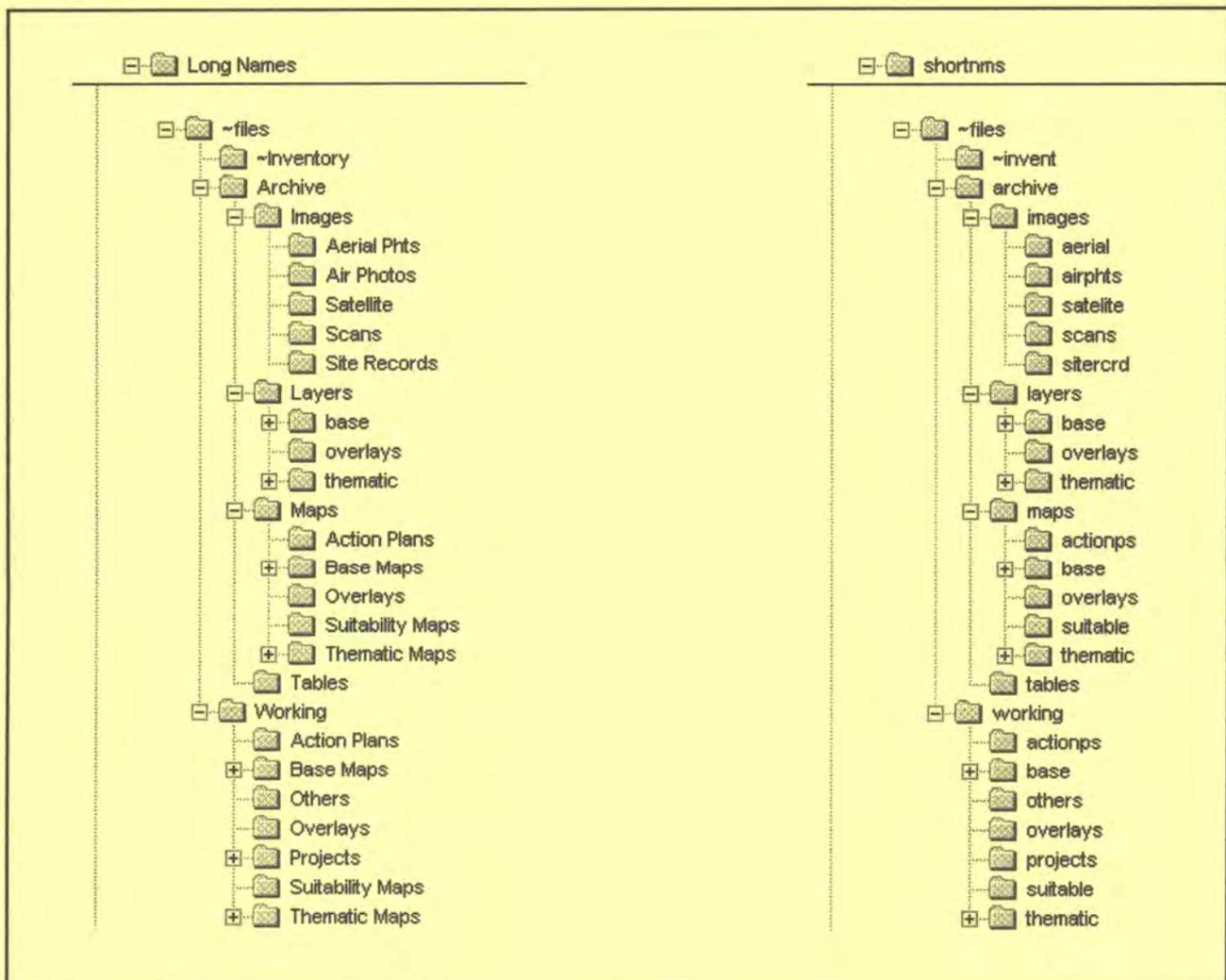
How to structure the digital data of the EMIS

Examples of a data file system

Inventory, Archive Folder, Working Folder

The digital data will be stored in three main folders: inventory, archive and working. The inventory folder stores the meta-database of the EMIS, the archive folder stores the up-to-date, finalised layers, maps and tables, while the working folder stores current projects and layers. Once a project or layer is finalised in the working folder it will be transferred to the archive folder. In the same way, if a map or layer stored in the archive folder needs updating, this file will be copied to the working folder, where the necessary changes are being done. Once you are satisfied with the update, the old map or layer remaining in the archive will be replaced with the new one. Remember: the purpose of the archive folder is to be able to open ready maps at once without changing layout, scale or print size.

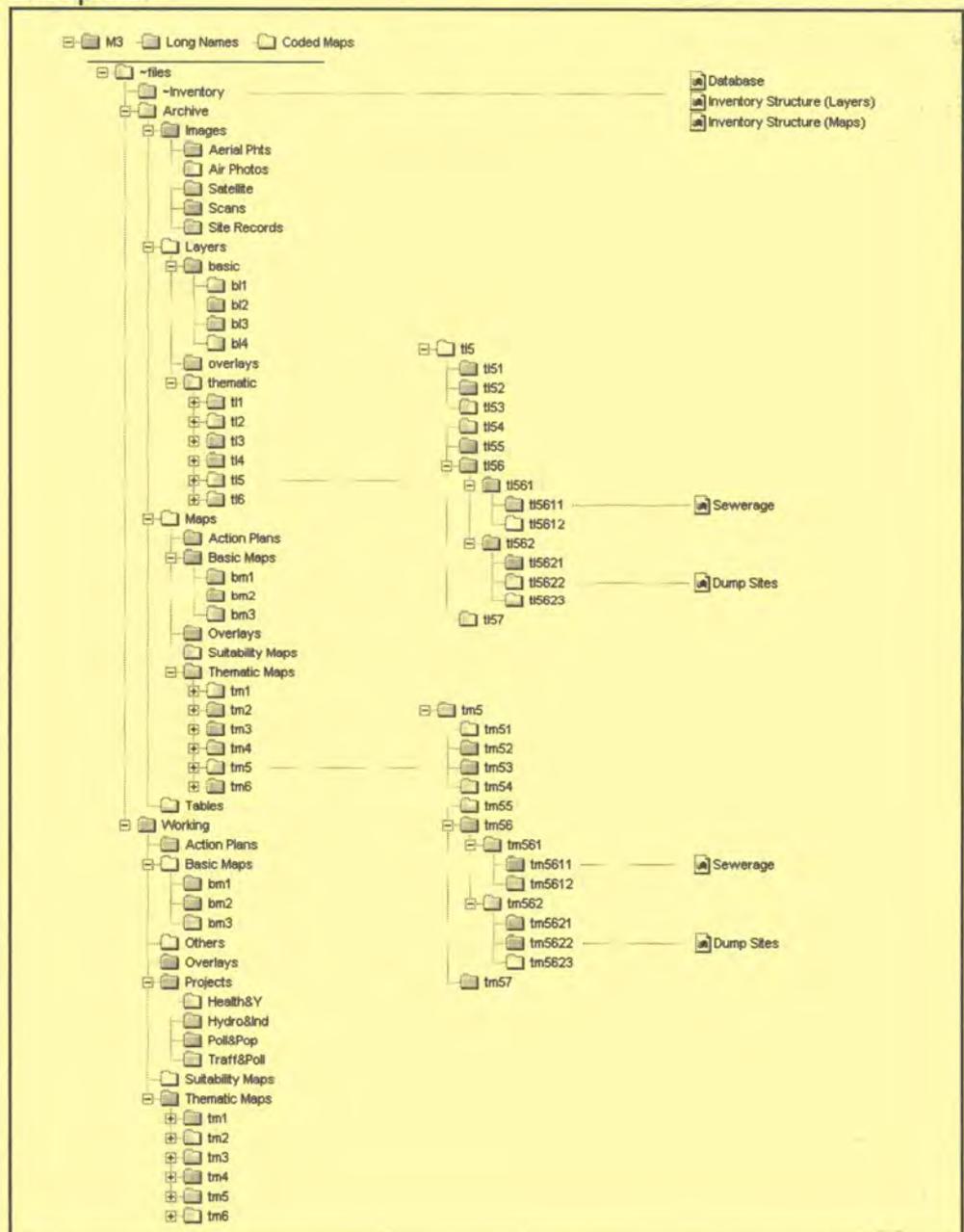
Example 1:



In the archive there are four subdirectories: *Images*, *Layers*, *Maps* and *Tables*:
In *Images* aerial photographs, satellite images and scanned maps are stored.

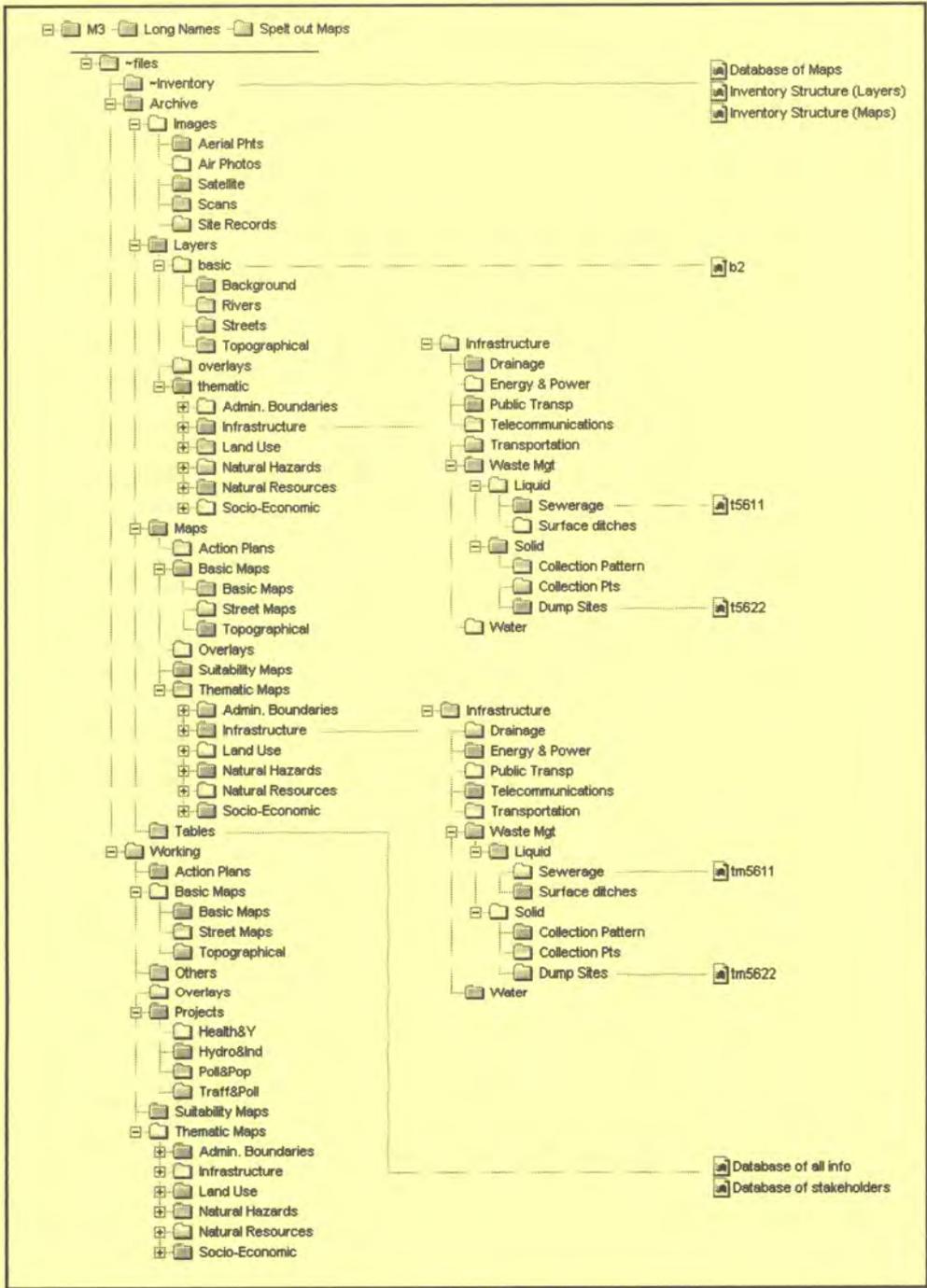
Tables contain the databases of environmental and development issues, ideally separated by each cities' environmental priority issues. The spatial data is stored in the folders *Layers* and *Maps*. This separation between *Layers* and *Maps* is necessary because a layer can be used in several maps and several layers can be used in one map. The *Maps* directory contains ready made maps (in ArcView GIS: Project (*.apr) files, in Map Maker Pro: Map files). The *Maps* directory is ideally structured according to the environmental priority issues so that Issue-Specific Working Groups have faster access to their maps. The difference between the data structure on the left (*long names*) and on the right (*shortnms*) is that the latter uses names for folders and files which are no longer than eight letters (the MS DOS concept of eight plus three file names). This can be important if your system still based on an MS DOS operating system or if you exchange data frequently with people using other systems, such as UNIX. Also, ArcView's internal file manager ("Manage Data Sources") can not handle long file names.

Following are two examples which show the file tree in more detail:
 Example 2:

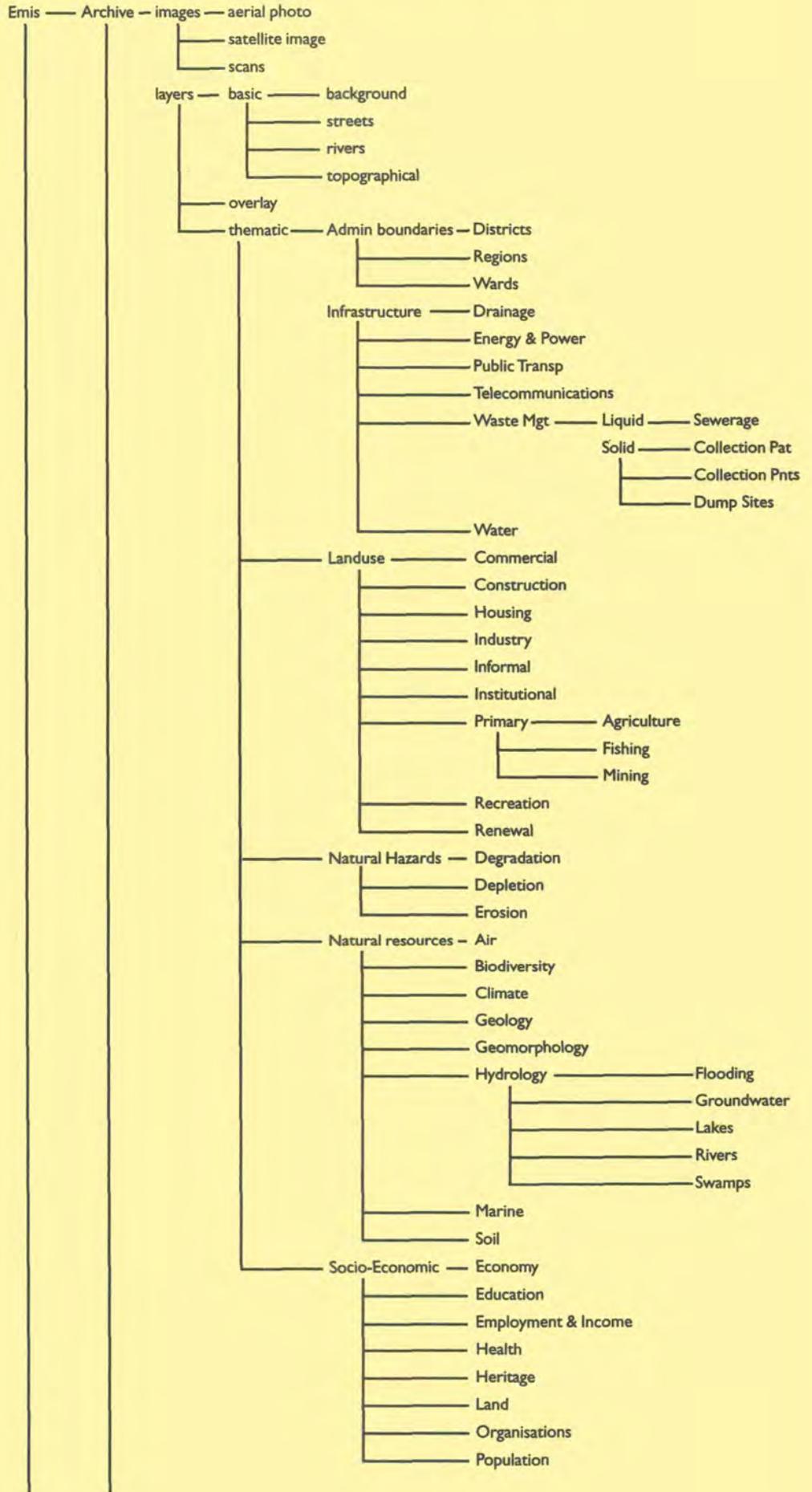


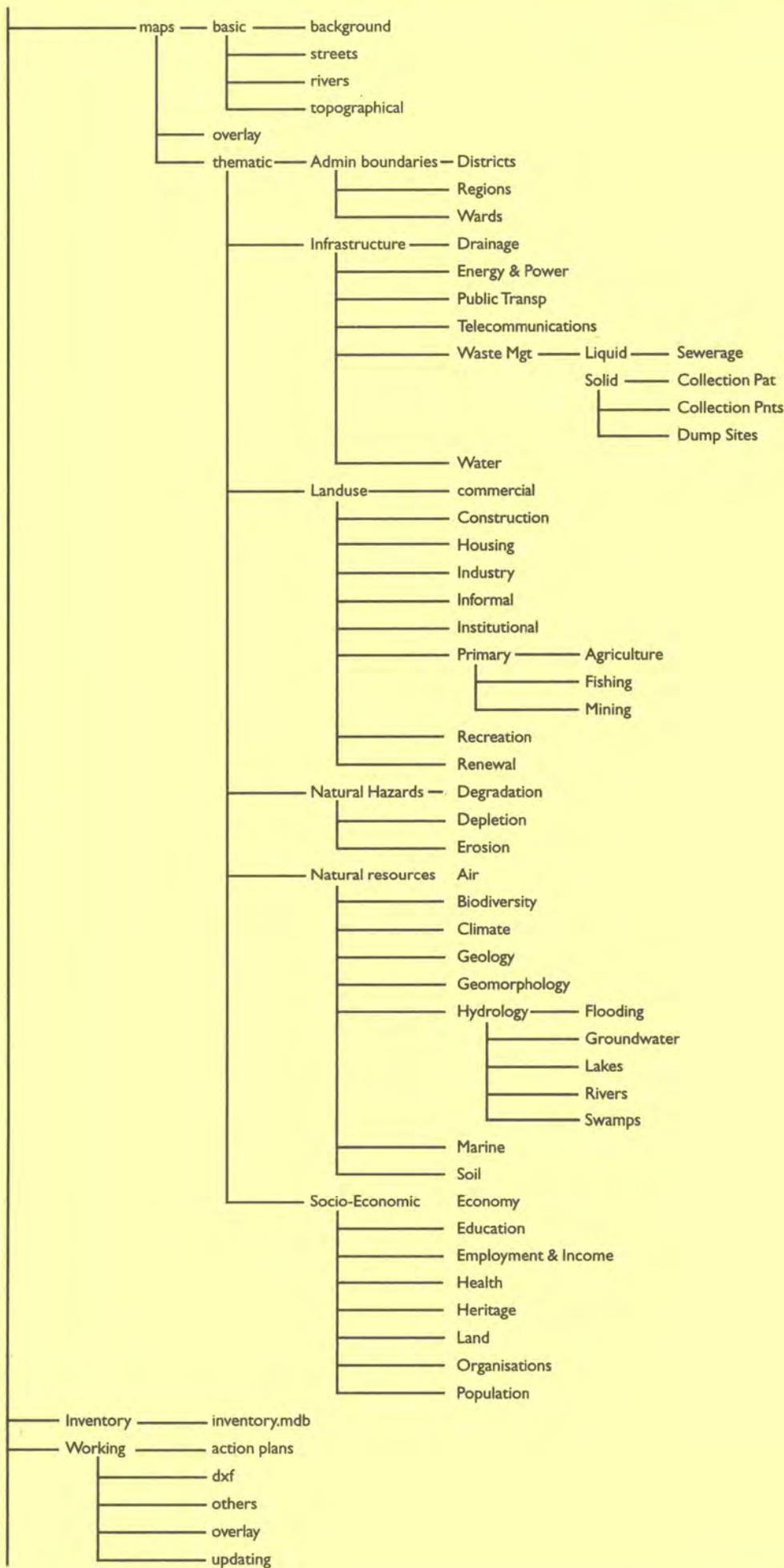
The main difference between these two examples is the way the layers and maps are named: either with a code according to the mapping coding system is used or with a name describing the content of the map. This latter version is easier for somebody new to the EMIS, but has its limits when several versions or similar topics are saved. With the first system, it is easier to link to the map database, the map coding system and the data file system.

Example 3:



Example of a Filing Structure for EMIS





Basic Map

- Tool 8** Creating a Basic Map
- Tool 9** Standard Layout
- Tool 10** Digitising with a Digitising Board
- Tool 11** Digitising with Scanned Maps
- Tool 12** Data Conversion
- Tool 13** Purchasing Images

Tool 8: Creating a Basic Map

Checklist for creating a Basic Map; Examples of basic layers

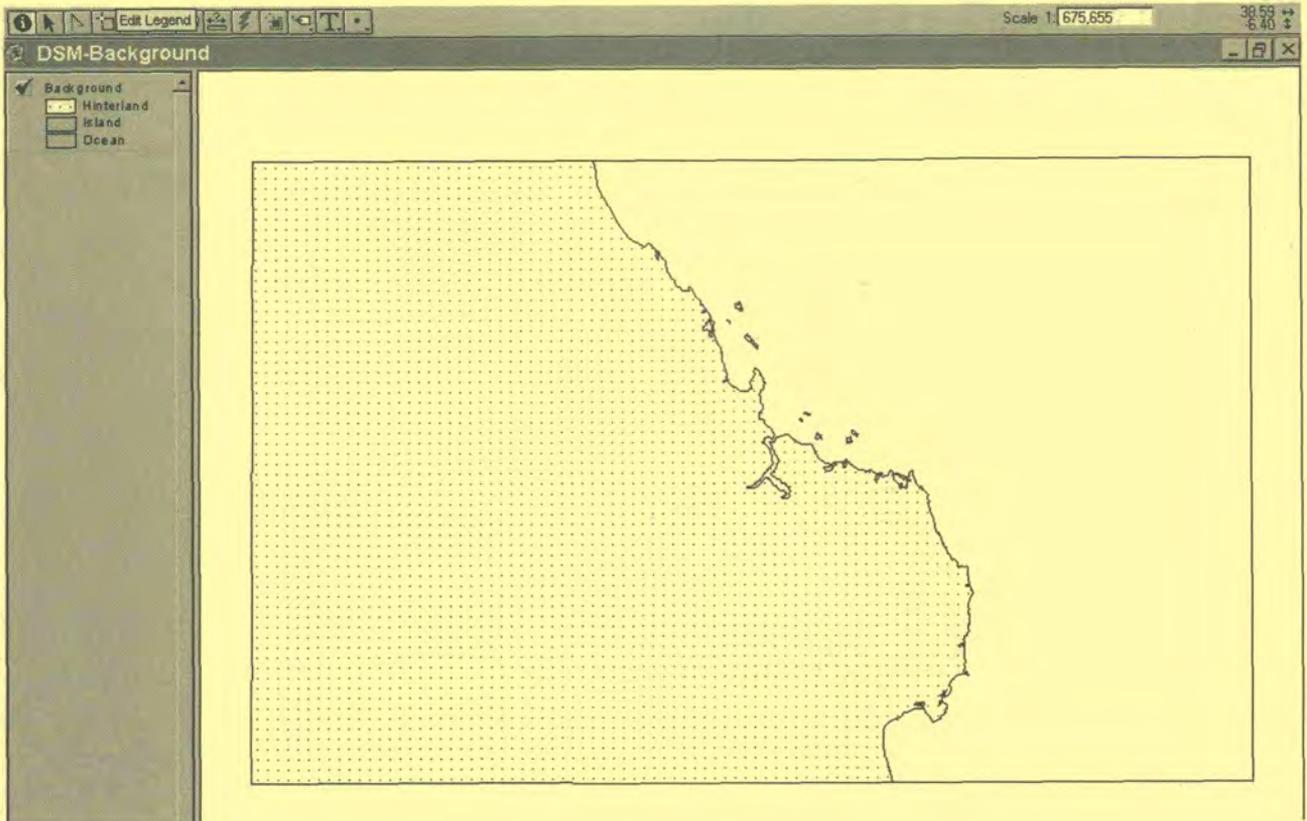
Checklist for creating a Basic Map

This checklist is used to define on which map source is it based, which layers are produced and how the Basic Map will look. For more information about the standard layout of EMIS maps, refer to Tool 9: Standard Layout.

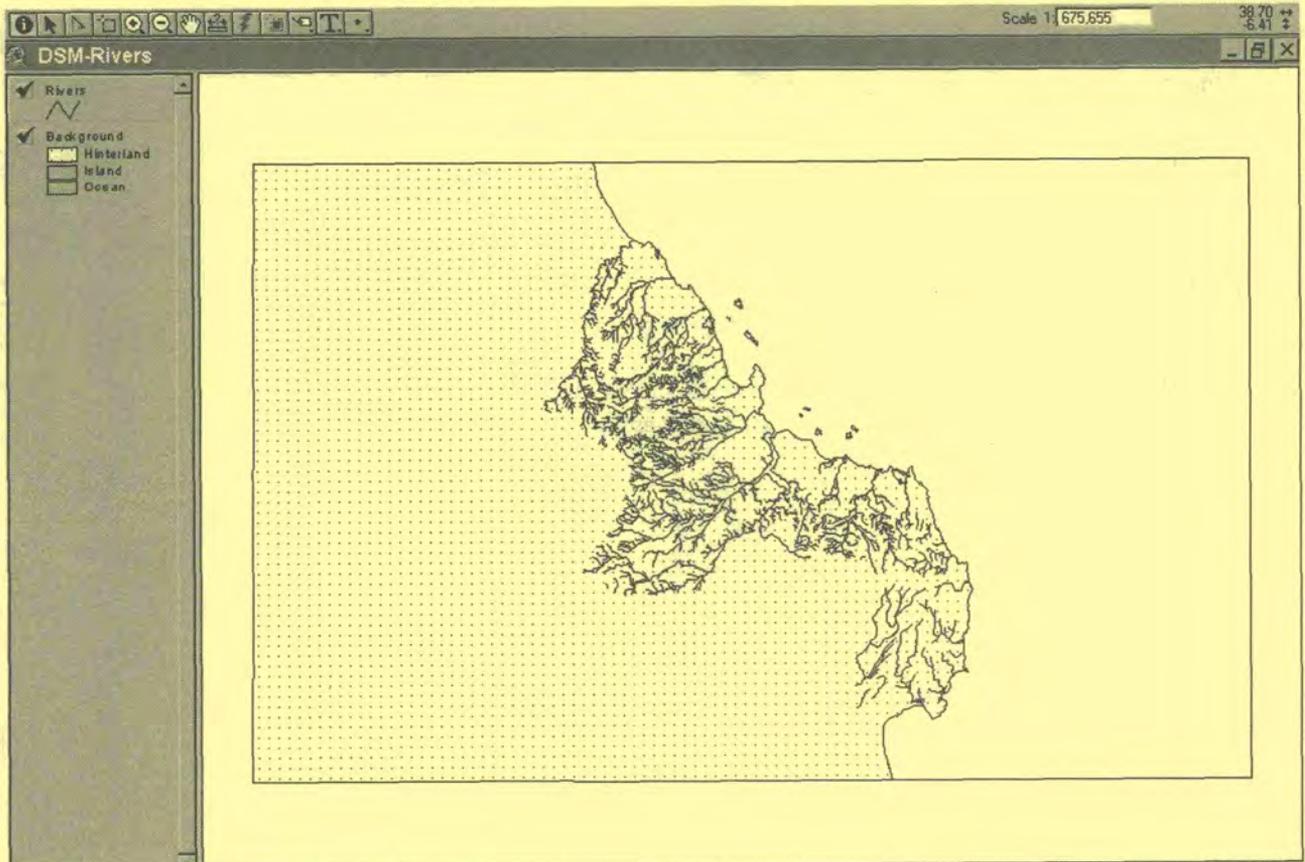
- Area to cover: _____
(Which area should your maps and analysis cover? Indicate landmarks)
 - Scale: _____
(If you want to use different scales, indicate which ones)
 - Source map(s): _____
(Which sources will you use as a basis for your Basic Map)
 - Projection: _____
(What is the projection and datum which you will use in the Basic Map? Does this match to other existing data?)
 - Layers
(Which layers should be included in your Basic Map?)
 - Rivers
 - Roads/Streets
 - Landforms
 - Administrative boundaries
 - Contour lines
 - Built-up area
 - Layout
(How should your standard layout look like?)
 - Paper size: _____
 - Orientation: landscape ____ or portrait ____
 - Cartographic features: _____
 - Typical title _____
 - Standard source _____
 - Colour and/or black & white _____
 - Images _____
(Do you have to update layers with more recent images?)
-

Typical Basic Map Layers

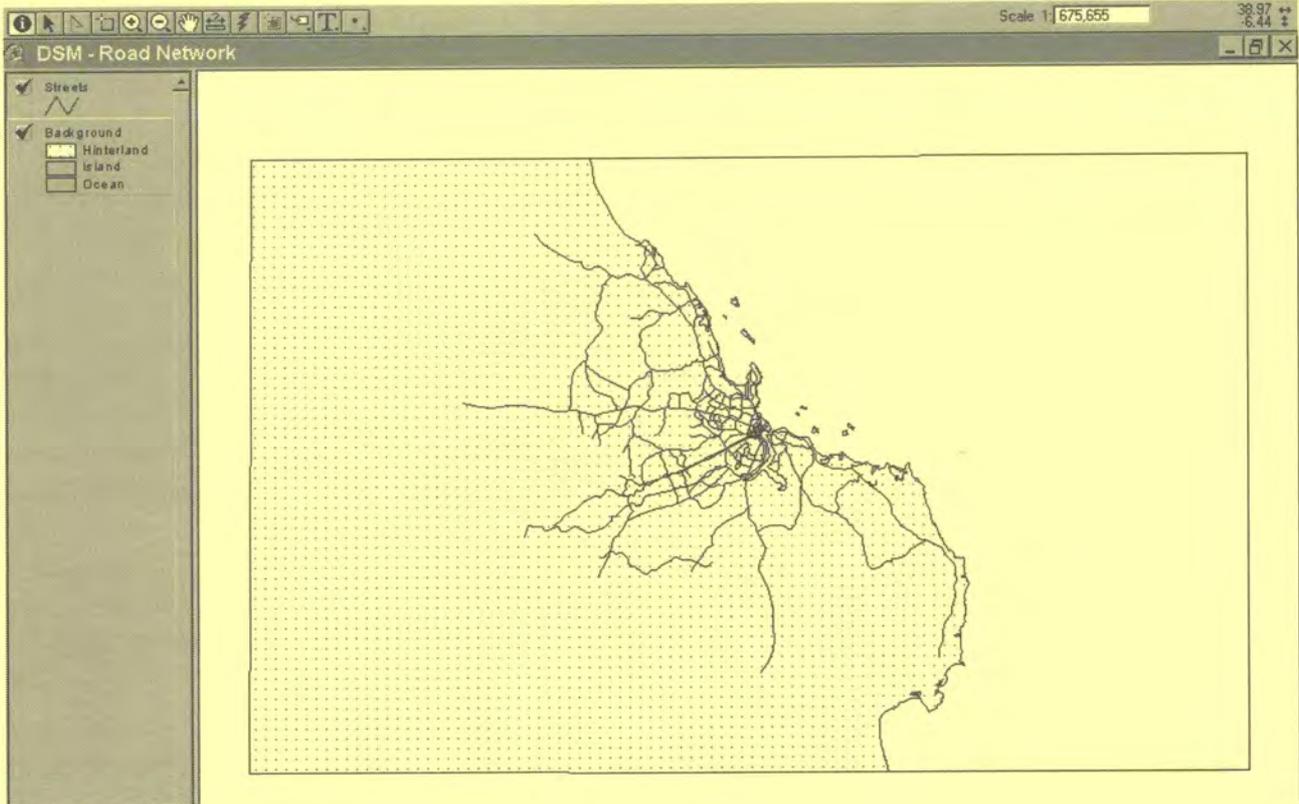
Background, such as coastline, hinterland, ocean and islands. Note: all features are polygons which share the coastline as the same common boundary:



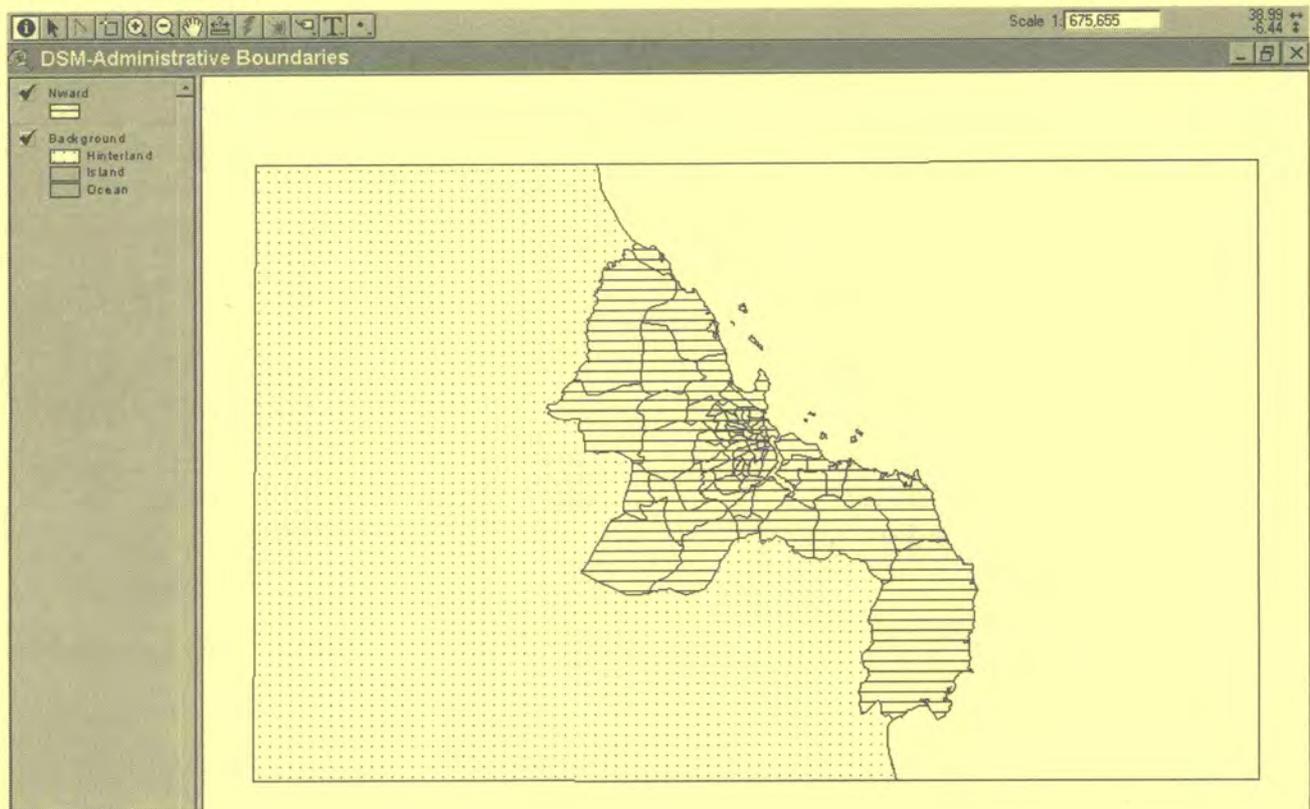
River network:



Road network:



Administrative Boundaries:



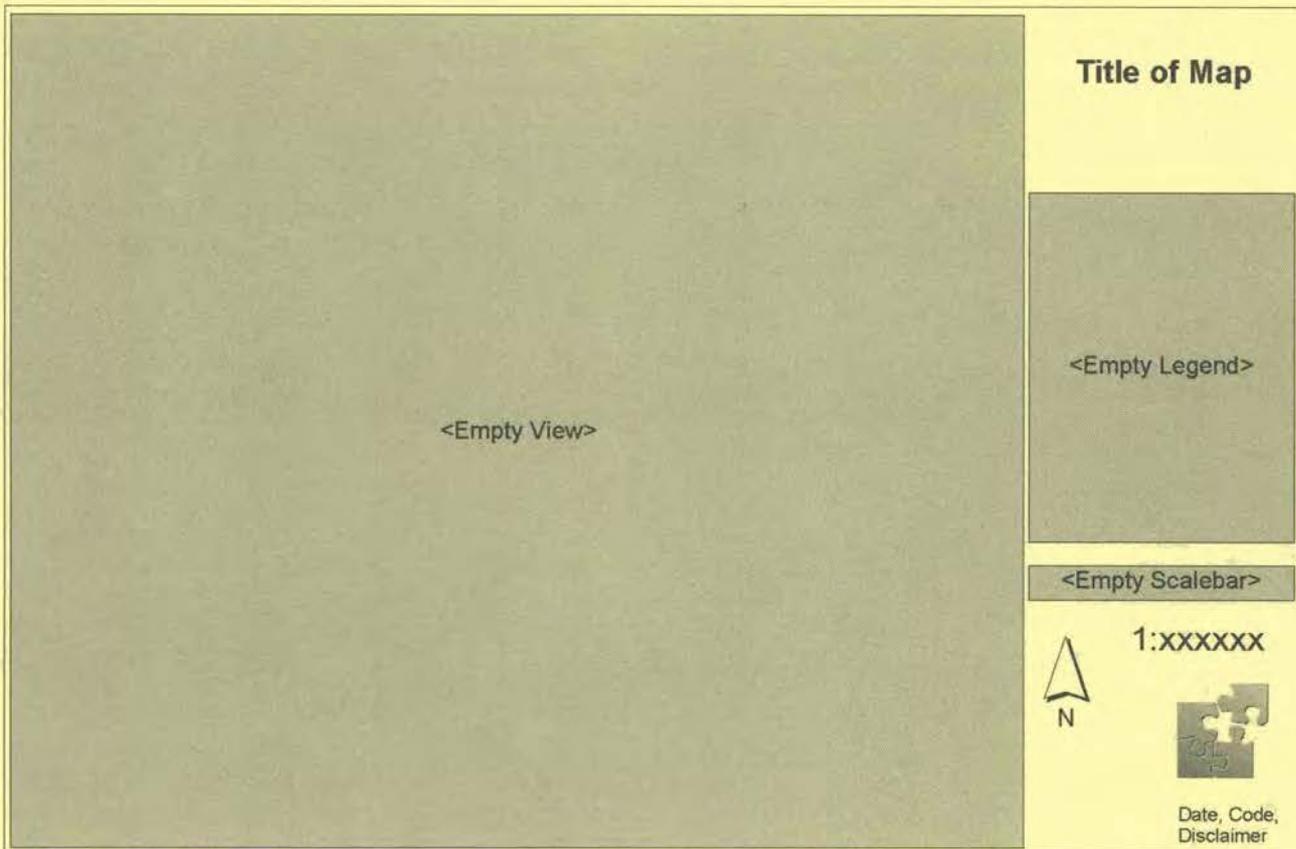
Tool 9: Standard Layout

How to use a template to lay out a map

Standard layout, How to create a template in ArcView GIS, How to use a template in ArcView GIS

Standard Layout

The maps prepared for the EMIS will all have the same appearance. A clear standard layout will save you time in the production of maps. Such a standard layout also helps to create a recognisable visual identity for the EMIS Unit. Tool 8: Checklist for creating a Basic Map, has introduced some of the decisions that need to be taken in developing a standard map layout. Tool 9 now provides more detail on how to make these choices. You will find customised templates on the accompanying CD-ROM, which look like this:



Standard questions for developing a layout:

- **Paper size and orientation**
Which size will the map normally be printed? Which orientation of the paper best suits the area to be shown on the map (landscape or portrait)?
- **Cartographic elements**
How will the north arrow look?
Where will the legend be placed, what will be legend title and which measuring units have to be indicated?
What type of scalebar will be used? It is best to use both, a scalebar and the scale in 1:n (e.g. 1:50000)

- **Title of the map**

The purpose of the map title is to make the topic and the geographic area of the map immediately clear (e.g. 'Landuse in Dar es Salaam' or 'One Way Street System in the City Centre of Dar es Salaam').

Please use the same title properties (font, size, colour, etc.) for different maps.

- **Logo**

Usually, the maps produced by the EMIS Unit contain the unit's logo or the official logo of the municipality.

- **Disclaimer**

The disclaimer includes project name, map code, date of the map, author(s) of the map, source of the information and the data used (including date of the source information) projection used, and filename.

For example:

Project: Nairobi River Basin Project; TM4-3

Cartography: Peter Kibe, Inti Trujillo

Source of information: Mapping and Survey Department, Data from Issue-Specific Working Group on Sanitation

Date: December 1999

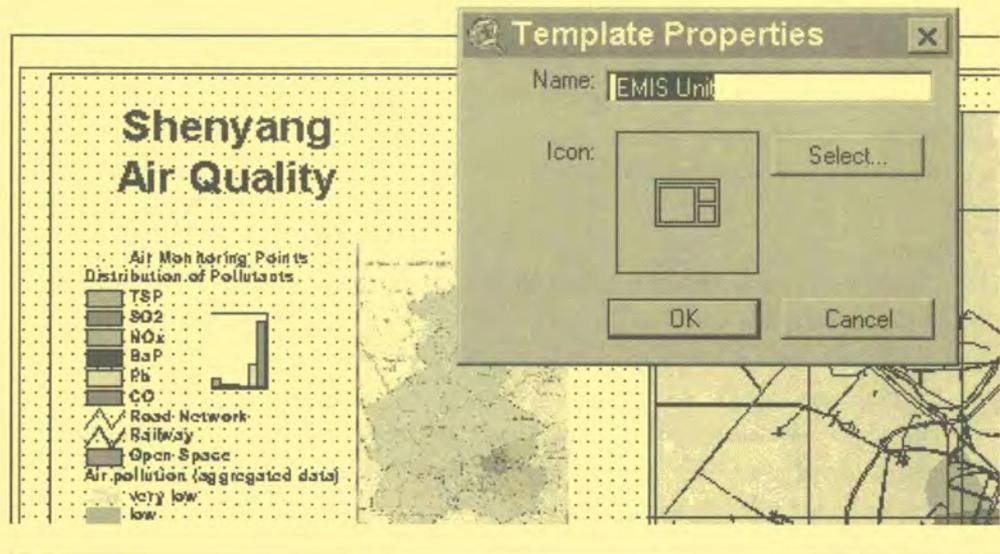
Projection: UTM Zone 37, Clarke 1880, New (1960) Arc

File name and location: C:\nairobi\archive\maps\thematic\landuse.apr

Create a template in ArcView GIS

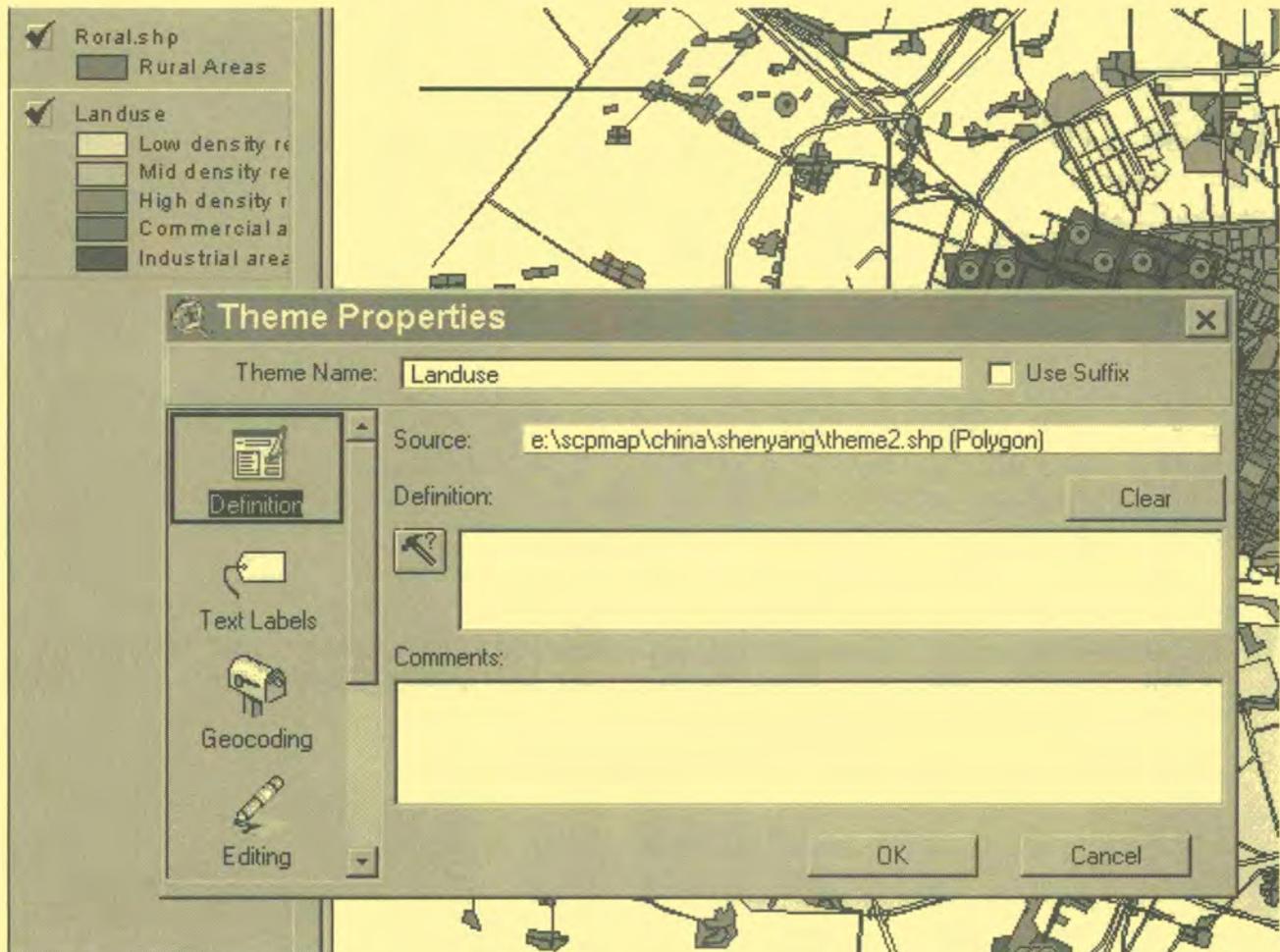
Any layout can be saved as a template. You can use the standard templates provided with the software to create your own customised layout template for your EMIS.

1. Open the Project Dialog Box in ArcView GIS
2. Click the Layout icon
3. Click New Layout
4. Go to menu Layout -> Use Template
5. And choose the template you want to adjust
6. Now you have to:
 - Define the page set-up
 - Type in a title
 - Type the disclaimer
 - Make any other changes necessary (frames, logos etc.)
7. To save this layout as a template, go to menu Layout -> Store as Template
8. In the Dialog Box, give your template a name and choose an icon to represent it
9. Press OK



Use a template in ArcView GIS

After you have prepared a particular view in ArcView GIS you will publish this view with your customised layout template. Make sure you have defined the map projection and set the map units. Under the Theme Properties, you can customise the names of the individual themes the way you want to make them appear in your legend.



1. **From the View menu choose Layout**

Select the template you want to use

2. **Check the scales**

There is a live link to the view to which your layout refers to. You can adjust the scale, in order to make the map extent fit on the page or to show a 'round' scale, e.g. 1:20000.

3. **Adjust the legend**

You may have to simplify the legend to change the text and the arrangement of the symbols. If you want to change the size of the text and boxes evenly you have to select all boxes and text. Group them and resize them. Do not forget to mention the units of the measurement of what is shown on the map. Note: If you "simplify" objects on the layout they will lose the live link to your respective view.

4. **Type the title**

Change the title according to the subject of the map and the map extent.

5. **Change disclaimer**

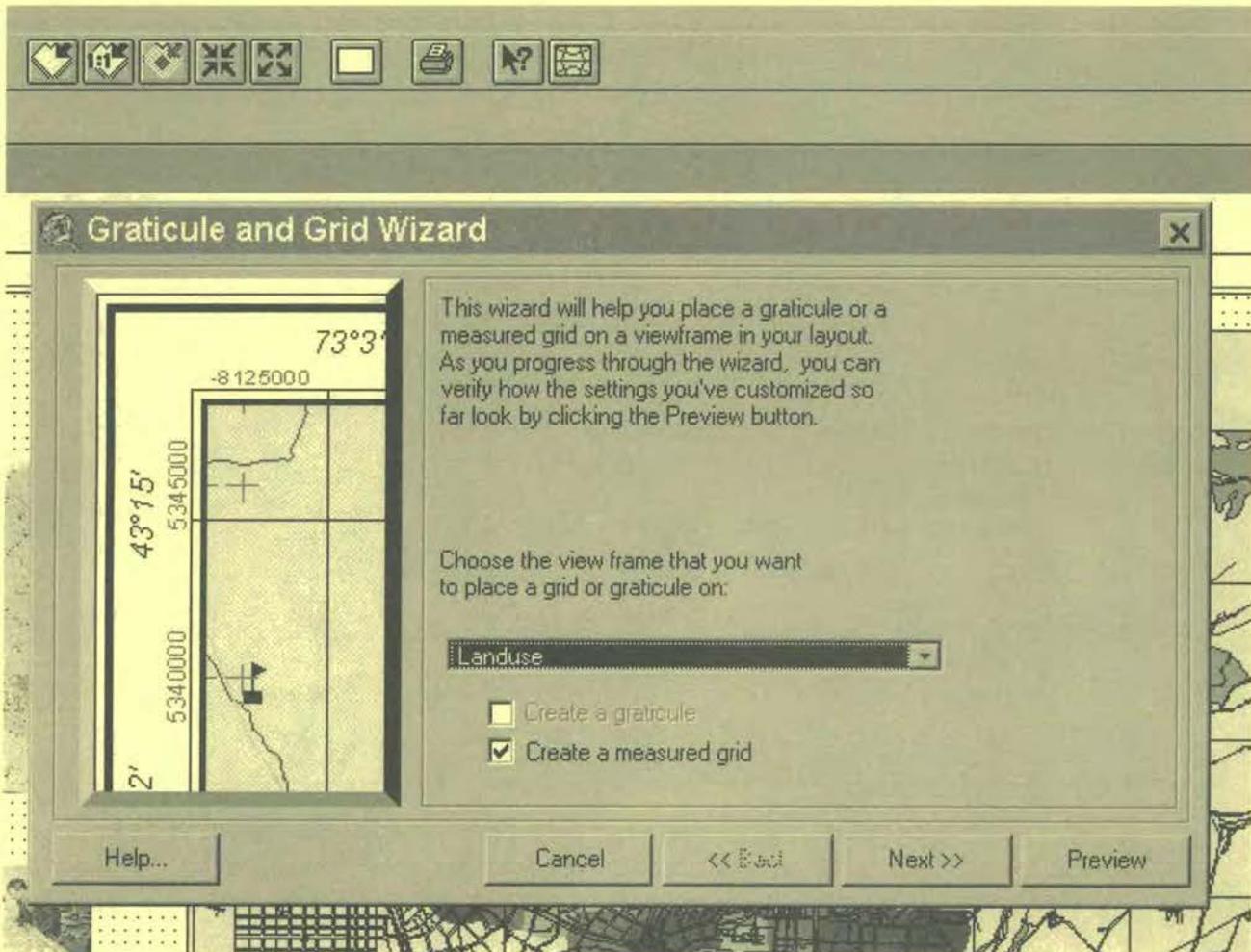
Please type in the correct date and filename, and probably the source of the information. Do not forget to mention the year of the data shown on the map.

6. **Add gridlines**

Load Extension "graticules and measured grids"

A new tool button appears on the right side of the iconbar

Click on the button while you are in the layout and follow the instructions of the wizard.



Tool 10: Digitising with a Digitising Board

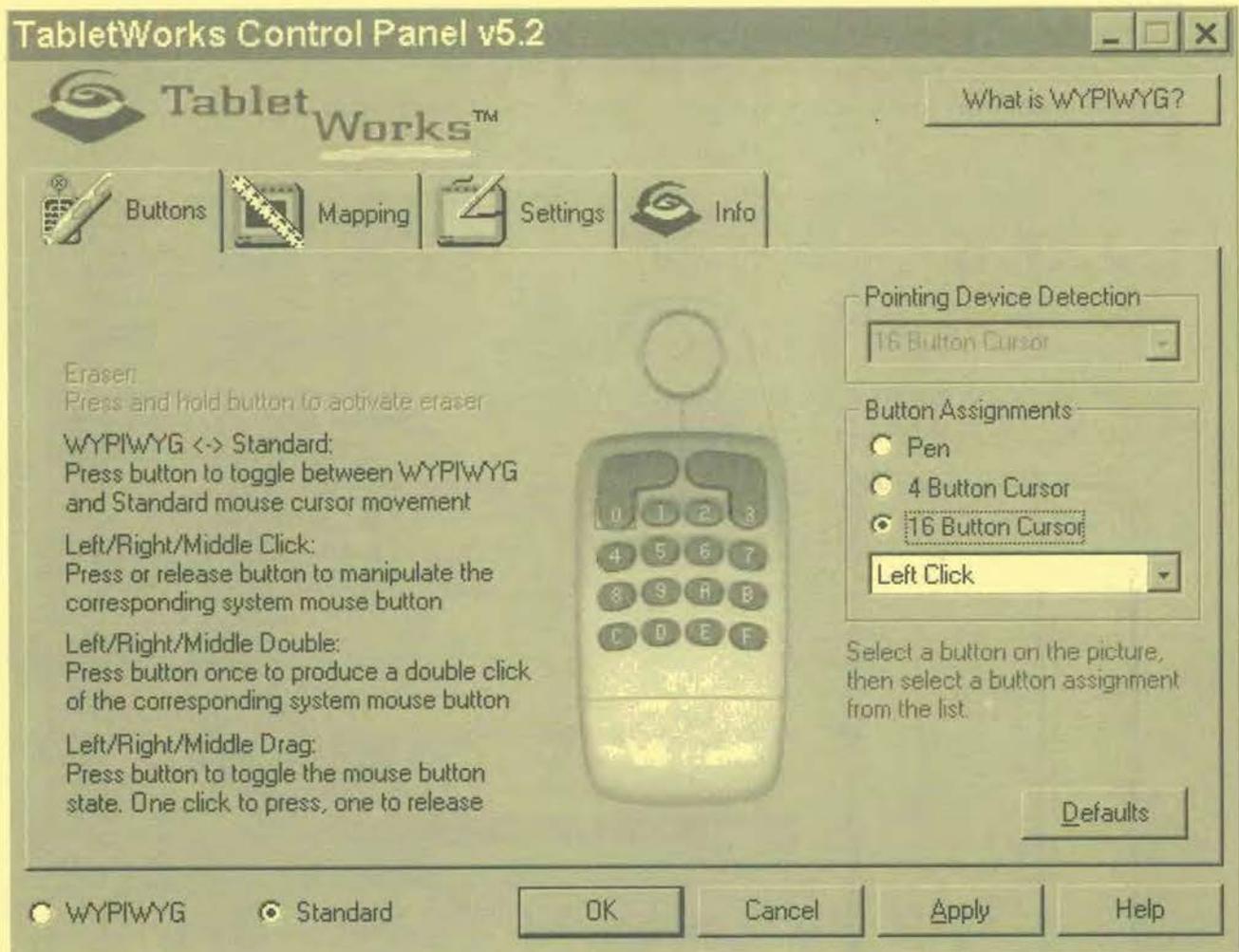
How to digitise maps using a digitising board

Preparation for digitising, Digitising in ArcView, Digitising in MapMaker

Preparations for digitising

The most accurate way of digitising data is by using a digitiser. Set up your digitiser and make sure that it communicates well with the computer. In most cases the digitiser has to be switched on before starting the computer. Modern digitising boards come with WinTab compliant drivers (or make sure that you order a digitiser which is WinTab compliant). The driver software will allow you to assign puck (the tablet's pointing device) buttons accordingly (please refer to your User Manual of the digitising board). For example, a 16 button puck could have the following assignments:

Button No. 0: Left Click
 Button No. 3: Right Click
 Button No. 1: Left Double Click



Your map should be reliable, up-to-date, flat, and not torn or folded. Paper actually expands or shrinks according to weather conditions. To minimise distortion between digitising sessions experienced digitisers often copy paper maps to a more stable material like mylar. If the map is bigger than your digitising board, it is advisable to photocopy the map sections instead of folding it.

Discuss the features to be digitised with the mapping group.

Note: *if the map contains too much information, it can be difficult to trace lines consistently. Therefore trace the lines for the respective layer manually on tracing paper before you digitise.*

If your map has a grid or a set of known ground points, you can use these as your control or reference points. If not, choose at least four distinctive locations, such as road intersections, and mark them on your map with a pencil. Give each one a unique number and write down its actual ground coordinates. You will use these control points to register your map to the geographic space in your view.

Digitising in ArcView GIS 3.2

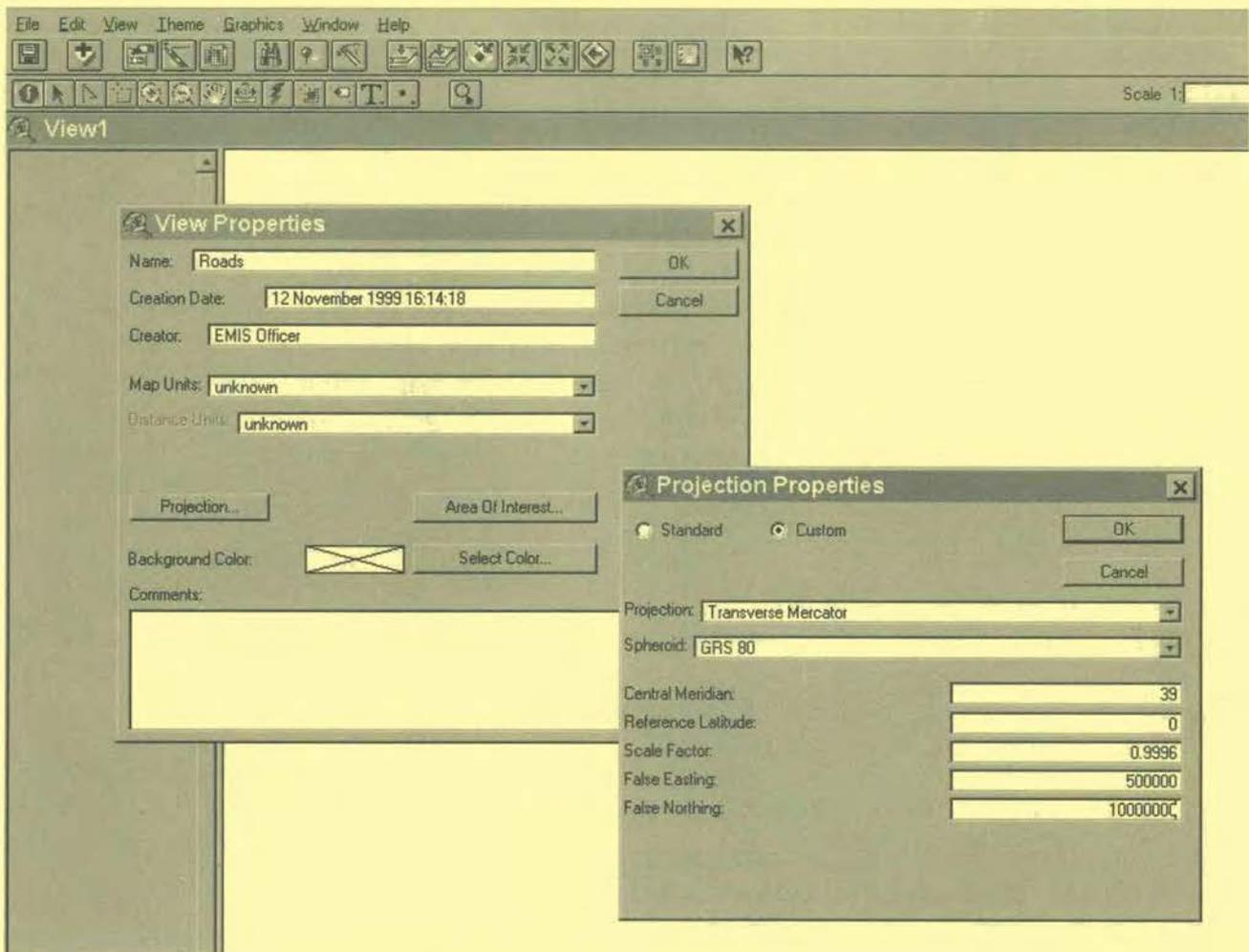
(For detailed instructions, please read the relevant section in the ArcView GIS Manual.)

ArcView GIS allows you to prepare accurate digital maps of high quality. This makes ArcView GIS a full-fledged GIS software.

Prepare the view

Before you register the source map and start digitising features, you must prepare the view by specifying the map units that you want to use. Then set the projection according to the source map. If you do not set this information correctly, your newly digitised features may be incorrectly stored and you may not be able to correct the problem after digitising features.

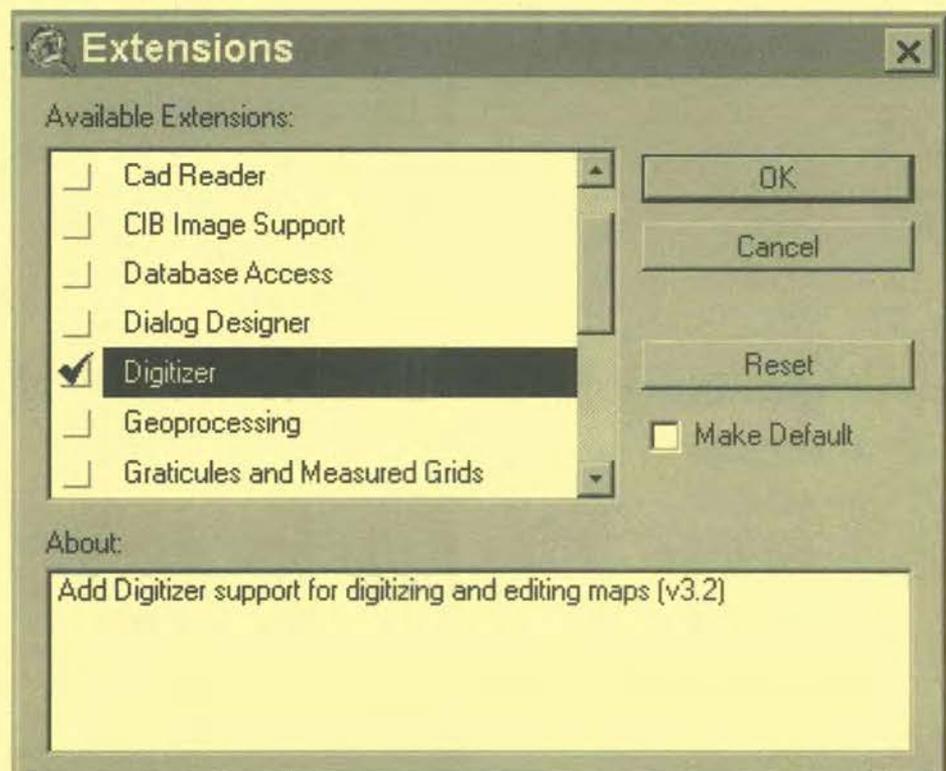
1. From the View menu choose **Properties**
2. In the dialog that appears, click the **Projection button**
3. Set the projection properties so they match the projection used by the source map you will be digitising. If necessary use the custom projection parameters to **match** your source map's parameters (e.g. datum, false northing etc.).
4. Press OK
5. Set the desired Map Units from the dropdown list. By default, the map units are metres.
6. Press OK



To load the digitising extension

Go to File > Extension

Put a checkmark (✓) on digitiser extension.



To register the paper map

1. From the View menu choose Digitizer Setup. Specify how much error you will allow by entering a value in the Error Limit field (optional).
2. Click the digitizer puck icon and begin using your digitizer tablet's pointing device. Digitise at least four control points you have identified on your paper map. A record appears in the dialog for each control point you digitise.
3. Type in the actual ground co-ordinates for the control points in the X Co-ordinate and Y Co-ordinate fields.
4. Once you have entered at least four control points and their true co-ordinates, ArcView displays the error at each control point in the Error field. It also calculates the Root Mean Square (RMS) error and displays the information as calculated error.
5. Compare the calculated error with the value specified in the Error Limit edit box. It should be lower than the Error Limit. If the calculated error is larger than the Error Limit, you cannot register your map, and you will have to do one of the following.
Re-digitise the control points on your paper map.
Re-enter the corresponding ground control points.
Increase the value in the Error Limit edit box and press the TAB key.

Note: Substantial increase in error tolerance may lead to poor quality digitising.

6. Click the Save button to save the ground co-ordinate values for future use so that you do not need to re-enter the co-ordinates when you re-register the map. Click on the Register button. This will register your map and dismiss the dialog box.

Digitizer Setup

14723
5834

Load... Save...

	Id#	X Coordinate	Y Coordinate	Error
*	1	250000.000000	9862000.000000	8.6565
*	2	250000.000000	9873000.000000	8.6512
*	3	267000.000000	9873000.000000	8.6772
*	4	267000.000000	9862000.000000	8.6826

Error Limit: 0.008 in

Calculated Error: 0.007 in

Error Report... Register Cancel

Digitising

1. **Create a new theme**
 - VIEW > NEW THEME
 - Define type of features (line, point or polygon)
 - Name and save the shapefile
2. If you are going to digitise a line or polygon shapefile it is helpful to define the **snap environment**
 - THEME > PROPERTIES
 - Choose EDITING
 - Put a checkmark (✓) in general or interactive
3. **Start digitising**
4. **Save your work continuously** while you are digitising.

Please note: After a longer break (e.g. lunch break) you should re-register the map. The paper can shrink or expand or somebody may have moved the map.

Clean your geometry

After you have digitised all the features on your map, the shapefile is still not yet ready to be used. While digitising, many little errors will occur which you might not see straightaway. One way to correct these is to adjust the geometry to existing layers. ArcView GIS does not have a cleaning command such as ArcInfo's "CLEAN".

e.g. You have digitised housing areas. These areas are very often separated by road. Therefore it is useful to compare an existing road layer with the digitised housing areas and to adjust the areas where necessary.

Another thing is, that even though you have used the snapping environment not all lines may have snapped.

e.g. You have digitised the rivers and ditches in a neighbourhood. The river-network should be completely linked together, otherwise there will be problems analysing later on. So you have to zoom to all the line junctions to connect them if necessary.

Add information to the attribute table**Adding attributes to the features for layout**

All colouring, hatching or styling of your points, lines or polygons is done through your attribute table. The attribute table is a dBase based database table, which contains information for each feature in your map.

1. Activate the respective THEME (shapefile), open its attribute table (make sure that you have the right table) and **start editing**. The VIEW Window and the TABLE window should be both on your screen.
2. **Add new Field**, enter a meaningful name, define whether the data will be numbers, strings, Boolean or dates, and adjust the width of your new column.
3. Activate the VIEW window and **push the Select feature button**. Click on a feature and it will turn to yellow. The respective row in the table will also turn yellow.

4. Activate the TABLE window, choose the edit button and **fill in your data** in the highlighted cell in your new column.
5. Repeat 3 and 4 until your table is filled.

Note: SAVE EDITS while you are filling data to avoid loss of data.

6. STOP EDITING

Calculating LENGTH or Area of a feature

1. Open attribute table of the respective theme and START EDITING
2. ADD NEW FIELD (numeric)
3. Click the CALCULATE button to display the field calculator dialog.
4. In the expression box type:
[Shape].ReturnLength
or
[Shape].ReturnArea
5. Divide by the respective factor in order to get sqkm or ha values in the field, e.g. divide by 100,000 to show ha with metres as map units
6. and click O.K.

Digitising in Map Maker Pro

Map Maker Pro's digitising facility is more basic than the facility in ArcView GIS, but it works equally well.

Prepare

If the digitising board is properly connected to the computer, Map Maker Pro will recognise it immediately. See TOOLS > DIGITIZER (ACTIVE)

To calibrate the paper map

- Go to TOOLS > DIGITIZER > CALIBRATE
- Click at the bottom left corner (the control point)
- Type in the co-ordinates of that control point (in metres, such as UTM)
- Define the map units (default is metres)
- Click at the top right control point
- Type in the co-ordinates of that control point (in metres, such as UTM)
- Click OK

If you move your digitising puck across the digitising board, the co-ordinates in the bottom left corner of Map Maker Pro will change.

Digitising

- Choose the drawing tool you need.
- Digitise
- Save Live Layer as a drawing (dra-file)

Note: in some cases the digitised drawing does not appear on the screen while digitising. In this case, just draw one small polygon, save the live layer, clear the screen and open the saved drawing into the live layer. From now on, the objects are visible while digitising.

Clean your geometry

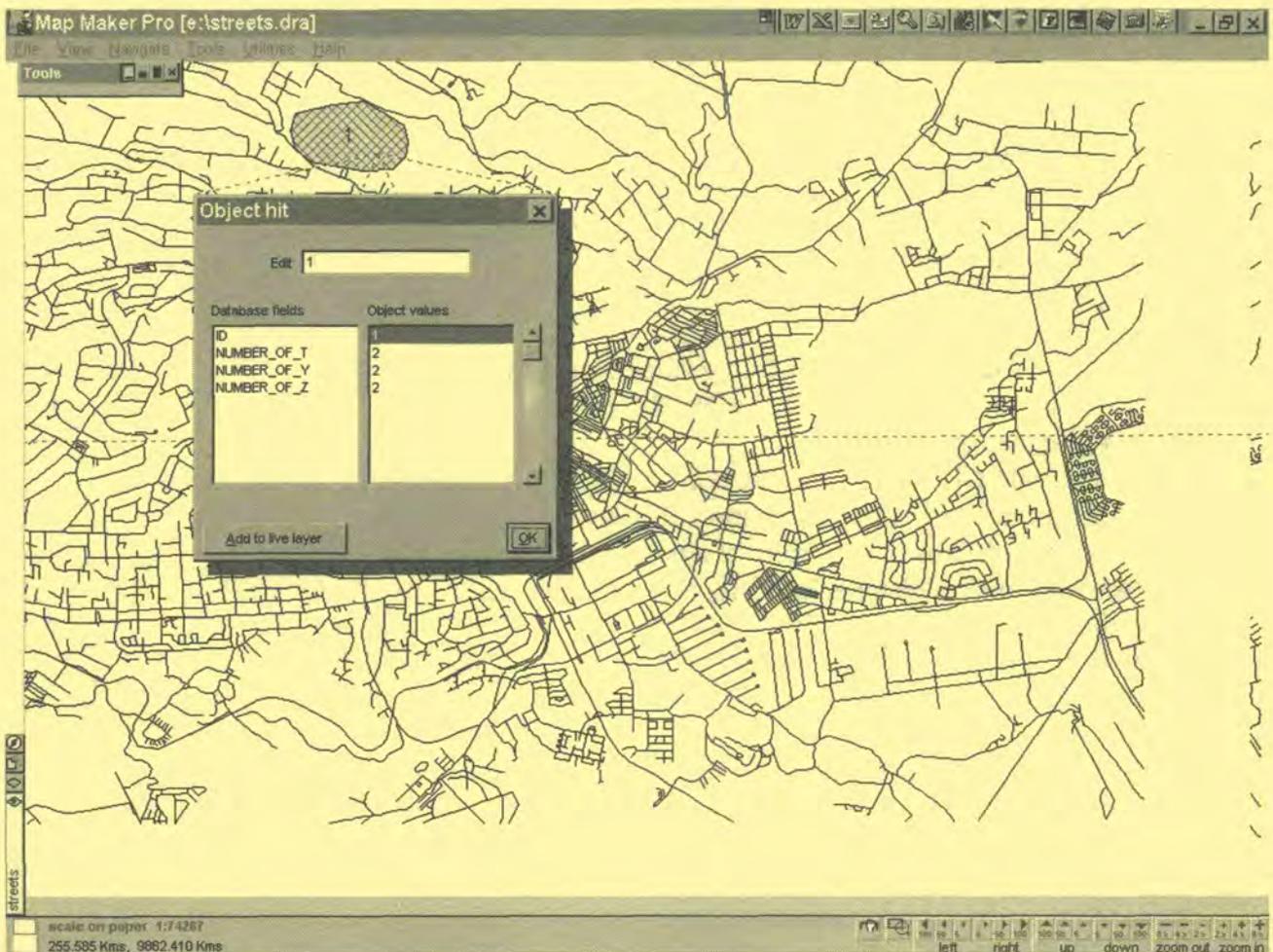
Choose the edit tool to clean the geometry or use the various functions of the “live layer transforms” such as “Tidy Line Junctions”, “Tidy Common Boundaries” etc.

Add information to the attribute table

Adding attribute data to a table is easier in Map Maker than in ArcView GIS. After digitising, follow the steps:

1. Go to File>Data and choose “Generate data file”;
2. Select the previously digitised dra-file;
3. Choose “dBase III dbf” in the next dialogue box and specify the number of columns you intend to fill;
4. Type a name for the new dbf file (take the same as the dra file);
5. Click OK and the new Attribute Table to your drawing will appear.

Once you have created the table, your Query Tool allows you to edit the attributes directly by clicking the particular object.



Tool 11: Digitising with Scanned Maps

How to digitise maps onscreen using a scanned map or imagery

World file, GeoTiff, Scanning, georeferencing with Map Maker Pro, digitising onscreen with Map Maker Pro and ArcView GIS

World file - GeoTiff

Images are stored as raster data, where each cell (pixel) in the image has a row and column number. Maps in the EMIS are stored with real-world co-ordinates like longitude-latitude, UTM or others. In order to display images (scanned maps or aerial photographs) together with already digitised maps it is necessary to conduct an image-to-world transformation that converts the image co-ordinates to real-world co-ordinates.

Some image formats, such as ERDAS, IMAGINE, BSQ, BIL, BIP, GeoTIFF and grids, store the georeferencing information in the header of the image file. However, other image formats store this information in a separate ASCII file, otherwise called world file. It is easy to identify the world file which accompanies an image file: world files use the same name as the image, with a "w" appended. For example, the world file for the image file mytown.tiff would be called mytown.tiffw.

The contents of the world file will look something like this:

```
20.17541308822119
0.000000000000000
0.000000000000000
-20.17541308822119
424178.11472601280548
4313415.90726399607956
```

The image-to-world transformation is accessed each time an image is displayed. The transformation is calculated from either the world file or the header file.

GeoTIFF format is a non-proprietary geographic TIFF format. The purpose of GeoTIFF is to provide information that lets raster imagery (scanned maps, satellite images, results of geographic analysis, etc.) be read automatically into correct position and scale within many GIS softwares. GeoTIFF is read by most GIS platforms. The end-user does not have to translate for each application which means no duplication of files, no entering of strings, co-ordinates, generation of proprietary control files, etc. Users who may not be fully familiar with "projection" or "datum" can easily get their imagery loaded in their GIS with the correct position and scale.

The official homepage of GeoTIFF is at NASA-JPL:

<http://www-mipl.jpl.nasa.gov/cartlab/geotiff/geotiff.html>

SPOT maintains a WWW pointer page to a variety of GeoTIFF resources:

<http://www.spot.com/anglaise/news/press/devconf/resource.htm>

Scanning of existing maps or images

1. Preparation

- a) Study and discuss the original map with the Mapping Group, regarding the quality of the original, acceptable errors, the area to be scanned, and mechanisms for calibration.
- b) Determine the features (e.g. roads, rivers, houses, contour lines) which should be digitised and to be converted into points, lines and polygons after scanning.

2. Scan paper map

Note: *find a good balance between good resolution and reasonable file size. An A4 map should have a minimum resolution of 100 dpi, and should fit on a diskette. GIF or JPG formats are compressed graphic formats. A 1MB TIFF file can be converted to a 100 KB JPG file.*

3. **Rotate the scanned image** to its original direction, if necessary. You can use a graphic programme, such as MS Photo Editor (part of MS Office).

Note: *Scanned images (maps, aerial photographs) can not be directly calibrated and adjusted to real world co-ordinates in ArcView GIS. Without calibration your final map will not have the right scale and will not show valid distance units. Use uncalibrated maps for producing "quick and dirty" maps only. Otherwise use ArcView extensions or Avenue scripts such as Register and Transform Tool (on CD-ROM), Image Warp, etc.*

Georeferencing with Map Maker

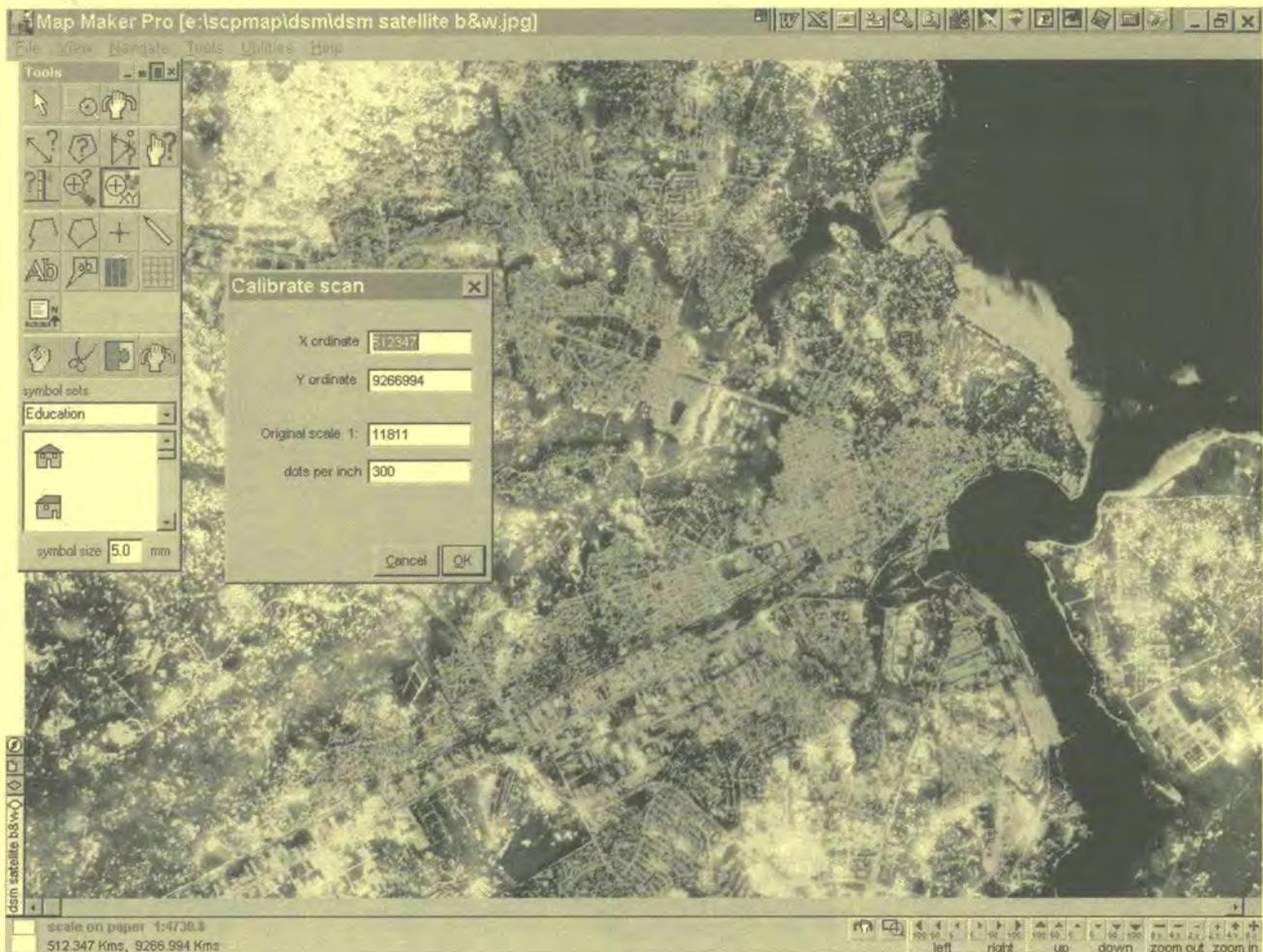
Map Maker Basic and Map Maker Pro software offer a simple but useful tool for calibrating scanned images. In order to calibrate the scan, you need the following information:

- a BMP or TIFF file;
- one reference point;
- the x-y co-ordinate of the reference point (in metres, such as UTM);
- the original scale; and
- dots per inch of the scanned image.

You also have the option of inserting a value for rotation.

1. **Click on File - Clear screen** to ensure that no file is loaded into the Live Layer. A bitmap file can only be calibrated if it is the only layer present in the Live Layer.
2. **Go to File - Open and select the bitmap file (BMP or TIFF)** to be calibrated. Use the navigation tool, Pan by Dragging, to manoeuvre the image so that a location with the known co-ordinates is visible on the screen. If you are using a scan of a paper map, for example, you might use a grid intersection as the known reference point.

3. **Select Tools - Calibrate scan.** The cursor changes to crossed hairs. Locate the cursor over the known point. Click once with the left mouse button and release. A dialogue box appears. Enter the co-ordinates of your reference point, then the scale of the scan in the third field down. The next field down (dots per inch) should already show the resolution you chose when you made the scan. You may have an aerial photograph, which has not been produced to scale, a sketch map or a bitmap that you acquired digitally. You can use a known distance. To determine the scale in such cases, you must know the distance between two fixed points. Double-click on one known point. Now drag the cursor to the second point and click again. A dialogue box similar to the box described above will appear but here you enter the distance in metres between the reference point and the second point.

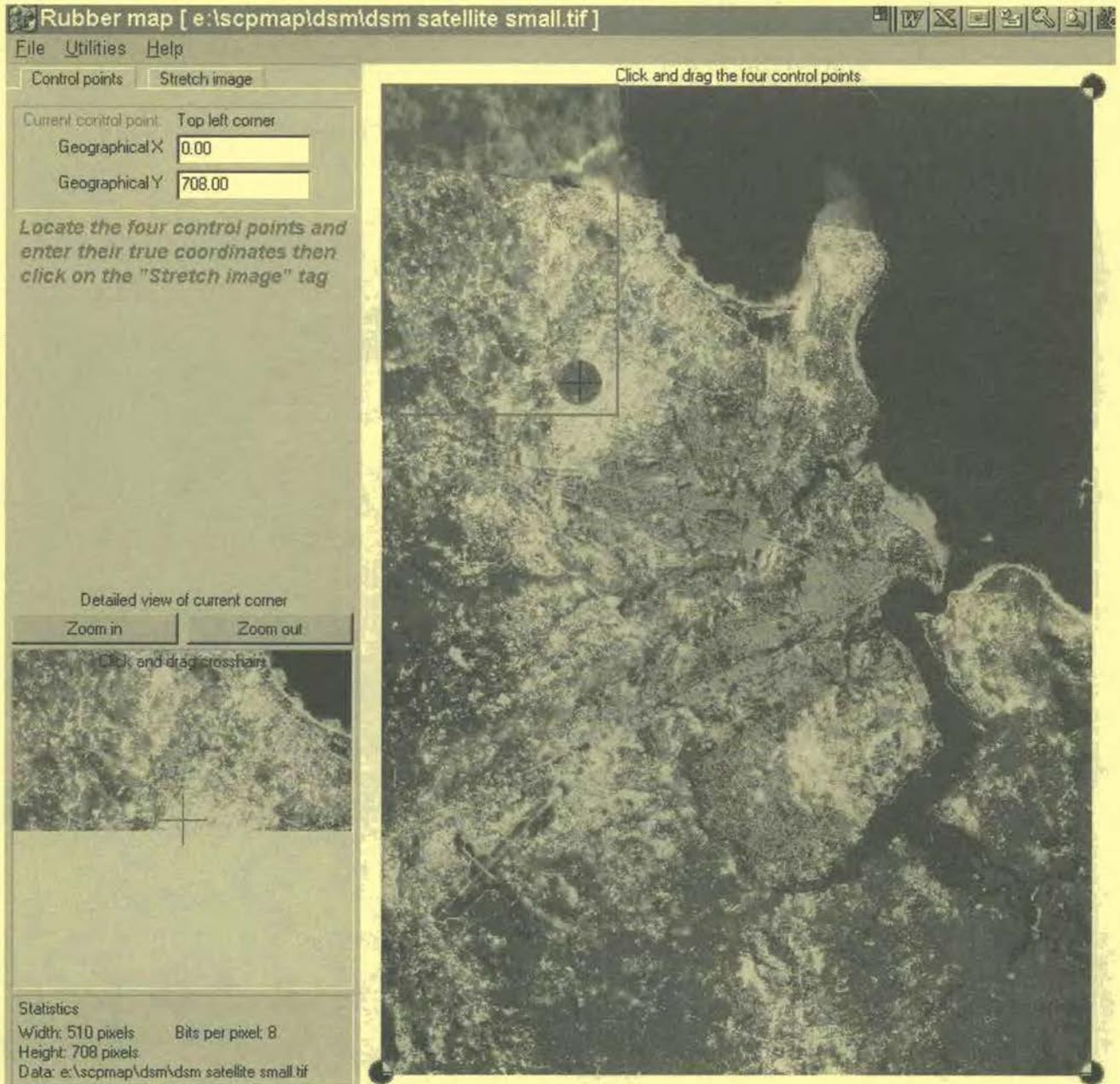


4. **Click OK.** The scan automatically reloads in order to accommodate the scale. Now, distances, areas, and co-ordinates should be correct.
5. Choose an appropriate **drawing tool** and start digitising the features you need.

Note: This method does not rectify the image and does not correct any distortions. This tool is only to be used if there is no other possibility of rectifying your image.

Map Maker offers an additional useful extension for more accurate image registration called Rubber Map.

Briefly, this operates in two modes: "Four control points" and "Rubber sheet". The four control points are fairly self-explanatory, you simply locate four known points and enter their true co-ordinates.



"Rubber sheet" requires Map Maker Pro from version 2.3 (dated after 26th Oct 1998). Load your bitmap in Map Maker Pro and use the "calibrate bitmap" tool to approximately calibrate the image. Then overlay your correct vector data, which may be a few known points or the complete vector data of roads and boundaries etc. Load these vectors into the "live layer". Go to the Live layer - Transform menu and click on "add rubber sheet". Now use the "edit object" tool to drag the intersections of the rubber sheet grid to distort the vector data to make it fit the bitmap. When you have a good fit go back to the Transform menu and click on "save rubber sheet".

Now go back to “Rubber Map”, choose your bitmap, choose rubber sheet distortions, choose the rubber sheet data you just saved in Map Maker Pro. When you click on “generate bitmap” the bitmap will be distorted using the rubber sheet distortions in reverse to make it fit to the correct vectors.

Those rectified images have a fairly high accuracy. Since ArcView GIS does not offer accurate image rectification, you can use Map Maker Pro for digitising and export the drawings to ArcView GIS.

Georeference in ArcView GIS

ArcView supports the following image formats as themes: ARC Digitised Raster Graphics (ADRG) (with extension), BMP, BSQ, BIL and BIP, Compressed ARC Digitised Raster Graphics (CADRG) (with extension), Controlled Image Base (CIB) (with extension), ERDAS, GRID, IMAGINE (with extension), IMPELL Bitmaps (Run-length compressed files), Image catalogues, JPEG (with extension), MrSID (with extension), National Image Transfer Format (NITF) (with extension), Sun raster files, TIFF, TIFF/LZW compressed.

Note: *ArcView GIS does not rotate, or warp, images. If your world file has non-zero rotation terms (D and B parameters), the image may change its position relative to vector data in the same view when you zoom or pan.*

To register an image in ArcView the script “**register.avx**” can help. This extension can be found on the CD-ROM or at the ESRI homepage (<http://www.esri.com>). This extension was created to register aerial photos that are already ortho-rectified. This extension works with jpg and bmp type images, as well as with, tif, bsq, bip, bil, and sun image types.

This extension will create a world file for an image by picking control points between the image and a projected feature theme. The first order fit can shift the image up or down and stretch the image both vertically and horizontally. Keep this in mind because it will not “warp” or “rubber sheet” the image.

1. To use this extension **place it in your ext32 directory** and from the File -Extensions menu select the Image to Map World File Creator.
2. You should see a blue diamond on the Project Button Bar. Press this button to begin and you will be asked for the name of the image you want to create a World File for and the name of the Feature Theme you want to register it to.
3. On the left side of your tool bar you will see a new tool that looks like a flag. Choose this tool and with it pick Ground Control Points (GCP's) that have the same spatial location for both the image and the feature theme, i.e. Pick a point on the image. Pick a point on the feature theme that is the same location. This constitutes 1 GCP pair.
4. Now continue: Pick a point on the image, pick a point on the feature theme that is the same location.

5. Continue doing this until you have at least **6 GCP pairs**.

For a first order fit you need a minimum of 3 pairs but it is recommended that you have twice the minimum so the code is set up so that you have to pick 6 pairs.

6. Once your GCP's are chosen **minimise the two views** and open the table called Ground Control Point Table.

This table has 6 fields:

<i>Use Pnts</i>	<i>You will notice every record has this field ON</i>
<i>Input x</i>	<i>For the image x co-ordinate</i>
<i>Input y</i>	<i>For the image y co-ordinate</i>
<i>Output x</i>	<i>For the output x co-ordinate</i>
<i>Output y</i>	<i>For the output y co-ordinate</i>
<i>rms</i>	<i>Will display the Root Mean Square for each record</i>

7. You will notice a new button "C" on the Table Button Bar. This button will calculate the fit and rms values for your control points. Press it and then look at the rms values in the RMS field. Typing OFF in the Use Pnts field can turn off any one record that gives you a high rms value.
8. Keep calculating the rms and turning records off until you are satisfied with the total rms. Just keep in mind that you have to have **6 GCP pairs ON** for it to work.
9. Once you have completed this task you should see a new button on the Button Bar that looks like a pencil and paper. This button will write the world file. Press it and you will be asked where to save the file. You should save it in the same directory as the image itself.
10. The next time you open the image and feature them into a new view, both will register correctly.

Avenue Script programmers are continuously developing new scripts for georeferencing images in ArcView GIS (for example ImageWarp, Image Georeferencing, Rift). The scripts usually are in zip format and contain a text document explaining the tool and the installation procedure. Please check the ESRI homepage (<http://www.esri.com/arcscripsts>), where you can download hundreds of scripts for free. The CD-ROM also contains a collection of scripts.

Digitising in Arcview GIS

ArcView GIS does not allow the calibration of scanned images. However, for producing “quick and dirty” maps, a scanned map can be loaded for digitising in ArcView GIS.

1. **Activate your JPEG and/or TIFF image EXTENSION**
Under File> Extensions >; put a checkmark (✓) on “Image Extension”
2. **Open your scanned image**
(Select IMAGE SOURCE, instead of FEATURE SOURCE)
3. **Create a NEW THEME,**
specify the type (POINT, LINE or POLYGON) and give it a meaningful name
4. **Start digitising on-screen.**

SAVE EDITS while you are digitising to avoid loss of data in case of computer problems.

5. **STOP EDITING** when finished.

Note: *for digitising polygons, you can use three types of digitising modes for:*

- *normal polygon drawing*
- *splitting existing polygons into smaller polygons*
- *adding new polygons to existing polygons with common boundaries*

Tool 12: Data Conversion

How to convert existing maps to a different software format

Compressing and de-compressing, *.dxf to *.shp, *.e00 to *.shp, *.agf to *.shp, data conversion through Map Maker Pro, map assemblies and compiled maps

Usually, digital data, such as maps and databases, is produced in a variety of different formats which cannot be read directly by all software. In order to open external data with your software, you have to import it. First check the export and import possibilities or functions of your software. The range of the import and export possibilities of the various GIS programmes changes with every new release or up-date. Today, the data of most of the common programmes is interchangeable without loss of data. This tool provides you with some examples and some step by step descriptions of how to transfer data between different systems.

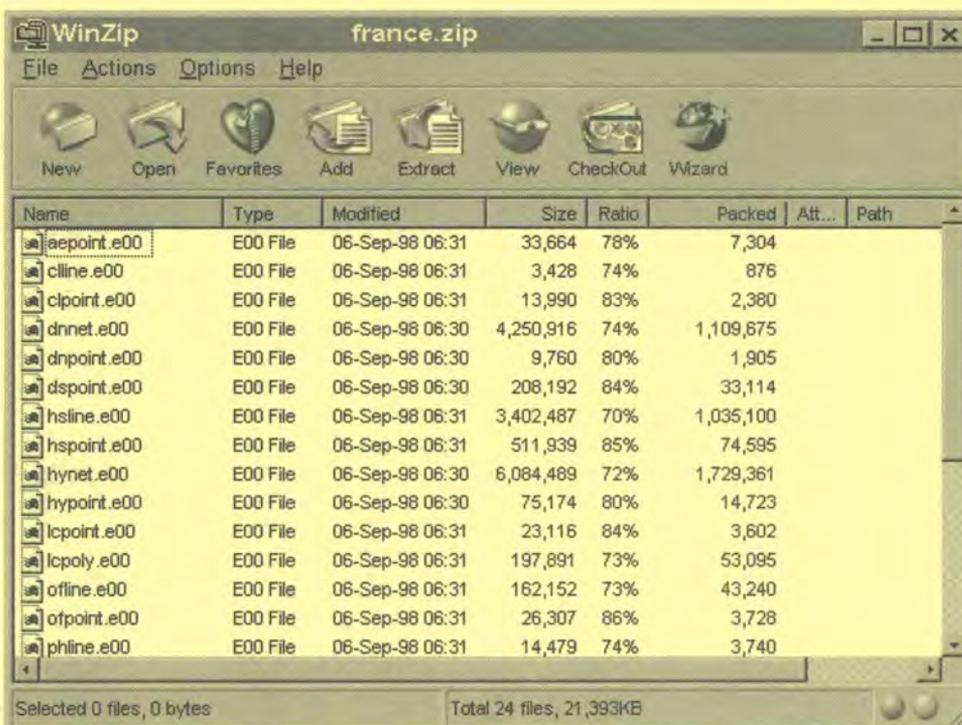
Compressing and decompressing data

Digital maps can be enormous files which will not fit on one diskette. For example, the data set of 4 square kilometres at a scale of 1:2500 in dxf format can easily exceed 10 MB in file size. These huge files are also too large to exchange through e-mail. Often, servers do not allow attachments exceeding a certain size. It also takes too long to download these attachments. In order to solve this problem, compression and decompression programmes have been developed. For example, a dxf-file of 10 MB size can be compressed by more than 90%. The most common compression application is the ZIP programme which is available in both MS DOS and MSWindows versions. You will find both programmes on the CD-ROM and you can download WinZip at <http://www.winzip.com/>.

WinZip

You access WinZip through Windows like any other Windows application. A

Zip archive (*.zip) can contain several compressed files. These are displayed in a table in the WinZip programme window. Clicking on the Extract button will decompress all files in the zip archive, double-clicking on an individual file will decompress the individual file.



Ziping

To compress files once in WinZip:

- 1) Create a new archive by clicking on the New button, or open an existing archive by clicking on the Open button.
- 2) Click on the Add button.
- 3) Find the file you wish to compress and highlight it. Then press Add.
- 4) When WinZip has finished compressing the file, the green light at the bottom right corner of the window goes on.

You can add more files to the archive, open or create another archive, or simply exit the current archive by exiting WinZip or choosing Close Archive from the File menu (in which case WinZip will remain running). WinZip allows you to span a zipped file across multiple diskettes. This is useful for zip files larger than 1.4 MB (the size of a diskette). By clicking on Properties under the File menu you can see the size (in bytes) of the archive currently open. Choose "Self-extracting files across multiple diskettes".

The later versions of compression programmes integrate themselves in MS Windows Explorer. If you click with the right mouse button on one or more files or a whole directory, a menu will appear which contains the option to compress (for example "Add to Zip" or "Add to file.zip").

Please note: Preferably use new diskettes for spanning. Diskettes develop bad sectors very easily. If the zip-file is saved to a sector which turns bad you will not be able to open your zip-archive.

DOS Zip

The WinZip programme is still based on the three MS DOS programmes below. Those executables are very small in size and are often attached to a zipped file on the same diskette. This allows the user of the compressed file to open it without having the programme installed on her/his computer. The executables for MS DOS Zip are:

- pkzip.exe - for zipping (compressing)
- pkunzip.exe - for unzipping (decompressing)
- pkzipfix.exe - for fixing zip files

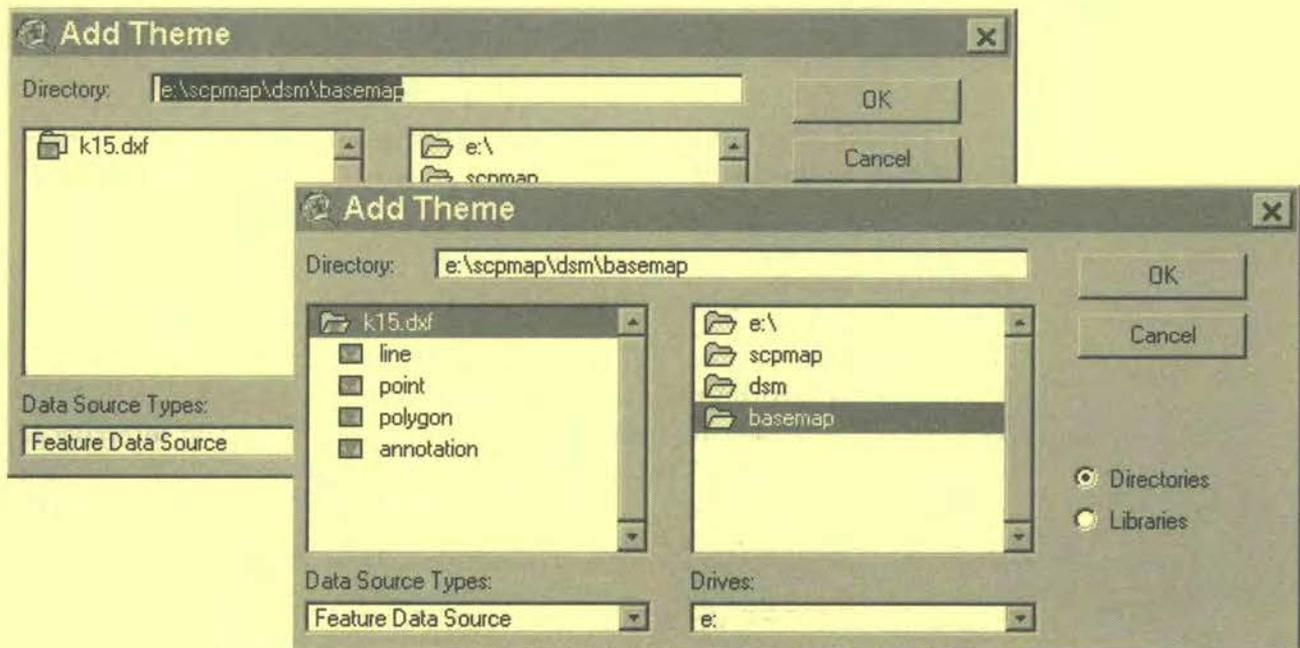
Tip: Create the directory "Zip" in your root directory and place the three executable files into it.

Unzipping

1. Open MS DOS Prompt
2. Change directory to your zip program (using cd .. and cd zip)
3. type in pkunzip > you get a set of instructions.
4. Type for example pkunzip a:/example.zip c:/emis/actual/example

Ziping

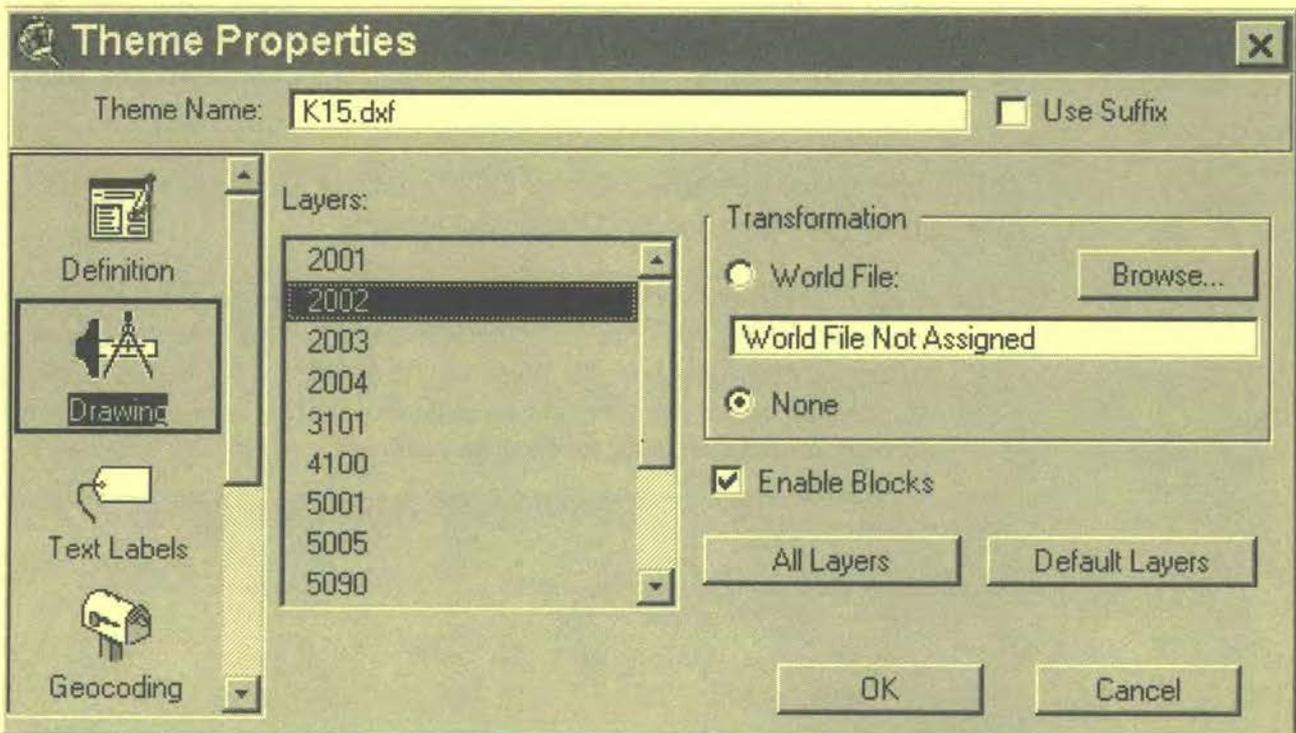
1. Open MS DOS Prompt
2. Change directory to your zip program (using cd .. and cd zip)
3. Usage: PKZIP [options] zipfile [@list] [files...]



3) **View Layers** you want to convert

Theme > Properties > Drawing.

You can see the layers which are currently active (highlighted), and can choose which of these you want to remain active for conversion. For example, you may want to choose only 4 layers (perhaps those relating to buildings and not natural features).



4) **Convert File (Data)**

Theme > Convert to Shapefile

You are asked "Add Shapefile as theme to view?" > Yes.

Now you can **work with the file in its shape** format (*.shp) from within ArcView GIS.

From release 3.2 onwards, ArcView GIS offers the possibility to export shape files to dxf format. For previous ArcView GIS versions you can place into ArcView ext32 directory a small Avenue script (ArcView's internal programming language) which allows you to export your files to dxf. The file is available on the CD-ROM.

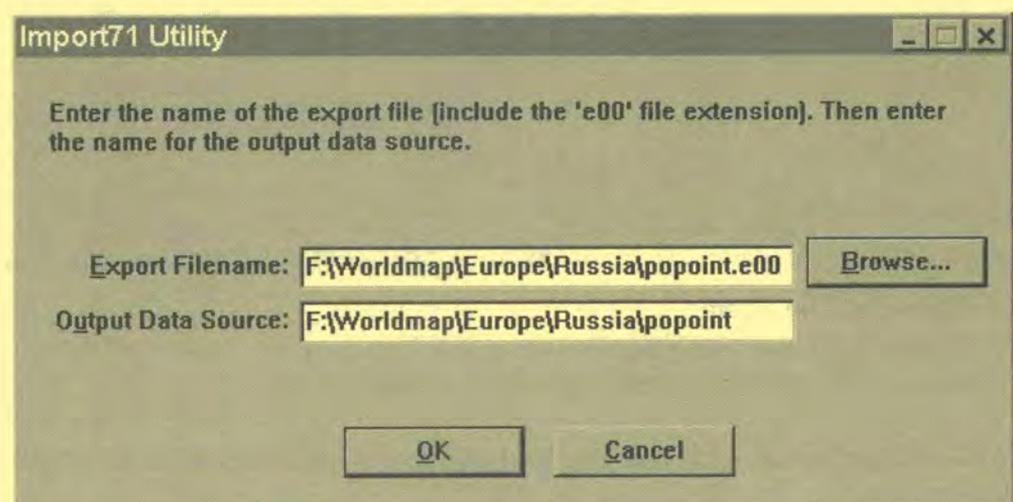
*.e00 to *.shp

The e00 format is an ArcInfo interchange file format to transfer ArcInfo data from ArcInfo platforms to other systems. To use these kinds of files in ArcView GIS they have to be imported. If you receive ArcInfo data in interchange format you can use IMPORT to convert it to a data source in a format that can be added to a project or view in ArcView GIS. IMPORT can be found as a programme item in the ArcView GIS programme group.

1. To run IMPORT, **double-click the IMPORT** programme item in the ArcView GIS programme group.
2. You will be **prompted for parameters**
 - [interchange_file]** - the prefix name of the ARC/INFO interchange file to be converted to a coverage or database data file. You can supply a pathname as part of the specification.
 - [output]** - the name of the data source to be created. You may include a full pathname.
 - SHIFT** - a double precision interchange file will be imported. If the SHIFT keyword is not specified, IMPORT will display a warning message indicating that the data will be truncated, and the file will be imported to a single precision coverage.

More convenient is the use of the IMPORT71 utility. A dialog box asks you for the Export File Name and the Output Data Source.

Tip: if you have a larger number of e00 files to import (within the same directory) you should change the "Start in" path of the icon properties to the directory where you have the export files. When you browse the Export File Name it will start in the target directory and you will save time by minimising clicking through various directories for each file to import.



*.agf to *.shp

Since the ArcView company ESRI has taken over Atlas GIS the data conversion between the two programmes has become quite easy. For older Atlas GIS versions the following steps allow you to convert data from Atlas to ArcView:

1) **Check your data** to transfer

Within Atlas GIS make sure only one feature type (region, line, point) is included in your .agf, and only the information and regions you want to transfer. ArcInfo will create new polygons for each area surrounded by lines. Look for additional tables, information that will fit to your .agf.

2) Using **I(mport)E(xport)** in directory i.e. (you will find the IE programme on the CD-ROM)

- go to dos prompt, cd .., cd ie, type: i.e. (infile) (outfile) /type /att

e.g. to transfer agri.agf to an ArcInfo exchange file

```
type ie c:\agisw\sdpgis\agri.agf c:\karin\agri.e00 /type region /att
c:\agisw\map\agri.dbf
```

3) **Importing data to ArcInfo** (this requires the ArcInfo or PC ArcInfo programme)

- change directory to stored exchange files
- type arc at dos prompt

```
arc: import agri agri
arc: build agri line
arc: clean agri agricl # # 0.00002
```

4) use the data in **ArcView GIS**

- exit dos-Prompt and start ArcView GIS

5) You can use the data immediately, but if you want to edit the data in ArcView GIS, you have to convert the data to a shapefile.

Data conversion through Map Maker Pro

One of the major advantages of Map Maker Pro is the ability to read many different map formats and at the same time export the data to many formats. If you have to transfer data from one GIS software to another, without these programmes having the right filters, you can take a shortcut through Map Maker Pro. For example, if you want to get shapefiles that are readable in MapInfo, you import the file in MapMaker and export it in MapInfo Format.

Note: Always check the transferred data carefully, because when using two filters, attribute data can be lost or geometry may change.

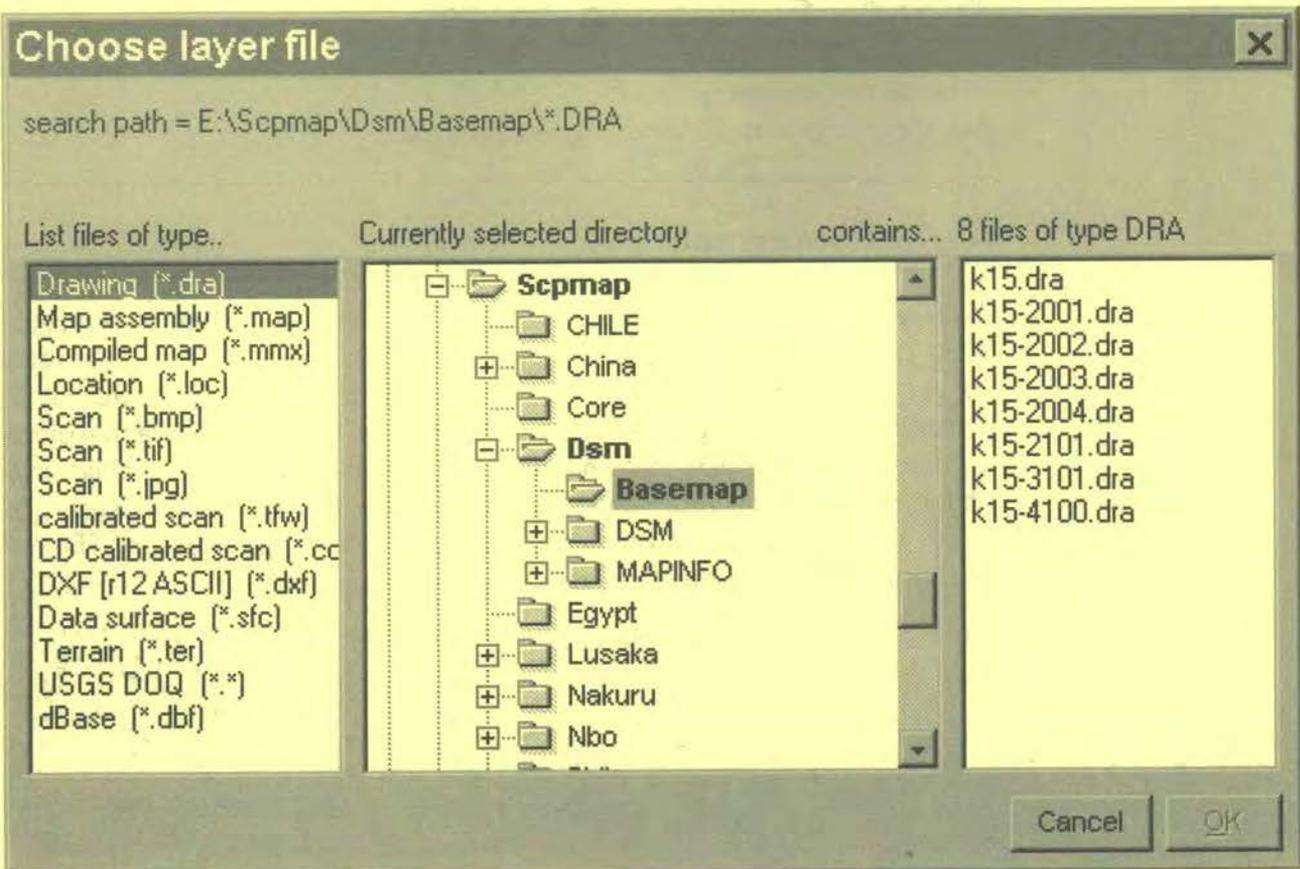
Import	Export
ESRI Products Interchange (*.E00) coverages (*.aat, *.pat), shapefiles (*.shp)	ESRI Products Interchange (*.E00) shapefiles (*.shp)
MapInfo MIF files	MapInfo MIF files
AutoCAD, C.A.D programs Data eXchange Format (*.dxf)	Data eXchange Format (*.dxf)
USGS DLG Vector data Digital Orthophoto Quads (DOQs), Digital Terrain Models (DTMs)	
Others such as Atlas GIS IDRISI GPS data NMEA-0182, NMEA-0183, Trimble, Garmin	

1. Go to **Utilities > Import file** and you will see a range of options.
2. Choose the one that suits your data.
3. **Check** if the import has worked properly.
4. Go to **Utilities > Export file**
5. Choose **dra to shapfile**

Map Assemblies and compiled maps

A GIS map is usually a composite of various elements. For example, an ArcView GIS project file (*.apr) only contains information about the data used (and the references to it) but not the data itself (map assembly). Therefore, if you copy an *.apr file to a different computer you will not be able to open your map, unless you have copied all its related components (shp, sbn, sbx, shx, avl, and dbf-files) with it. This can be quite cumbersome in ArcView GIS. A thematic map can easily contain several dozen different files. The command 'Manage Data Sources' in ArcView GIS allows you to copy, delete or rename shapefiles easily, provided the filenames follow the 8.3 concept. Avenue script programmers have started to develop software which allows compilation of ArcView GIS maps (see references on the CD-ROM).

Map Maker Pro offers a clever way to save a map as a compiled map (*.mmx). The compiled map can be compressed, transferred to another computer and opened with all its components.



Tool 13: Purchasing Images

How to find imagery

Aerial Photographs, Satellite Imagery, Addresses

Aerial Photographs

Aerial photographs are a standard resource for producing and updating maps. They can usually be found in the planning departments or in mapping and survey departments. However, although data from large-scale aerial photography is desirable for urban surveys, it is slow to acquire, becomes outdated fast, is costly (several hundred thousands US Dollars) and difficult to obtain regularly. Small format aerial photography (SFAP) provides details of urban areas and is 5 to 10 times cheaper than normal photography. SFAP is usually suitable for developing basic layers for an EMIS.



Aerial Photograph of Kibera, Nairobi

If you decide to use standard aerial photographs you should clarify with the Survey Department on what has been done already in terms of rectification and further processing of the photographs. Usually, Survey Departments have the necessary equipment for ground control, stereo plotting, etc. Some commercial companies offer digital rectification for competitive prices. The following is a description of Digital Orthophotography by Rob Wooding and associates:

What is Digital Orthophotography?

Orthophotography is the technique whereby aerial photographs are first “stretched” and then mosaiced together to make a true map. The process is complicated because a number of factors that are inherent in all raw photography have to be removed if an accurate map is to be produced. The main problems to be overcome are:

- **Height distortion** - Anyone who has looked at an aerial photograph showing a tall building will have noticed that on the side closest to the centre you can see the whole wall of the building and not just the roof. For a map (which is a vertical view) you want just the base (or footprint) of the building. Well, what goes for buildings, goes for hills and mountains too. Positioning errors due to height distortion can easily be 20%.
- **Photograph geometry** - A photograph is a radial projection. That is a fancy way of saying that the only things you can reliably measure on a photograph are angles from the centre and even that is only true if the photograph is taken perfectly parallel to the ground. Of course that happy state never exists and every photograph is rotated, tipped and tilted to a greater or lesser extent and the effect of that has to be removed.
- **Camera characteristics** - To make a map one is simply measuring visible things on an aerial photograph. Using digital techniques one can reliably make those measurements with an accuracy of about 0.02 mm. However, if the exposure was taken over 3 km up in the air and we want the map accurate within 1 metre, we have to know the details of the camera (such as the focal length and symmetry) ten times better than we can measure on the photograph. In other words to 0.002 of a mm!
- **Miscellaneous errors** - It will be appreciated that with these sort of accuracies there are a host of other nasties that creep in. Lens distortion is a bad one but it is constant and once it is known it can be eliminated. Film instability due to temperature change and stretches from bad handling is not constant and causes problems. There are other lesser contributors such as atmospheric refraction and earth curvature but the effects of these are normally minimal.

The advent of high speed computing and digital image handling has made so called Soft Copy Photogrammetry (the process to produce a digital orthophoto) quicker, simpler and more automated than it used to be. However the key to the overwhelming advantage of digital orthophotography lies in the ability of the computer to take in a pair of stereo images and automatically derive the critical ground heights of that terrain. Although the mathematics to solve this problem has been known for more than fifty years, the technology to actually do it has only become available in the last four or five years.

The following is an overview of the process :

Aerial Photography is commissioned to physically photograph the area of concern. Strips of photography are flown with 60% overlap and 25% sidelap. This ‘stereo coverage’ provides the information required to produce an orthophoto.



Image Capture is the next step in the process. This involves scanning of the photographs into a computer readable format. For mapping purposes one requires a scanner that precisely translates what is on the film to the same position on the digital image. Normal scanners cannot do this but the Vexcel scanner is one of the three types in the world that is designed for this purpose.

Ground Control is then conducted by sending a survey team to the area. Their job is to identify a set pattern of features on both the photograph and on the ground and then survey them using precision GPS. This is essential in order to provide a frame of reference to a known geographic coordinate system and to make sure the heights are related to mean sea level.

Once this data is collected and correlated, a mathematical model of the surface of the ground is created in the computer. The process used to perform this is called Image Correlation and the result is an accurate grid of heightened points called a Digital Terrain Model (or DTM). The spacing of the points varies from job to job but typically might be in the 5 to 20 metres range. The final rectification of the original images is conducted one picture element (pixel) at a time by using the height model to work out each correct position and little by little a new (now orthogonal) photograph is built. To extract contours from the DTM and add that information to the image is a fairly trivial additional process.

Digital images create huge data sets and require high hard drive storage capacity (in the range of 1000 Giga-Bytes). These sets also require some serious computing horse power such as workstations produced by Silicon Graphics.

It must be emphasised that the result you get from this process is completely different from the result from what is known as a 'rubber sheet warp'. In that process the photograph is physically stretched to some known reference points like an old map, in an attempt to achieve some sort of scale. Unless the ground is dead flat the accuracy of this process is obviously poor. Despite these drawbacks a warped image does have its place for quick information and map detail updates.

Source: Rob Wooding and Associates, Mapping and Imagery Consultants, South Africa, at: <http://www.rwa.co.za/>

Satellite Imagery

Satellite data complements and supplements data available from both aerial photographs and conventional ground sources for urban planning. The biggest strength of satellite-born-sensor data is its regularity, speed, and economic efficiency. Also, the data is available in analogue and digital form, which helps for analysis. The current satellites allow data to be generated up to 1:50,000

scale using IRS (LISS-1 I) and up to 1:25,000 scale using SPOT data.

Over the years, satellite-based remote sensing data has been successfully utilised for large-scale mapping, environmental monitoring, landuse classification etc. With satellite data in high spatial resolution (up to 1 m in single panchromatic or lower resolution in four multispectral bands, i.e. full colour), it is now possible to explore its potential in the different areas of urban management and planning, such as urban housing, urban utilities and infrastructure, urban transportation and traffic planning, urban water supply and sanitation, urban cadastral and real estates, urban tourism and recreation, urban ecology and hazards, urban census, urban land use change detection, urban base map preparation, and urban land use zoning.

Satellite images help to produce new and to update existing maps. For urban planning purposes the SPOT panchromatic images (maximum resolution is 10x10 metres) are (still) most commonly used. The company SPOT Images offers customised images, which can be easily imported into ArcView GIS, Map Maker Pro, or MapInfo. These GEOSPOT image maps are derived from satellite data and present geographical information in the most user-friendly form. The approximate cost of an image on CD-ROM is between US\$ 1,000 and US\$ 5,000, depending on the year (images more than three years old are kept in an archive and are considerably cheaper than new ones), the level of processing (from raw data to ortho-rectified data) and the size of the composite.

SPOT Image offers the possibility of subscription to their SIRIUS Spot Image Catalogue. The subscription allows you to browse the Spot global archive of more than 7.5 million scenes acquired since 1986. It informs you about quality, level of processing and prices.

Spot Image - SIRIUS - Welcome on SIRIUS Spot Image Catalogue!
<http://sirius.spotimage.fr/anglais/Welcome.htm>

Example of a query result: Kano, Nigeria

The screenshot displays the SIRIUS Spot Image Catalogue interface. On the left, there is a satellite image of Kano, Nigeria. On the right, there is a map showing the location of Kano within Nigeria. Below the map, there is a search bar and a table of commercial information.

Commercial information	
Delivery time:	From 15 to 45 days according to option
Price:	2800.00 Euro
Geographic location	

Comparison of Landsat, Spot and IRS imagery:

	Landsat	Spot	IRS
			
Satellites (launched)	Landsat 7 (1999)	Spot 4 (1998)	IRS-C (1996)
Resolution	Multispectral: 30 m Panchromatic: 15 m	Multispectral: 20 m Panchromatic: 10 m	Multispectral: 23m Panchromatic: 10 m
Spectral Bands (microns)	0.45-0.51, 0.52-0.61, 0.63-0.69, 0.75-0.9, 1.55-1.75, 10.4-12.5, 2.1-2.3 pan: 0.52-0.9	0.50-0.59, 0.61-0.68, 0.78-0.89, 1.58-1.75, pan: 0.61-0.68	0.52-0.59, 0.62-0.68, 0.77-0.86, 1.55-1.7 pan: 0.5-0.75
Total coverage of earth	In 16 days	In 26 days	In 24 days
Products		GIS GeoSpot (Geo Tiff) Standard Spot Scene Format (CAP) IA or IB	
Size of image	200 km by 180 km	60 km by 80 km	
Prices as of January 2000		US\$ 1,000 to 4,000	

New satellites are continuously being launched into orbit. For example, the new IKONOS satellite produces images with a resolution of about 1 m (<http://www.spaceimaging.com>). SPIN II, a satellite which was launched by the Russian military (<http://www.spin-2.com/>), sells images through the Microsoft Terra Server.

The various space agencies have started efforts to co-ordinate their activities in space and have created the Working Group on Information Systems and Services (WGISS) under the Committee for Earth Observation Satellites (CEOS). CEOS is the accepted international forum for intergovernmental co-ordination of national and regional Earth observation satellite mission programmes. WGISS focuses on the provision of products, tools and services to realise the full potential of Earth observation satellite data. Membership of WGISS is made up of representatives from space agencies and from major programmes (typically in the field of global environment) that are affiliated to CEOS. WGISS work covers information systems and services from the ground segment through to the provision of complete datasets for specific applications. WGISS products and expertise should be of value to both experienced users of Earth observation data in industry and scientific research as well as to those investigating possible applications of Earth observation data for the first time. For more information, contact the Global Resource Information Database (GRID) of the United Nations Environment Programme (UNEP), <http://www.unep.org> or <http://wgiss.ceos.org> directly.

Addresses

Landsat TM

<http://landsat7.usgs.gov>

<http://edc.usgs.gov/landdaac/tutorial>

Indian Space Research Organisation (ISRO); New BEL Road; 560094 Bangalore; India; Tel: +33-91-80-333-4356 Fax: +33-91-80-333-4298

National Aeronautics and Space Administration (NASA); 300 E Street SW; Washington DC 20546; USA

<http://www.nasa.gov/>

SPOT IMAGE; 5, rue des Satellites; BP 4359; F 31030 Toulouse cedex 4; France; Tel: +33-5-62-19-40-40 Fax: +33-5-62-19-40-11

<http://www.spot.com>

Swedish Space Corporation

Box 4207, S-17104 Solna, Sweden

Tel: +46-8-7336 200; Fax: +46-8-987 069

Space Corporation Group, Kiruna, Sweden

<http://www.satellus.se/>

Space Imaging - The Visual Information Company

http://www.spaceimaging.com/index_text.htm

Consulting Companies providing low-cost air photography and image processing

For example:

Rob Wooding and Associates

21 Pearson Road. Everton, 3610, South Africa

Tel: +27 31 767 0066, Fax : +27 31 767 4484

Email Rob at : rwa@iafrica.com or Hal at : Hal@rwa.co.za

<http://www.rwa.co.za/>

LANDMARC

Tel: +31-172-506 020, Fax: +31-172-507 814

LANDMARC (Africa) Ltd

P.O. Box 60478, Nairobi, Kenya

Fax: +254-2-338 131

Norway Mapping Group A.S.

P.O. Box 25, N-1301 Sandvika, Norway

Tel: +47-67-525200, Fax: +47-67-525297

<http://www.eksport.com/delt/ser/nmap.html>

<http://www.statkart.no/geotorg/nmg/>

Thematic Maps

- Tool 14** Standard Set of Thematic Maps
- Tool 15** Attribute Data
- Tool 16** Preparing Thematic Maps
- Tool 17** Collecting Mapping Data in the Field

Tool 14: Standard Set of Thematic Maps

A non comprehensive list of Thematic Maps for the EMIS

Typical maps for an Environmental Profile, examples of additional Thematic Maps

This list provides you with some topics for Thematic Maps in an EMIS. The list is derived from the more comprehensive inventory list in Tool 6: Map Coding. The first part of the list details a number of maps and topics, which provide the core of most EMIS. These maps are usually required to illustrate the Environmental Profile (EP). The second part of the list provides more map titles, just to give an idea of the topics which the Thematic Maps should cover.

Standard Set of Thematic Maps

Environmental Setting:

Geology
Typical landforms
Soil composition and soil types
Amount of yearly rainfall in mm
Typical wind pattern during the year
Ground water table in metre underneath the ground
Rivers and lakes (usually part of the basic map layers)
Natural vegetation (Flora) and surroundings

Chemical content in the air
Chemical content in water bodies
Soil erosion in mm per year
Flood prone areas
Land-slide prone areas
Other environmental hazards and time of occurring

Development Setting:

Administrative boundaries (usually part of the basic map layers)
Land use pattern
Industrial sites and type of industry
Location and types of markets
Health centre and hospitals
Types of housing
Age and condition of housing areas
Road network (usually part of the basic map layers)
Electricity and water supply network
Sewerage network
Waste Collection points and schedule of collection
Amount of solid waste in tons per week

Population density per hectare (based on the respective administrative unit)
Population growth (e.g. from 1990 to today)
Land value
Income distribution

Distribution of CBOs, NGOs, political organisations and religious groups.

Examples of additional Thematic Maps

Geomorphology

Temperature iso-hypses

Ecological areas – ecotones and surroundings

Urban agricultural landuse

Mining sites and amount of building material mined in tons

Location of aggregation of informal activities

Storm water drainage and flood control

Open spaces and cemeteries

Tourism facilities – location of hotels and number of visitors per year

Traffic flow over the day

Public transport – Bus routes and areas serviced

Age and gender distribution per administrative unit

Migration between the administrative units over the last five years

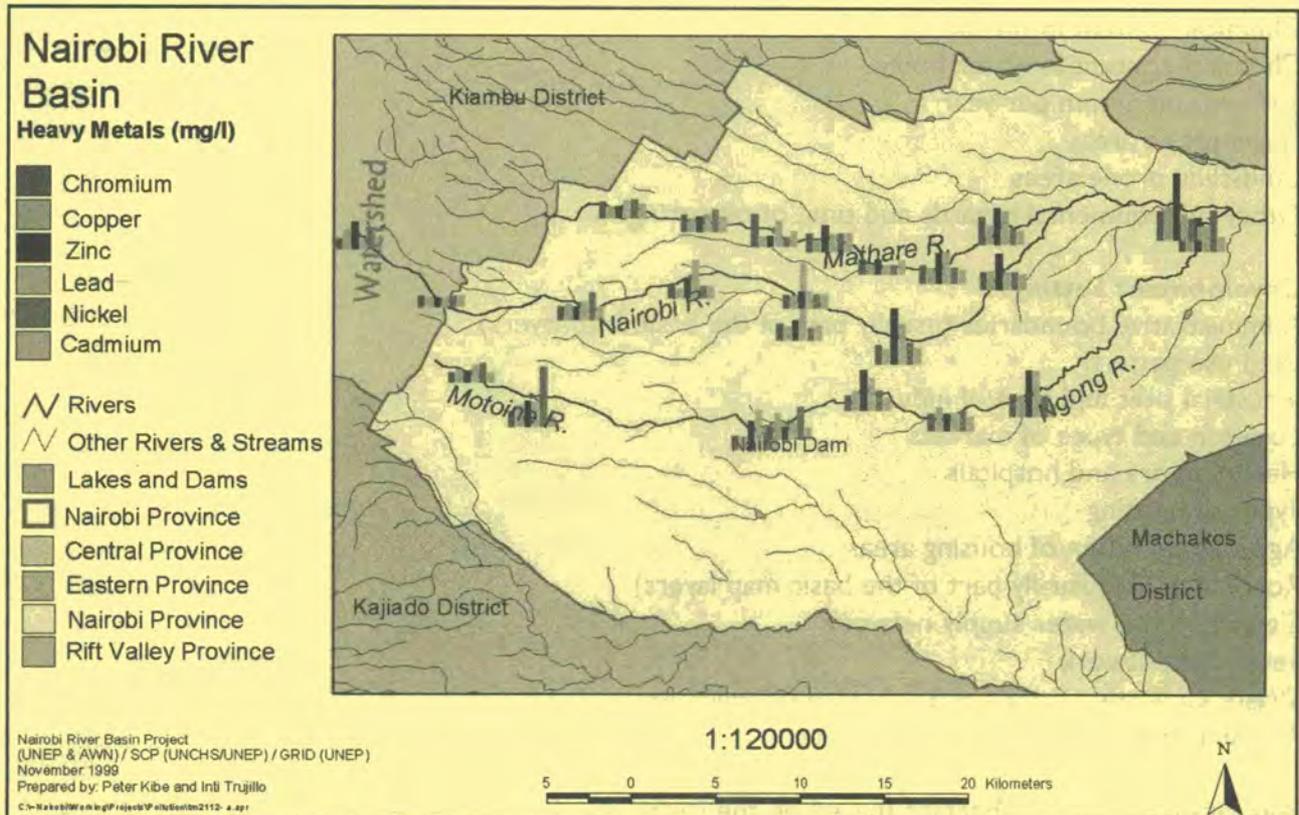
Students per school per administrative unit

Number of patients per doctor per administrative unit

Number of cases of cholera, malaria and other diseases per administrative unit per year

Employment rates per administrative unit

Example of a Thematic Map:



Tool 15: Attribute Data

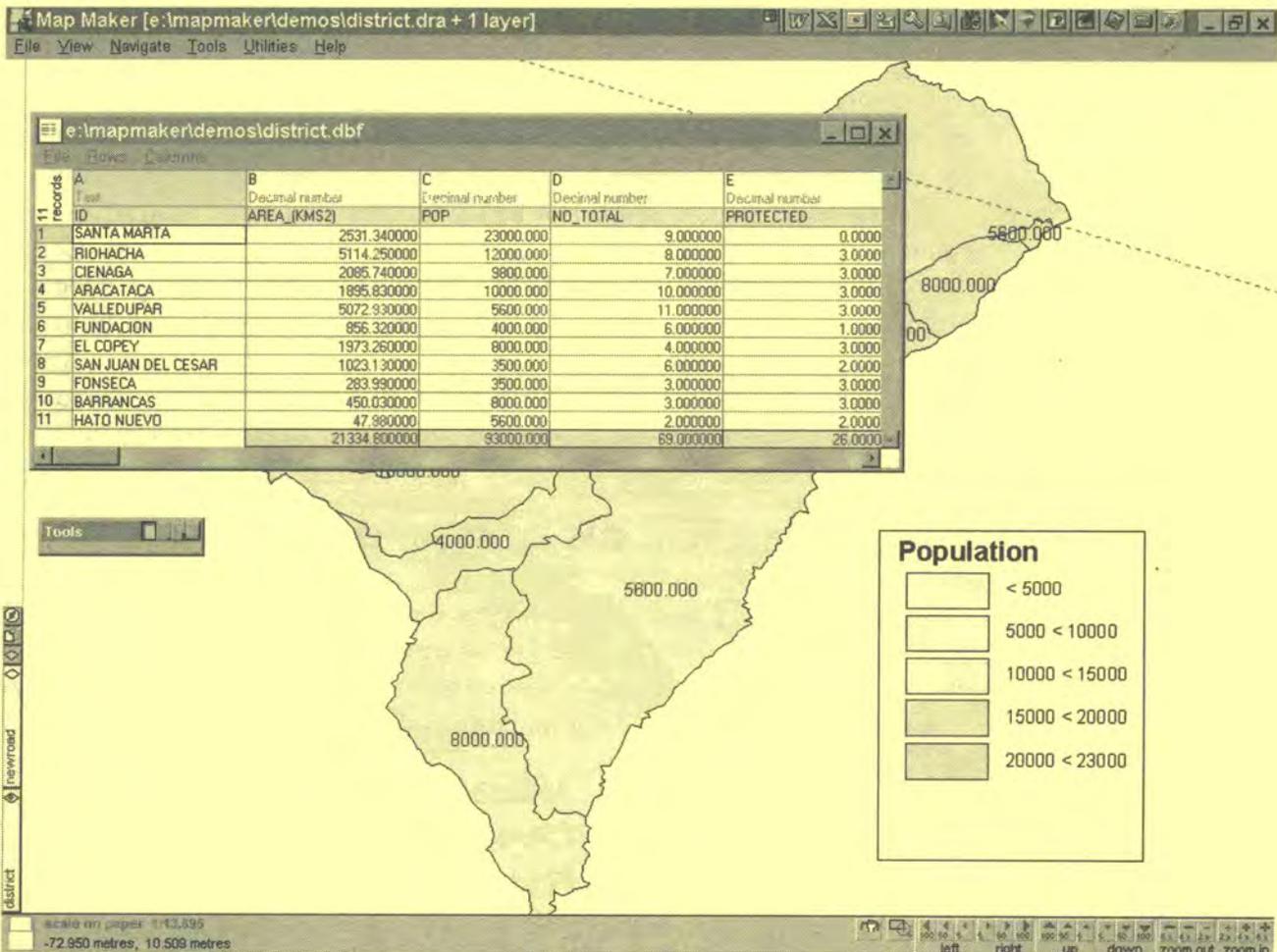
How to connect information to a map

What are attribute data, how to develop an Environmental Planning and Management (EPM) database, linking an external database to ArcView GIS

What are Attribute Data

In a GIS attribute data are commonly described as non-spatial data. A database will allow you to attach much more information to a point, line or polygon. A database is simply an electronic card index in which one "card" – or record – contains a set of information and a reference number to link the card to a particular object. For example, a line in a map can be a road, a river or an administrative boundary. We have to describe the lines in order to distinguish them from each other. Usually, this is done through different line styles and colours. In a GIS, each point, line or polygon is connected to the "card" through a unique identification number. This unique identification number is automatically added during digitising. Over time, information in the attribute table is expanded and up-dated.

Example of an attribute table in Map Maker Pro with a population map based on the attribute table:



How to develop an Environmental Planning and Management (EPM) database

Most of the information generated during the environmental planning and management (EPM) process, and in particular in the SCP process, is stored in reports (e.g. the Environmental Profile), minutes (from Issue-Specific Working Group meetings) and tables (e.g. statistical data from field research). The EMIS Officer with the support of the Mapping Group, converts the relevant information into a format which can be used to prepare maps.

For example, the Sanitation Working Group discusses the groundwater levels in the city. Since there is no scientific data available on the depth of the groundwater table, the Working Group contracts the Geology Department of the University to prepare a report on the geological situation in the city and the expected impact regarding the groundwater situation. At the same time, members of a community organisation complain about the difficulty of getting drinking water because it is too expensive to drill deep boreholes. In another area, a construction company is struggling with the construction of solid foundations because of the high water table. The EMIS Officer takes note of all these different fragments of information and enters them into the sanitation database. The compiled information already gives an idea of the different groundwater tables in the city which the EMIS Officer can convert into a map for the Sanitation Working Group.

Another example: A Slum Up-grading Working Group plans a transect (walking through the area of concern and taking note of the observations of the community members) and a participatory rapid appraisal (PRA) in order to assess the problem of flooding during the rainy season. The members of the community gather underneath a tree and start developing a “map” of their neighbourhood in the sand. The EMIS Officer had been invited by the community to observe the PRA so that she/he can include the information in the municipal EMIS (for this, the EMIS Officer also takes the geographic co-ordinates of relevant points with a GPS during the transect). With both the GPS generated co-ordinates and the PRA discussion, the EMIS Officer is able to produce a detailed map of the problems in the specific neighbourhood and to match it with the existing EMIS maps for further overlays and analyses.

Linking an ArcView GIS attribute table with an external database

Often, attribute information is already available in spread-sheet or database format. In order to avoid re-entering information into the attribute table of the GIS, techniques have been developed to link attribute tables to an external database. ArcView GIS provides a sophisticated way of linking various databases.

Connecting to a database

- 1) Open the map you want to link a database file with, and make the Project window active.
- 2) Under Project menu > SQL Connect > the SQL Connect dialog box appears.

SQL stands for "Standard Query Language."

- 3) Under the Connection title, choose the type of database file you wish to link up with (the application it was generated with) > press the Connect button > find the database file you wish to link to your map.
- 4) In the SQL Connect dialog box you can now see the different tables in the database file > click on any one of them and you will see the columns within that given table > choose the columns you wish to link with > by pressing Enter or double clicking on them you transfer them to the Select box; if you want all columns linked, choose <All Columns> which is represented by an asterisk (*) in the Select box
- 5) When you have finished selecting the fields (columns) you want to link with, press the Query button.
- 6) You now have the selected information from the database converted into an ArcView Theme Table. However, this method creates a table additional to the Attribute Table of your map, so you now have to combine the two.
- 7) To work with the database in the source application (e.g. MS Access) again, press Disconnect in the SQL Connect dialog box.

Combining two tables:

- 1) Select the windows of the two tables you wish to combine, making sure you do two things:
 - click first on the table you want to extract information from (the "old" table), and then on the table you want to import information into, which will remain in the end (the "new" table);
 - highlight in each table the column that corresponds to each other, i.e. the "key" field which identifies each entry on an individual basis.

Important: *The tables will not join if the "key" field entries do not coincide or are not set as the same type of fields (e.g. numbers vs. text fields). The contents of the corresponding "key" field of each of the two tables must be identical (including lower case/upper case, and spelling) otherwise they will not be recognised as being the same, even if only one of the entries (such as a name) is written differently. Those entries that do not match each other will not be included in the new table.*

Hint: *to avoid problems of given entries not being identical due to spelling errors or the like, it is useful to use codes (such as numbers) to represent the different entries. You can use these codes to link tables, thus reducing typing errors.*

2) Choose the Join tool from the toolbar.

The screenshot shows a software interface with a menu bar (File, Edit, Table, Field, Window, Help) and a toolbar. A status bar at the top indicates '0 of 24 selected'. On the left, there is a 'Views' panel with icons for Views, Tables, Charts, Layouts, and Scripts. The main workspace contains a window titled 'Table1' displaying a data table and a 'SQL Connect' dialog box.

The 'SQL Connect' dialog box is configured with the following details:

- Connection: MS Access 97 Database
- Tables: Pollution
- Columns: All Columns, Point, Location, River, pH, TfoCl
- Owner: (empty field)
- Select: (empty text area)
- from: Pollution
- where: (empty text area)
- Output Table: Table2

The 'Table1' window displays the following data:

Point	Location	River
1.000000	Ngong Rd. Dam	Ngong
2.000000	Muotoine Swamp	Ngong
3.000000	Ondii Swamp	Nairobi
4.000000	Dagoretti Bridge	Nairobi
5.000000	Naivasha Rd. Bridge	Nairobi
6.000000	J. Gichuru Rd.	Nairobi
7.000000	Nairobi Dam Kibera	Ngong
8.000000	Nairobi Dam Outlet	Ngong
9.000000	Mater Bridge	Ngong
10.000000	Choices Bridge	Ngong
11.000000	Donholm Bridge	Ngong
12.000000	Ruai Bridge	Ngong
13.000000	Nbi. R. Bridge, Mweki	Nairobi
14.000000	Kariobangi Bridge	Nairobi
15.000000	Chiromo Bridge	Masonga Wai
16.000000	Museum Hill	Nairobi
17.000000	Kamukunji Bridge	Nairobi
18.000000	Mathare Valley East	Mathare
19.000000	Mathare North Bridge	Mathare

Tool 16: Preparing Thematic Maps

How to prepare a Thematic Map

Types of data, a word on symbols and colours, creating Thematic Maps with ArcView GIS, creating Thematic Maps with Map Maker Pro

Types of data

Spatial data: Quite a number of Thematic Maps can be created directly from the basic map layers, such as rivers, roads or administrative boundaries, by linking the objects on the map and the relevant data in the database. However, for certain thematic maps the data needs to be collected from secondary sources (e.g. soil maps, geology maps, etc.) or obtained from fieldwork (see Tool 17: Collecting Mapping Data in the Field).

Non-spatial data: Data in the attribute data table is stored as text (string), numbers, dates, or Boolean (yes/no). For example, a map showing the districts of a city can be presented as a political map with each district in a separate colour. The names of the districts are stored as text in the attribute table. To show the population in the different districts (which is stored as numbers in the attribute table) it is more useful to use classes instead of the absolute numeric value to show areas with denser population. Charts are used to add multiple information to your map, such as the amount of different chemicals in a river.

A word on symbols and colours

Using symbols and colours in a map is a science on its own. Maps have a highly political relevance. Just imagine how maps have been used to push specific political agenda in the past. The choice of colours and symbols can radically change the power of a map. It is very important to consult the mapping group on the appearance of a map.

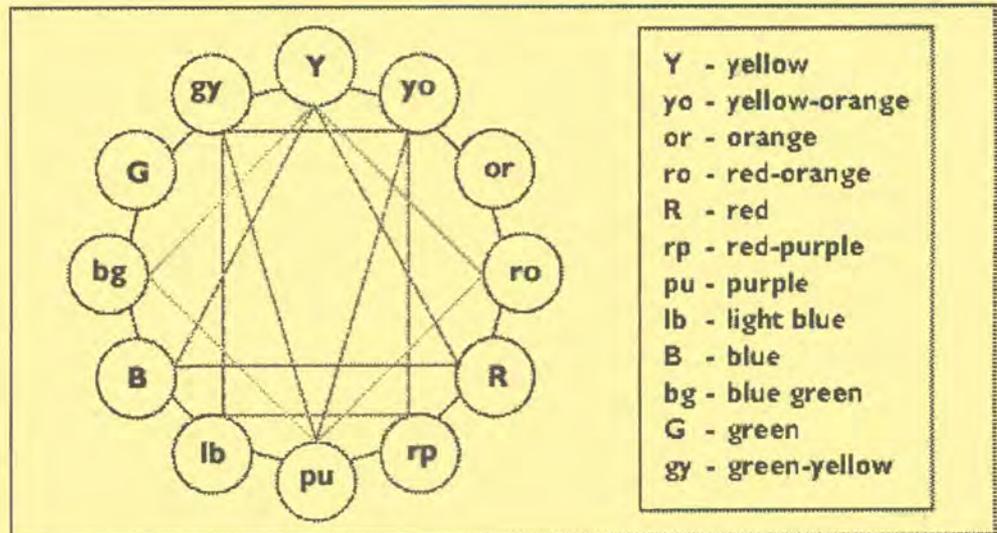
The various GIS software packages offer a reasonably broad palette of symbols. You should choose symbols carefully and not overload the map and reduce its readability. There have been efforts to harmonise the use of symbols in cartography world-wide. These include cartographic grids, isolines, the appearance of water bodies, the display of hill shading, geological-tectonic/morphological features, the representation of built-up areas, agricultural symbols and self-explanatory symbols.

Producing multicoloured maps is a difficult area of cartography. Often, the layout of maps are disappointing because they are colourful but ignore any law of colour compositions. The EMIS Officer must have the ability to assess the expected colour associations the end user of the map has. It is not the place of this Handbook to describe the chemical, physical, physiological and psychological aspects of colouring. However, there are some major colour aspects to bear in mind when producing maps.

1. The choice of "close to nature" colours - over time, people have developed certain associations with particular colours: light green for open green land, dark green for forests, red for settlements, grey for dumpsites etc.
2. The "sensitivity value" of the colours - we distinguish between "warm"

and “cold” colours. The respective colours should be chosen according to the warm or cold areas (e.g. thermal effect of industrial effluent into a water body). Certain colours have collective or folkloristic associations (e.g. purple for the church), or some colours have symbolic associations (yellow for gold).

3. “Harmonic adjustable” colours - there is no common law of colour harmony. However, various researchers have developed principles for different purposes. Two or more colours are considered as harmonic if they result in a neutral grey if mixed together. The following colour combinations can be considered as harmonic:



There are many more factors which influence the appearance of a coloured map, such as (a) the mutual influence of two strong neighbouring colours; (b) the colour weight (e.g. the higher the value the greater weight of the colour - yellow is considered to have least weight, then orange, red/blue-green, red-purple, blue-purple and black); (c) the luminescence of the colour (yellow is the highest); (d) and the contrast effect of neighbouring bright and dark colours.

Thematic Maps with ArcView GIS

Numeric data maps

These maps are primarily for numeric data with a progression or range of values such as temperature or number of tourists. The information is represented with a colour ramp. A colour ramp has a beginning and an end colour and a range of colours in between which show the intervening colours of the spectrum.

1. **Double click the theme** in the Table of Contents to open the Legend Editor.
2. Change the Legend Type to **Graduated Colour**.
3. **Select a Classification Field**.
4. Either select a Colour Ramp, click Ramp Colours, or double click Symbol to open the Symbol window.

Codes Map

Unique Value maps display data values such that the symbol for one value is no more or less prominent than the symbols for any other value. To help make the seemingly confusing task of differentiating data in an anonymous way easy, each unique value in a theme is represented with a unique symbol. This is the most effective method for displaying categorical data like landuse or soil-type.

1. **Double click the theme** in the Table of Contents to open the Legend Editor.
2. Change the Legend Type to **Unique Value**.
3. **Select a Values Field**.
4. Either click Random Colours, and select from the list of Colour Schemes, or double click Symbol to open the Symbol Window to change the colours of your feature's symbols.

Example of the legend of a landuse map:

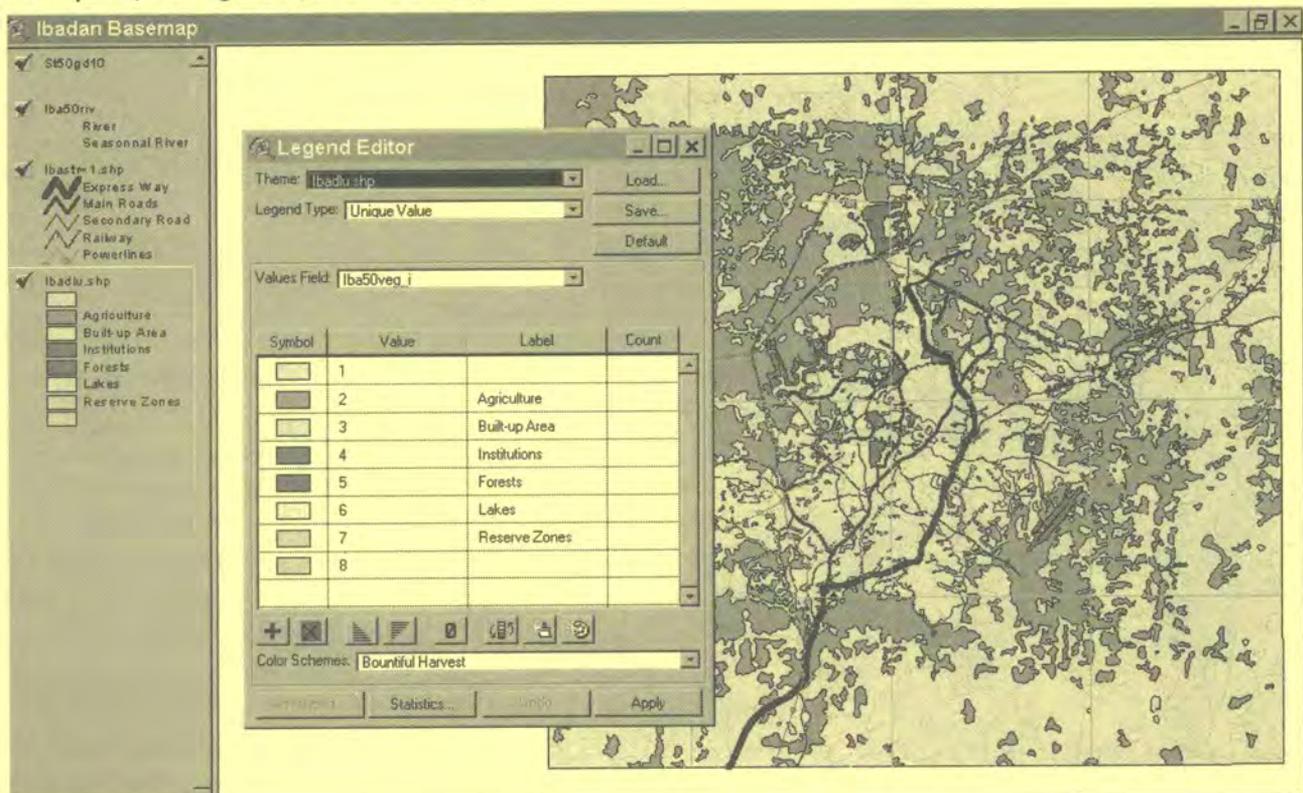


Chart Map

Certain features, such as a range of chemicals in a river, are displayed with a chart. The components of the chart correspond to data attributes which you specify, and the size of each section of the chart is determined by the value of each data attribute. Chart maps allow you to display the values of many data attributes at once. This is a particularly powerful tool because you can clearly show the relationships of different but related data with one clear symbol. For instance, you can map the income distribution by income ranges for a given population and clearly state which areas are dominated by a particular income.

1. Bar Charts

when you make bar chart symbols for your features, you can control the

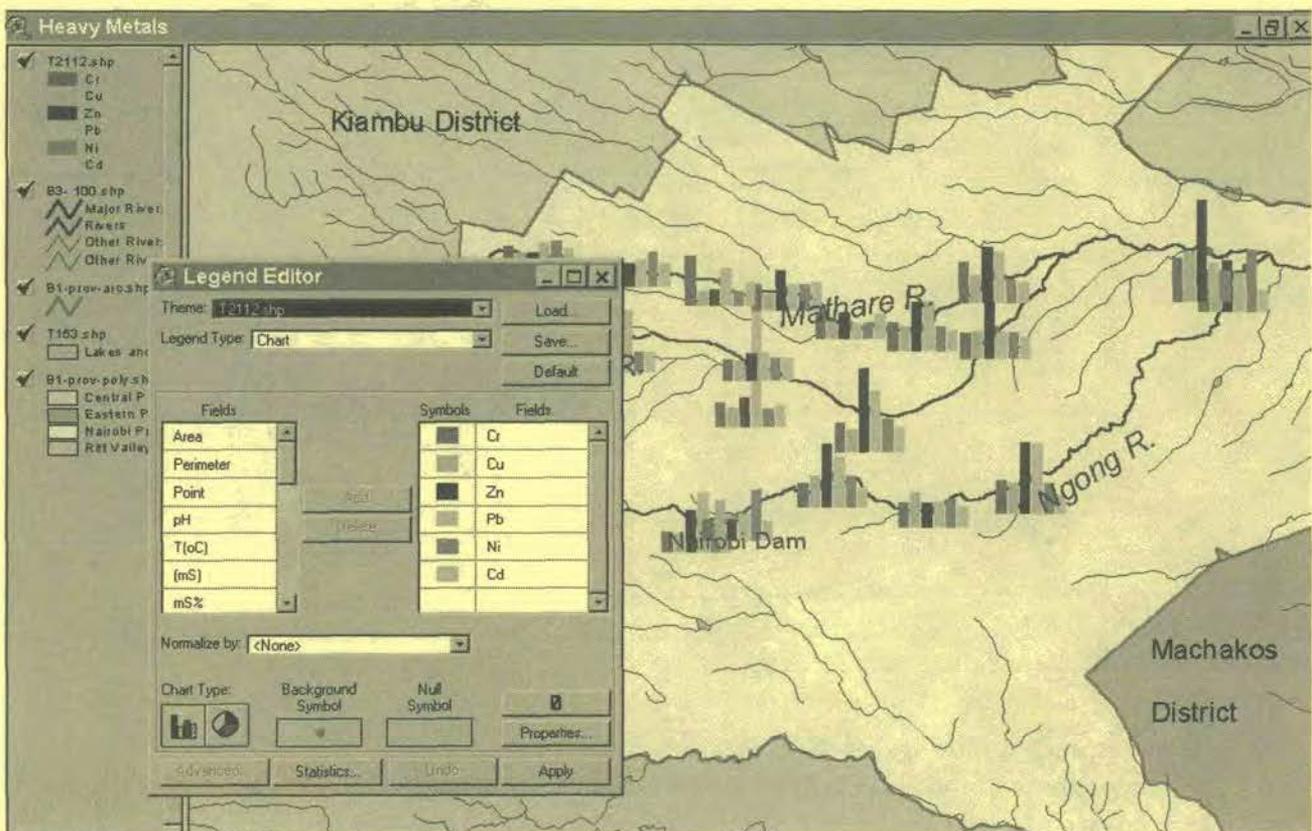
width, minimum height, and maximum height of each chart symbol. You can change these properties in the properties window.

2. Pie Charts

Pie charts begin with the first field you have chosen and rotate counter-clockwise from the three o'clock position. You can set a size field in the Pie Chart Properties window, the values of which control the size of each feature's pie chart symbol. You can set a minimum and maximum radius for your pie chart symbols in the Pie Chart Properties window as well.

Note: When you select a normalisation field, each field's values within your chart map are normalised by that field. You cannot change where the chart symbol is positioned on the feature it represents. Remember to check the units. The data is recorded in for each of your fields. You should not include a mix of percentages and raw counts.

Example of creating a map with bar charts:



Creating Thematic Maps with Map Maker Pro

Creating Thematic Maps with Map Maker Pro is less straightforward than with ArcView GIS. Opening a layer (dra-file) will prompt you with a dialogue box in which you choose "external data link". In the "style link column" you select the desired column. This enables you to use the numerical values in one field of each database record to control the display style of the corresponding

map object. Map Maker uses predefined style numbers which are linked to specific colours. You have to use "data bands" for linking a range of values or bands of values to a style. With the option "data points from external data" you can create pie charts, histograms and other charts from data points. Map Maker allows you to create your own preferred style list with your own preferred colours. The legend for these Thematic Maps is created through Tools > Furniture Makers. For more details and a step-by-step description please refer to the book "Teach yourself Map Maker" (Chapter: Attaching data) which you can find on the CD-ROM.

Tool 17: Collecting Mapping Data in the Field

What to prepare for data collection in the field

Checklist for equipment to take to the field, preparation of Data Sheets, preparation of working maps, using GPS for field work

Checklist for equipment to take to the field

- Pencil
 - Writing Tablet/Notepad
 - Working Maps
 - Paper, Data Sheets
 - Plastic document cover
 - Global Positioning System handheld receiver (GPS)
 - Laptop Computer (if available), including all wiring for connecting the GPS
 - Rubber boots and
 - Chocolate.
-

Preparation of Data Sheets

The sheets for filling in the data collected depend on the type of data to be collected. The sheets will have at least three columns:

- one to define the location,
- one for the data measured, and
- another one for any remarks and observations.

There are several ways of fixing the location. Either the XY co-ordinates found on a map, or by using a Global Positioning System handheld receiver (GPS) are noted, or a map is used to mark the location and the number of this location is noted in the sheet. If none of these possibilities work (for example, because the map is not precise and the GPS does not connect properly to the satellites) a detailed description of the location should be written down – ideally with a geographic to a known location (for example the distance in metres or a certain angle). Map Maker Pro provides you with some basic but very useful surveying instruments (angle measurer, distant estimator, clinometer, and a plane table base).

Example 1: Collection of water samples from a riverine system with a description of the state of the water:

Greentown Municipal Council	Sustainable Greentown Project			
Sanitation Working Group				
Water Quality Survey				
Surveyor Name: _____				
Date: _____				
Form No.: _____				
<p>This data collection form is intended to assess the water quality of Green River. Please enter the location from where you take the water sample, describe the colour and the smell of the water and note down any other relevant information:</p>				
No:	Location X,Y or figure	Location Description	Data	Remarks
1	y: 265343.70 x: 9863611.54		Water colour clear	
2	y: 265350.70 x: 9863612.54		Water colour brown to grey, smelling	
3		Approximately 20 metres from the junction of street a and b to the north, just underneath an acacia tree	Water colour dark with oil on surface	Industrial complex nearby

Preparation of working maps

The maps prepared for fieldwork are working maps. People will write on them, the maps will be folded and torn. Therefore the layout does not have to be very attractive, but it does have to be practical and easy to read. A map in black and white showing the research area is fine. The layers shown should be mainly for orientation, for example streets, buildings, contour lines and rivers and, very importantly a grid with co-ordinates. The paper used should be heavier than normal, so it will last longer.

Using a Global Positioning System (GPS)

The Global Positioning System (GPS) consists of three pieces. **Satellites** transmit the position information, **ground stations** control the satellites and update the information, and the **receiver** computes its location anywhere in the world based on the information it receives from the satellites.

The GPS receiver measures its distance from the satellites and uses this information to calculate its location. It does this by measuring the length of time the signal takes to arrive at its location. Based on the fact that the signal moves at the speed of light it can calculate the distance from the travel time of the signal.

Maintaining the 'fix' means that the receiver needs to continuously recalculate the information received from the moving satellites. Once there are a number of fixes much more information can be derived than merely location. For example, a GPS can calculate the travel direction (compass heading) by comparing current location to previous location. Similarly the GPS can keep track of travel distance, compute speed, record travel time and other valuable data.

There are different providers of GPS receivers, such as Trimble, Magellan, Garmin and others. For addresses, refer to Tool 2: Equipment.

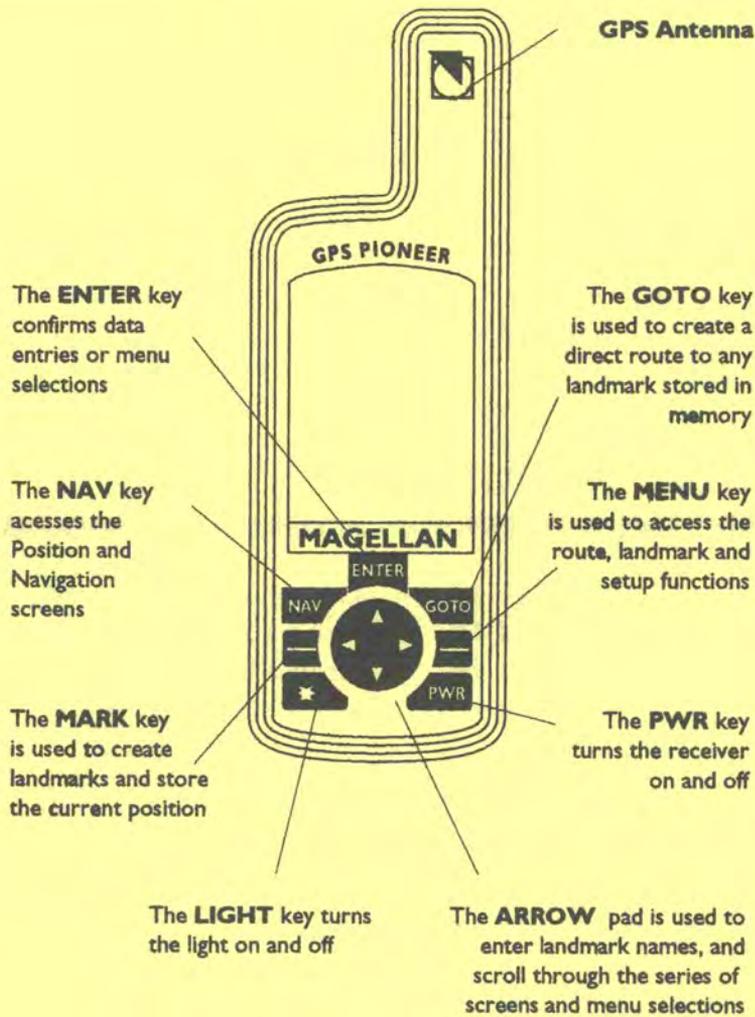
If you have purchased a GPS receiver you will get a detailed description of how to use it. Take your time to learn how to use it properly. Here is just a short description of how to use one of the GPS receivers from Magellan to give you an idea of how a GPS works:

You want to determine the extent of a flooded area during the rainy season. Put on your rubber boots and walk towards the water. Switch on your GPS and wait until it connects to the satellites. The screen will show you the latitude-longitude co-ordinates. Store this location with a unique name in the GPS memory (basic GPS receivers can save 100 locations, mid-range receivers up to 1000 locations). Now, walk around the flooded area, and repeat the storage of your position after every 20 metres (or less or more, depending on the desired accuracy) until you have returned to the point of origin. Back in your office, you can download the GPS data to your computer using a serial interface and the appropriate software or you can transfer the stored co-ordinates manually into an attribute table or a spreadsheet table such as MS Excel. ArcView GIS and Map Maker can translate those points into a map which can be overlaid with your existing maps.

Please note: In many cases, maps are projected in other projections than degrees of latitude-longitude (for example in UTM). Handheld receivers can switch to different projections. You have to make sure that the projection which you use for your GPS is exactly the same as the one you use for your maps. Otherwise you might get errors of up to several hundreds of metres.

The same method can be used to assess the latest expansion of rapid growing informal settlements. Some GPS receivers come with an external antenna which can be mounted on the roof of a car. If you have a portable computer, you can connect the GPS receiver to the computer and the GIS programme will draw the map while you are driving (usually with a position every second).

Magellan GPS Pioneer



REMEMBER: Handheld GPS receivers have an accuracy of 1-10 metres, depending on the quality of the satellite signal.

Sensitivity/Suitability Maps

- Tool 18** Ranking Environmental Issues
- Tool 19** Preparing a Suitability Map
- Tool 20** Preparing a Sensitivity Map
- Tool 21** Preparing a Service Delivery Map

Tool 18: Ranking Environmental Issues

How to rank environmental issues

Examples of manual ranking, ranking in ArcView GIS

Example of manual ranking

(from Eigen, J.: Information Management System for Environmental Planning and Management (EPM) in Cyprus, Nikosia 1987)

Ranking of maps involve subjective value judgements, such as determining which areas pose a more severe constraint to development, for example, critical water catchment areas close to an intake for municipal supplies, or areas along the coast with unconsolidated dunes. Ideally, this ranking should be based on decisions made jointly by all co-operating agencies.

The following example is derived from the EPM activities for the Metropolitan Lagos Master Plan, 1978, for establishing a common scale for overlaying resource and hazard maps. A pattern map was prepared in four steps:

1. Overlay of all maps showing those environmental constraints that can normally be overcome with engineering measures (e.g. flood prone areas, unstable soils);
2. Overlay of all maps showing those environmental constraints that relate to the preservation of resources and to often less tangible, but no less important environmental concerns (e.g. recreational areas, fishery resources);
3. Overlay of the two resulting maps that show combined engineering and preservation constraints;
4. Rank of constraints shown on the overall environmental constraint map so that it is possible to define for each rank of constraint a maximum permissible development intensity (e.g. natural state, recreation, or urban use).

As shown in the following figure, maps were overlaid by sorting the levels of constraint shown on each suitability or sensitivity map on a common scale. This common scale was then the basis for establishing levels of constraint on the combined map resulting from the overlay. For example, in terms of engineering constraints (Map 11 in the following figure) the most severe development limitations were presented by floodplains that are close to existing intakes for municipal water supply. The second most serious constraints were present if the areas had either unconsolidated dunes or were in the floodplain of critical catchment areas, but not close to an existing or planned intake. The combined ranking on the combined resulting maps can no longer be associated with specific environmental features such as alluvial plains of flooded areas. The different ranks of constraints on these maps remain therefore un-named and are instead identified with symbols such as degrees of shading, only. In producing the overall constraint map (map 13) a common scale is again introduced so that engineering and preservation constraint maps can be combined.

Map 1 Land Formation: Consolidation	Map 5 Catchment Areas: Water Supply	Map 2 Soils & Subsoils: Stability	Map 4 Drainage: Flooding	Map 11 Engineering Constraints		
				Ranking	Symbols	
	in floodplain near intake			5		
unconsolidated	in floodplain			4		
		serious constraint	difficult to reclaim	3		
alluvial plain	in critical catchment	soils constraint	flooded	2		
older dunes			reclaimed	1		
coastal plain sands	outside catchment	no constraint	drylands	0		

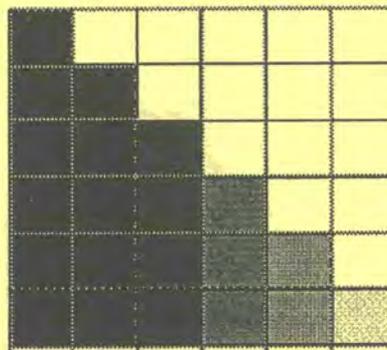
Map 3 Soils & Subsoils: Agriculture	Map 9 Existing Agriculture: Agriculture	Map 6 Fauna-Flora: Fisheries	Map 7 Landforms, Fauna: Recreation	Map 12 Preservation Constraints		
				Ranking	Symbols	
			urban recreation	4		
	forest reserves		natural state and scenic	3		
	modern agriculture	wetlands		2		
agriculture soils	traditional agriculture	subsistence fishing	natural state or scenic	1		
no significance	no significance	no significance	no significance	0		

Map 11 Engineering Constraints	Map 12 Preservation Constraints	Map 13 Overall Constraints		
		Ranking	Symbols	
		5		
		4		
		3		
		2		
		1		
		0		

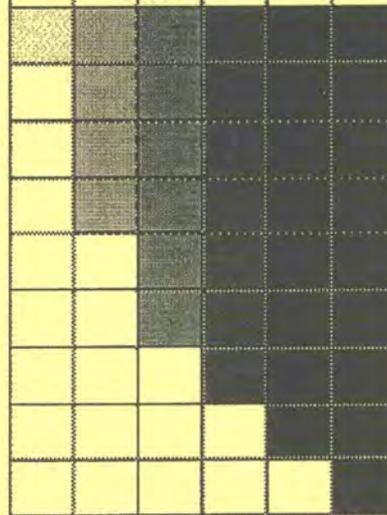
In the final step, the levels of constraint on the overall constraint map can be translated into a ranking scale that can be associated with levels of development intensity. The process results in a reversal of the ranking rationale. In areas with high environmental constraints only low intensity development is permissible and vice versa. This makes the map immediately applicable to land use planning. Of course, the meaning of each rank of suitability should be documented in a report that explains and interprets the development pattern map.

Transforming ranks of constraint into ranks of suitability:

Ranks of Constraint
5
4
3
2
1
0



Permissible land use intensity	Ranks of Suitability
Natural state	8
Limited recreation	7
Fisheries	6
Limited agriculture	5
Recreation	4
Agriculture	3
Limited urban use	2
Intense urban recreation	1
Urban use	0



Example of ranking using the ArcView GIS attribute table:

The ranking of a certain environmental or development issue is the result of an intensive working group process supported by the EMIS Officer. The method applies for Suitability Maps, Sensitivity Maps and for Service Delivery Maps. Areas in which a certain condition receive a ranking number which refers to the importance of the issue. The rank will be entered as a number (with number characteristic) in the attribute table of the relevant map. This allows you to generate a thematic map using colour ramps. In Suitability Maps the rank is highest for most suitable areas for a certain activity. In Sensitivity Maps the rank is highest for most sensitive areas (e.g. high pollution).

Attributes of Potmcl		
Area	Name	Rank
0.000170	Designated Sand extraction	2
0.000498	Designated Sand extraction with mining claims	3
0.000047	Designated Limestone extraction with mining claims	5
0.000331	Designated Limestone extraction	4
0.000066	Illegal Sand extraction	0
0.000057	Illegal Sand extraction highly affected	0
0.000110	Designated Sand extraction	2
0.000041	Illegal Sand extraction	0
0.000065	Illegal Sand extraction	0
0.000008		0
0.000828	Designated Limestone extraction	4
0.000100	Designated Limestone extraction with mining claims	5
0.000120	Designated Sand extraction with mining claims	3
0.000103	Designated Limestone extraction with mining claims	5
0.000117	Designated Limestone extraction	4
0.000701	Designated Sand extraction	2
0.000044	Designated Limestone extraction with mining claims	5
0.000086	Designated Limestone extraction	4
0.000065	Designated Limestone extraction with mining claims	5
0.000074	Illegal Sand extraction	0
0.000043	Illegal Sand extraction highly affected	0
0.000015	Designated Limestone extraction	4
0.000070	Designated Limestone extraction with mining claims	5
0.000055	Illegal Sand extraction	0
0.000195	Designated Limestone extraction with mining claims	5
0.000022	Illegal Sand extraction	0
0.000029	Illegal Sand extraction highly affected	0
0.000026	Illegal Sand extraction	0
0.000064	Illegal Limestone extraction with mining claims	1
0.000012	Illegal Sand extraction highly affected	0
0.000171	Illegal Sand extraction	0
0.000052	Illegal Limestone extraction	0
0.000120	Illegal Sand extraction	0
0.000109	Illegal Sand extraction	0
0.000076	Illegal Sand extraction	0
0.000038	Illegal Sand extraction	0
0.000070	Illegal Sand extraction	0

Attributes of Hazard			
<i>Area</i>	<i>Name</i>	<i>Name2</i>	<i>Rank</i>
0.000361	Beach erosion	highly	5
0.001238	Flood Prone	moderately	3
0.020810	Soil erosion	highly	5
0.000205	Beach erosion	moderately	3
0.000210	Beach erosion	moderately	3
0.021678	Soil erosion	moderately	3
0.000168	Beach erosion	moderately	3
0.000048	Beach erosion	moderately	3
0.000196	Flood Prone	moderately	3
0.000172	Flood Prone	highly	5
0.000715	Flood Prone	moderately	3
0.000242	Beach erosion	slight	1
0.000206	Beach erosion	slight	1
0.000033	Beach erosion	slight	1
0.000178	Flood Prone	moderately	3
0.000128	Flood Prone	moderately	3
0.000227	Flood Prone	highly	5
0.002260	Soil erosion	slight	1
0.000791	Flood Prone	moderately	3
0.002037	Flood Prone	moderately	3
0.001962	Soil erosion	slight	1
0.001020	Soil erosion	slight	1
0.000113	Soil erosion	moderately	3
0.000461	Flood Prone	highly	5

In some cases there is very little information regarding an issue which, however, is very relevant to the analysis of the environment-development interaction in a certain area. For example, the groundwater table plays an important role in city development strategies. But there may only be information available on areas with high groundwater tables and low groundwater tables. The EMIS Officer would probably classify the high groundwater table with the rank 1 and the low groundwater table with the rank 0. However, the working group might consider a high groundwater table as a serious environmental issue since people use it for drinking purpose and it is easily polluted through open car repair garages or pit latrines. Therefore the working group will probably decide on a rank of 5 for the high groundwater table and the rank 1 for the low groundwater table.

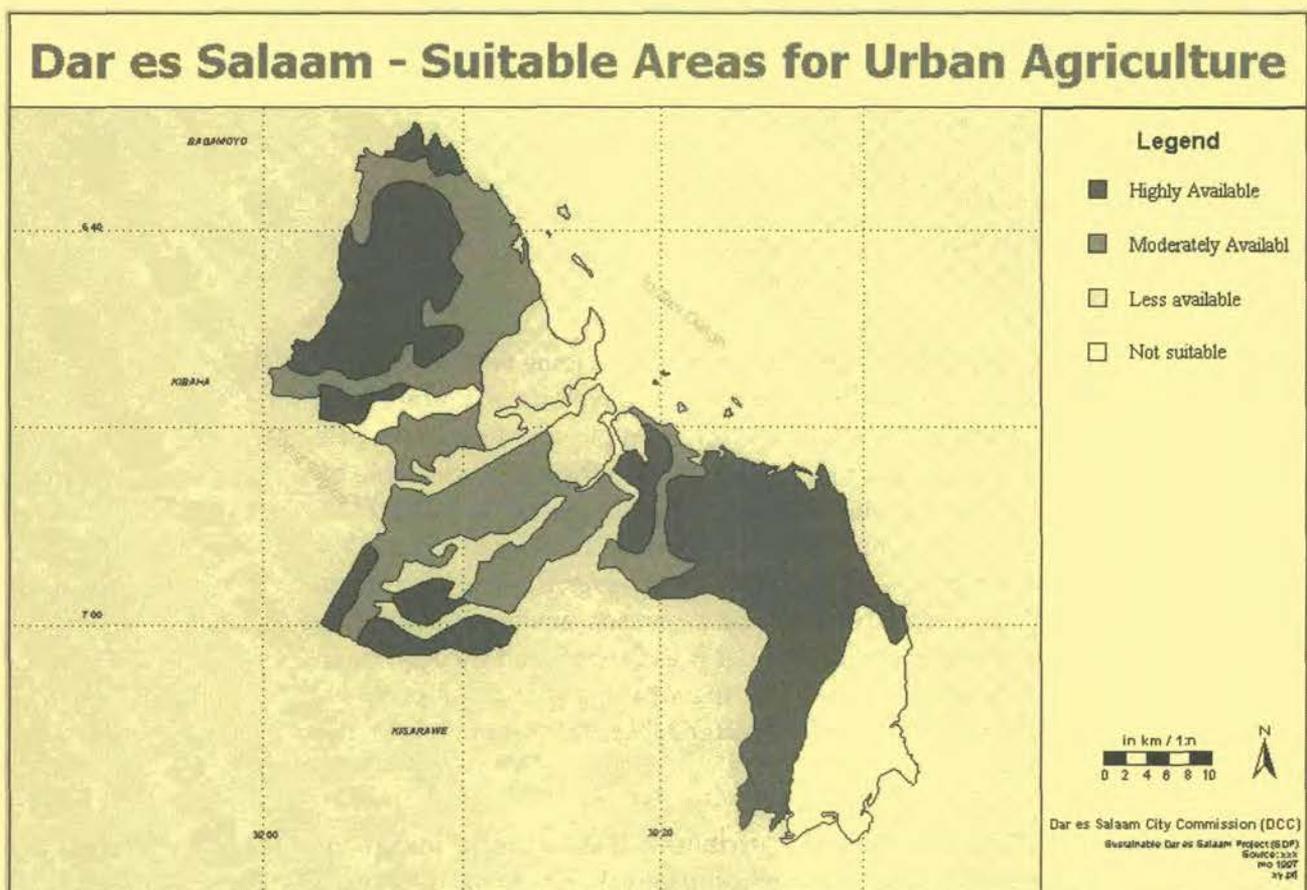
During overlays in a GIS programme the attribute tables of the various maps will be combined. The ranks of each individual map will be summarised into a new column (see tool 22: Overlaying maps).

Tool 19: Preparing a Suitability Map

How to prepare suitability maps

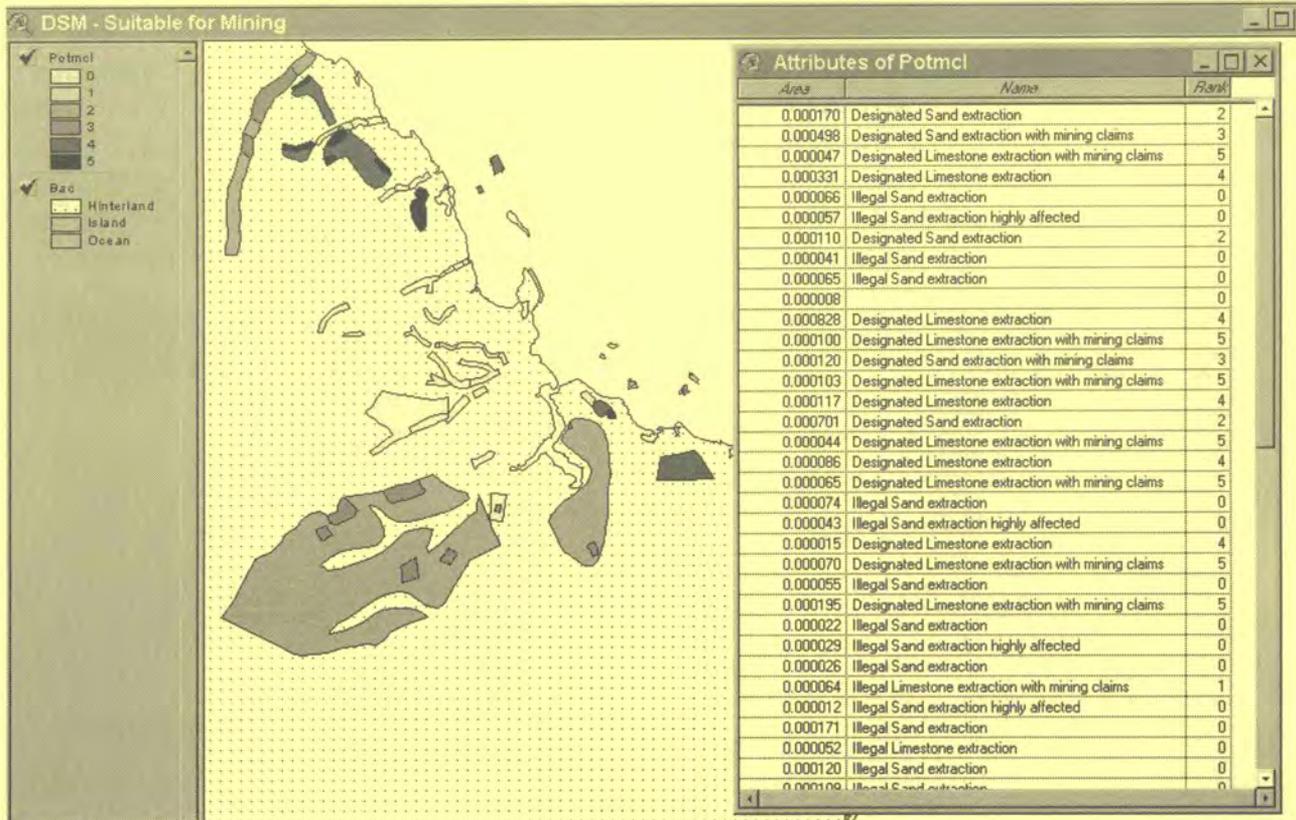
An Issue-Specific Working Group, for example on Urban Agriculture or on Mineral Resources and Mining, will develop a map showing suitable areas for a particular development issue. The development proposed is based on the analysis of thematic maps relevant to this issue and on an intensive working group process.

In many cases, the suitability map is drafted manually on a light table and later digitised on a digitising board (see Tool 10, Digitising with a Digitising Board). In other cases, survey teams will have collected ground co-ordinates with a GPS from which the boundaries can be generated (see Tool 17: Collecting Mapping Data in the Field). But in many cases, the analysis can be done from the overlay of thematic maps (see tool 22: Overlaying Maps). For example a certain type of soil in a certain type of micro-climate on a certain type of hazardous land can be classified as suitable for urban agriculture or not suitable for urban agriculture.



The Issue-Specific Working Group has (hopefully) developed justifications for the certain standards, rules and regulations which will apply for the particular areas which the map describes as suitable or not suitable. Those standards, rules and regulations are recorded in the working group minutes or in external or internal reports. The Mapping Group will decide which information should be linked to maps and how the information should be stored to make it

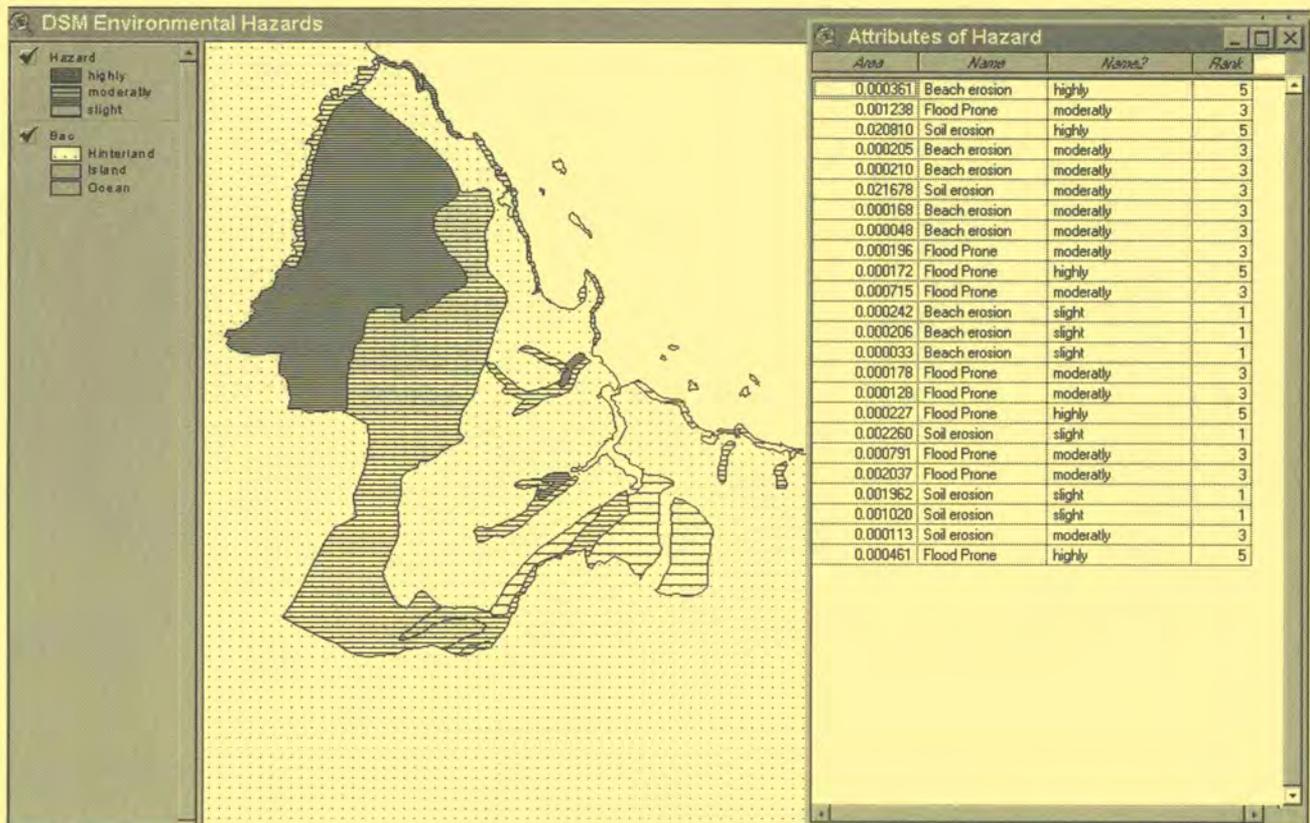
accessible for maps. Usually, a database programme, such as MS Access allows you to store extensive information which can be directly linked to a map (see Tool 15: Attribute Data)



Tool 20: Preparing a Sensitivity Map

How to prepare environmental sensitivity maps

The procedure for preparing Sensitivity Maps is similar to the preparation of the Suitability Map. Sensitivity Maps show environmental constraints which can be overcome with engineering measures (e.g. unstable slopes, air quality problems) and which relate to preservation (e.g. areas with endangered species). Sensitivity Maps are developed through an analysis of the thematic maps relevant to this issue, and through an intensive working group process.



Sensitivity Maps are made in the same way as Suitability Maps (see Tool 19: Sensitivity Maps). This tool will therefore concentrate on the generation of a sensitivity map from point sources.

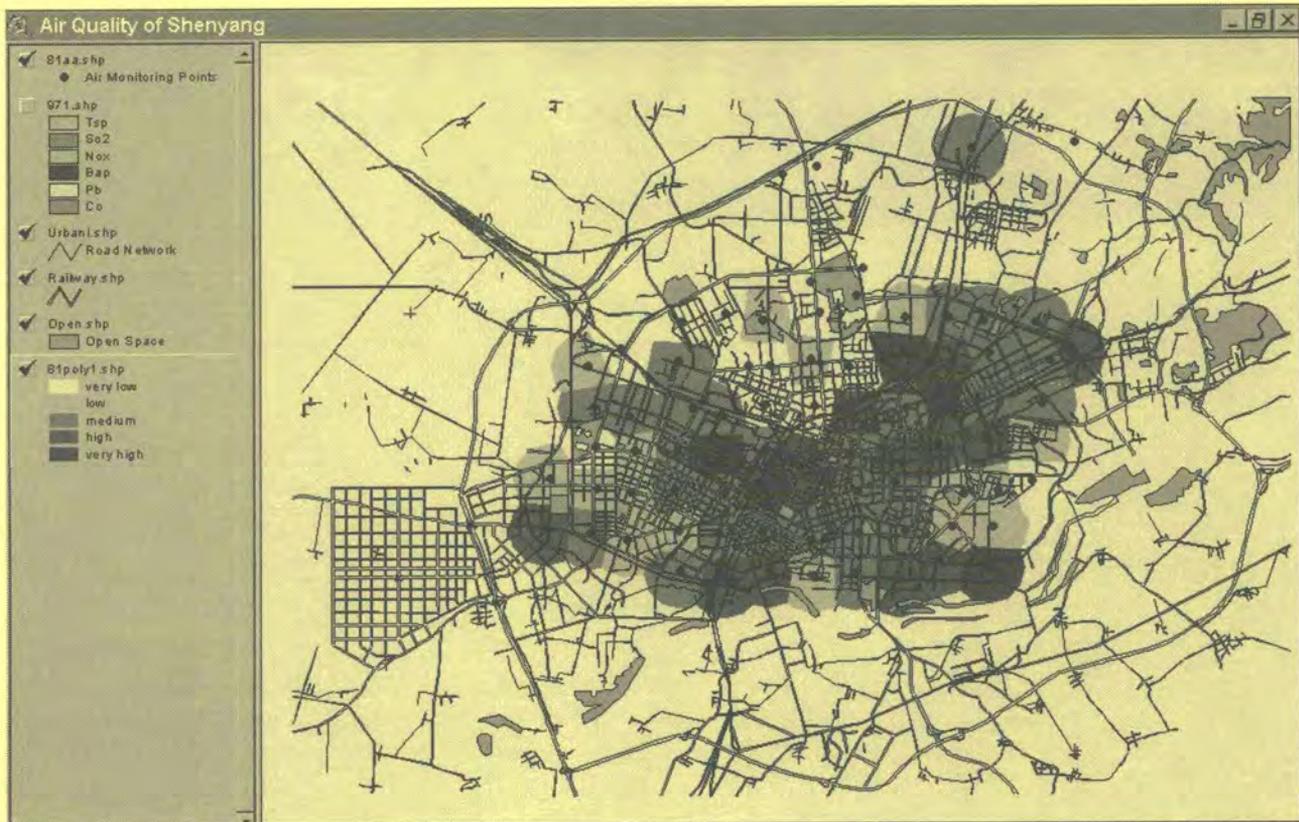
For example an industrialised city monitors the air quality situation through monitoring stations. The data from the monitoring stations are continuously collected and entered into a database system. The most common analysis method is to compare recent values of certain chemicals in the air with values from previous years. This analysis shows if a situation is improving or worsening, and can also be displayed on maps.

The EMIS uses monitoring data to determine areas of pollution, i.e. to show highly polluted areas and less polluted areas in the city. The process is, again, closely connected to the working group process. The Issue-Specific Working Group on Air Quality sets the standards, rules and regulations which will apply for the particular areas which the map describes as suitable or not suitable. Those standards, rules and regulations usually can be found in the

working group minutes or in external or internal reports. The Mapping Group will decide which of the information should be linked to maps and how to store the information to make it accessible for maps. Usually, a database programme, such as MS Access allows you to store extensive information which can be directly linked to a map (see Tool 15:Attribute Data)

The SCP Handbook and Toolkit on Urban Air Quality Management describes appropriate air quality models for specific circumstances. The base module of ArcView GIS does not have the tools for translating these models directly into maps. However, many procedures can be done 'manually' in ArcView GIS, or, even better, in Map Maker Pro. The ArcView extension Spatial Analyst allows you to perform simulations from the parameters you have derived from air quality management models.

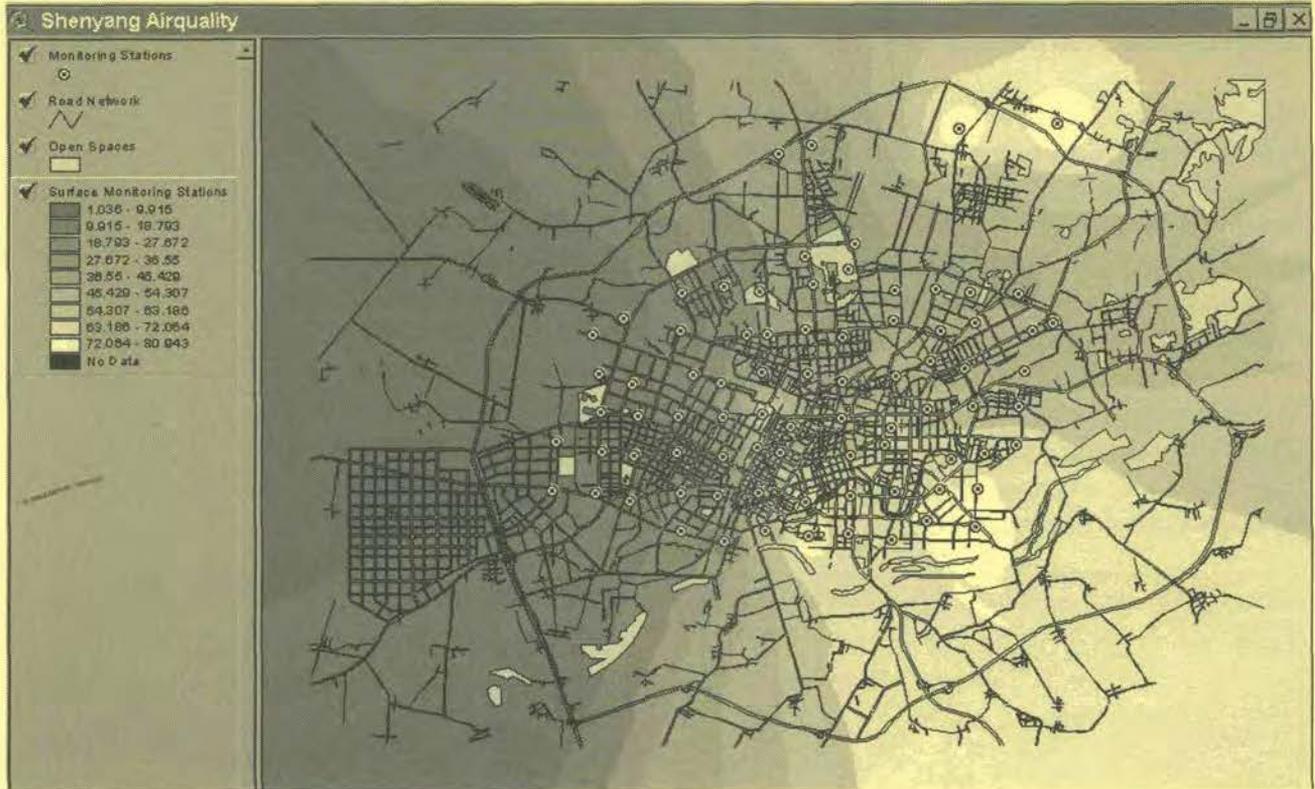
The following example shows areas of low to high air pollution in Shenyang, China. The working group on air quality derived an aggregated value of pollution from the concentration of various chemicals in the air, which were measured through a monitoring exercise.



The above map was produced with ArcView GIS ver. 3.0a and Map Maker Pro. The working group on air quality derived an aggregated value of pollution from the concentration of various chemical in the air measured through a monitoring exercise.

The EMIS team used the 'Polygons from Seeds' tool from Map Maker Pro in order to get polygons of equal distance around each monitoring station. The new geometry was exported to ArcView GIS and the attribute table of the monitoring points was attached to the new shape-file. The aggregate value of air pollution was used to generate the colour ramp.

ArcView's Spatial Analyst (see next map) allows you to generate a raster/grid map directly from points and it allows you to enter parameters which suit particular circumstances such as wind directions.



Tool 21: Preparing a Service Delivery Map

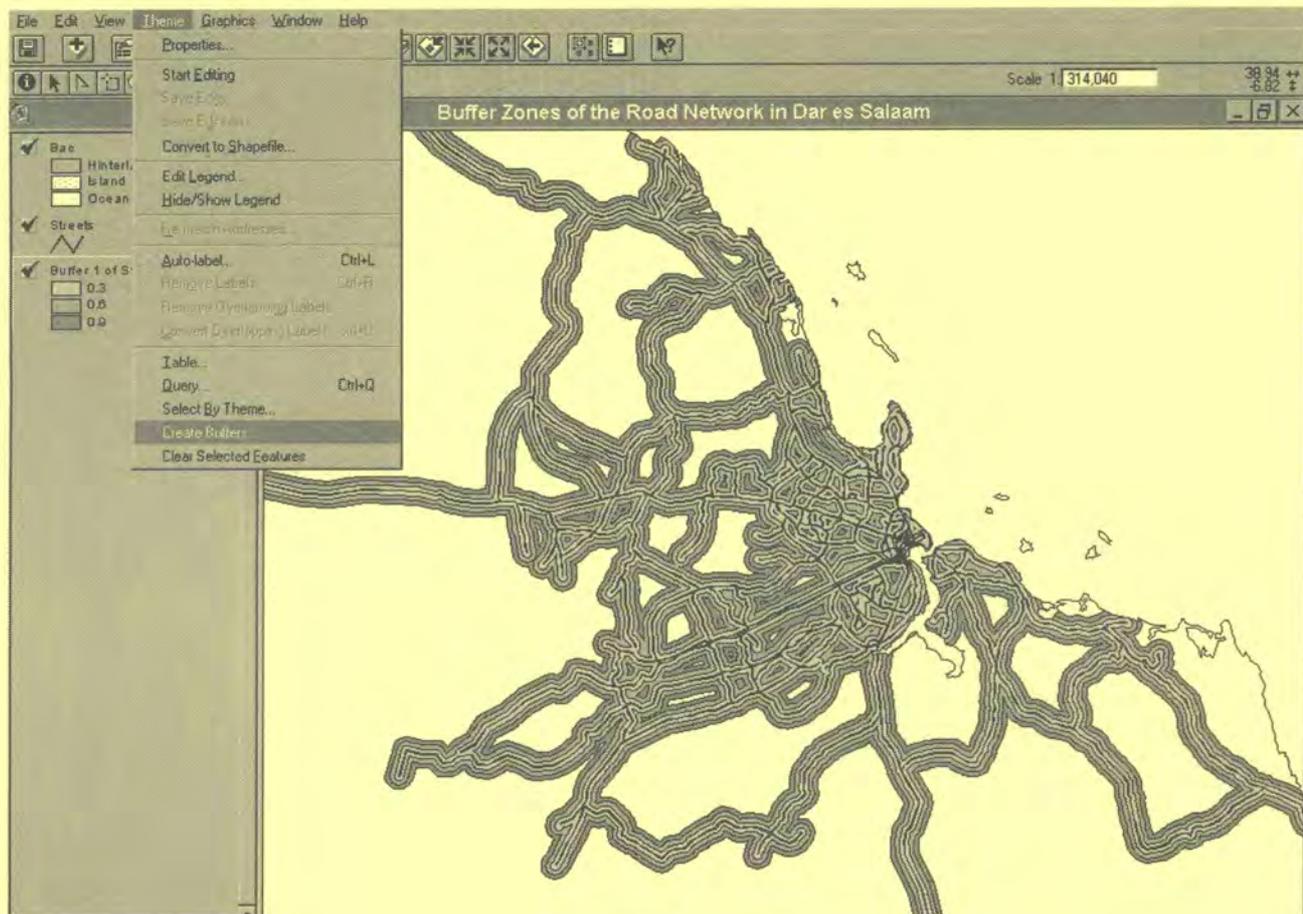
How to prepare service delivery maps

From utility networks to service delivery maps

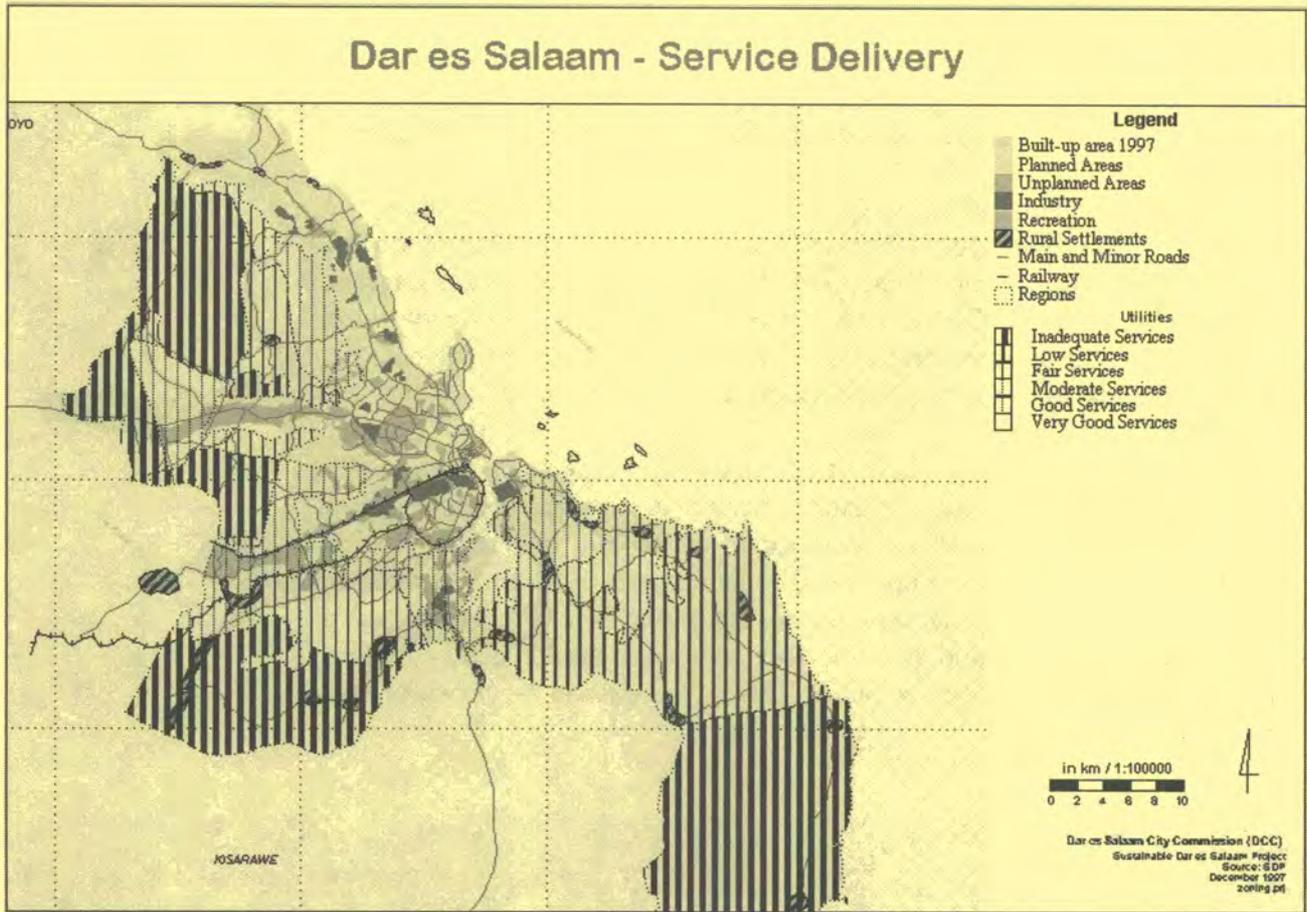
The Service Delivery Map is a special type of a Suitability Map. The Service Delivery Map shows the service availability in areas in terms of utility supplies such as, for example, access to roads, sanitation coverage, and electricity supply.

Service Delivery Maps are based on thematic utility maps which show the road network, the sewerage network, the power grid and distribution points and others. Again, the Mapping Group will decide on which utilities are relevant to combine in a Service Delivery Map. If there is an Issue-Specific Working Group dealing with infrastructure issues, it will be requested to decide on acceptable standards in term of accessibility to a certain utility.

After the Mapping Group has decided on the utilities to be mapped, the EMIS unit will prepare a buffer map for each utility. For example, a working group on transport has decided that a distance of up to 300 m from a road is considered as good access, of up to 600 m fair access, of up to 900 m poor access and beyond 900 m unacceptable access. In ArcView GIS (from release 3.1 and newer) you will find a simple tool to create the necessary buffers along the roads (see map below: Buffer Zones of the Road Network of Dar es Salaam).



The various utility maps can be ranked according to their importance in the city development strategy. The individual utility maps will be overlaid and combined in a Service Delivery Map, showing the areas of good, medium and poor utility supply (see map below: Dar es Salaam – Service Delivery).



Overlays

- Tool 22** Overlaying Maps
- Tool 23** Environmental Management Frameworks
- Tool 24** The Cities Environment Reports on the Internet (CEROI)

Tool 22: Overlaying Maps

How to manually and digitally overlay maps

How to do manual overlays, how to use the overlaying functions of ArcView GIS

Manual Overlays



Overlaying maps is best done manually. The cartographer of the EMIS unit prepares the necessary maps on tracing paper or the EMIS Officer prints digital Suitability, Sensitivity and Service Delivery Maps on a transparent medium. Those maps will be discussed by the co-ordinators of the individual Issue-Specific Working Groups, together with the EMIS Officer, at a light table. The group starts by overlaying two environmental issues and trace the new boundaries on a third, blank sheet of tracing paper. The group then adds a number code for each area and the summary of the ranks which are taken from the original maps. The third new map is then overlaid with another relevant environmental issue and another new map will be developed. This exercise can be repeated, ideally, for no more than six environmental issues, in order to produce a legible final map. The final map will be made up of small areas, each with its particular coding.

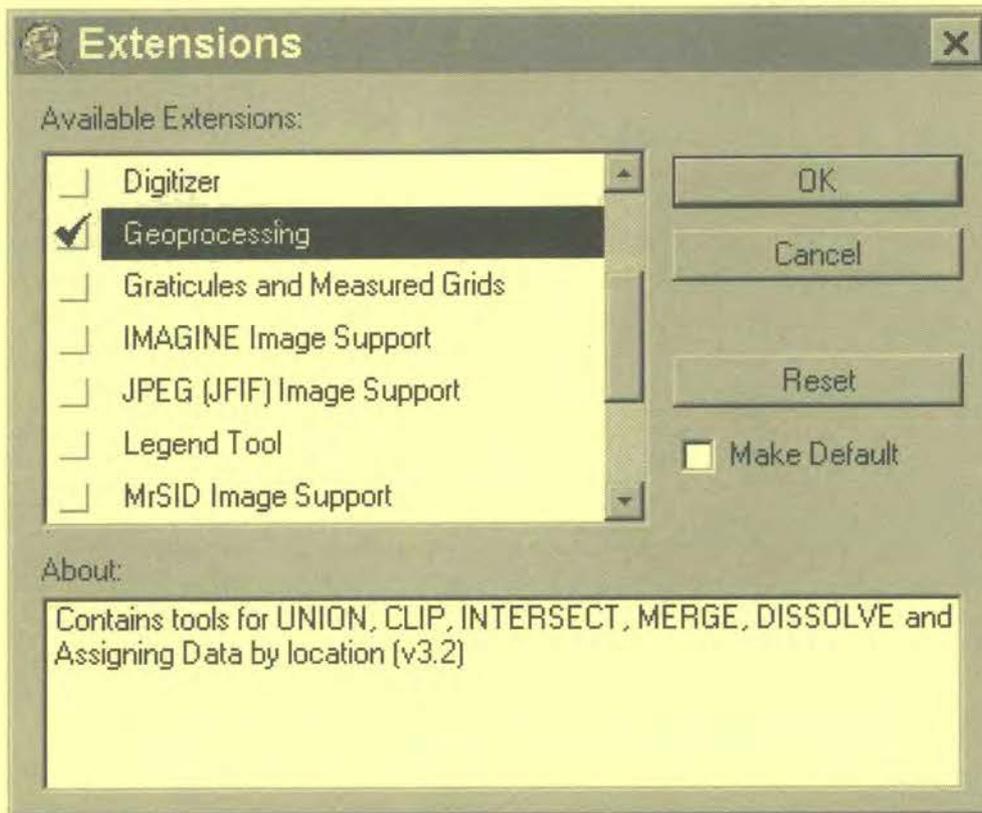
Overlaying functions in ArcView GIS



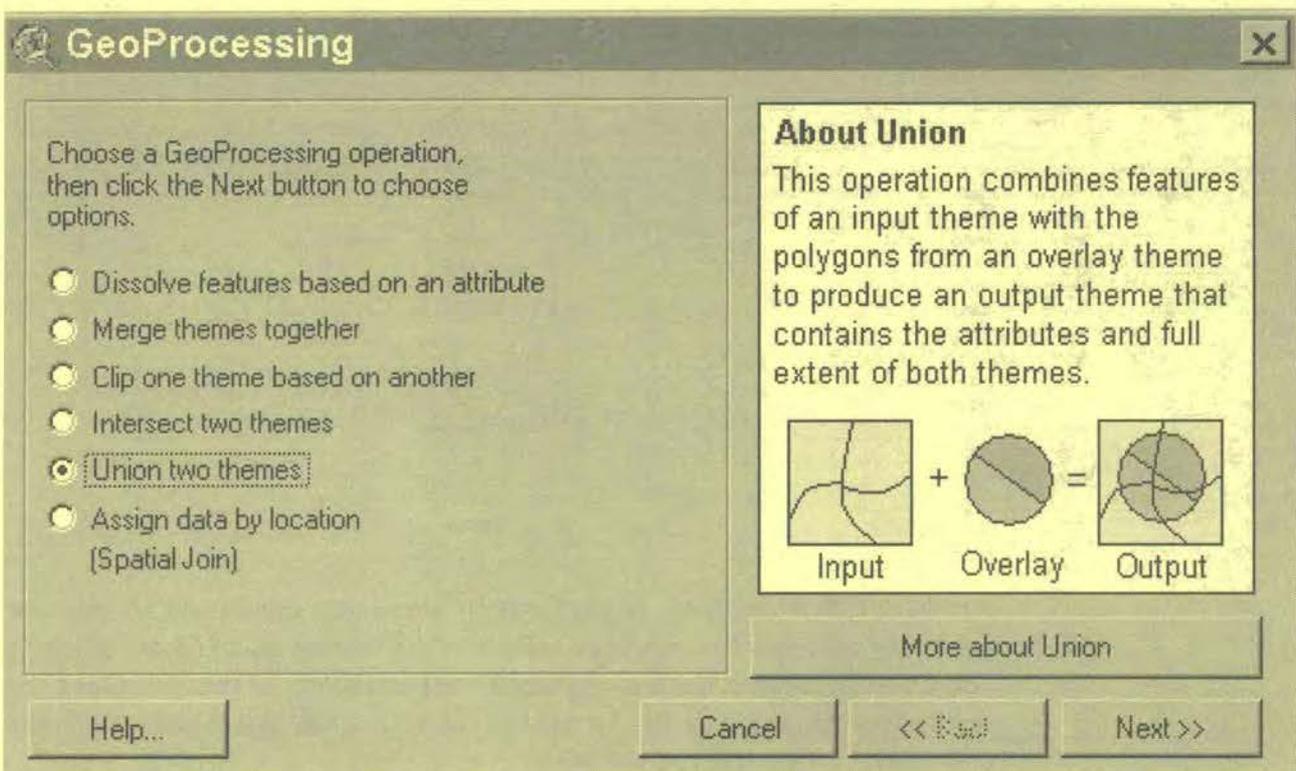
Before you start overlaying maps with a GIS, please be very sure that the key representatives of the Issue-Specific Working Groups fully understand the process and the desired end result. The process follows the same steps as manual overlaying with the only difference that the light table is replaced by the computer monitor. The overlaying will be done in a group which includes the relevant working group co-ordinators and the EMIS Officer, in front of the computer monitor. In some

cases you will have to make a printout on transparent paper and go back to the light table in order to discuss complex areas of conflict.

The technical procedure for making automatic overlays in ArcView GIS is straightforward and easy. First, you load the respective maps to be overlaid into your view and you activate the GeoProcessing extension.



Under View you will find the GeoProcessing Wizard. The wizard contains six GeoProcessing operations. For overlaying we can choose the operation 'Intersect two themes' or 'Union two themes'.



In the next step, the wizard will ask you which shape files to combine and what the new shape file should be called. Press the Finish button and ArcView GIS will generate the new geometry as shown in the following map.



ArcView GIS also combines the two individual attribute tables into one, putting the overlaid themes into sequence. Please note that you will have several columns containing the ranking of the individual Suitability / Sensitivity Maps. These have to be summarised into a new column.

Attributes of Min-haz.shp								
Shape	Area	Name	Rank	Area	Name	Name2	Rank	SumMin-Haz
Polygon	0.000170	Designated Sand extraction	2	0.000361	Beach erosion	highly	5	7
Polygon	0.000170	Designated Sand extraction	2	0.001238	Flood Prone	moderately	3	5
Polygon	0.000170	Designated Sand extraction	2	0.000000			0	2
Polygon	0.000498	Designated Sand extraction with mining claims	3	0.001238	Flood Prone	moderately	3	6
Polygon	0.000498	Designated Sand extraction with mining claims	3	0.000000			0	3
Polygon	0.000047	Designated Limestone extraction with mining claims	5	0.001238	Flood Prone	moderately	3	8
Polygon	0.000047	Designated Limestone extraction with mining claims	5	0.020810	Soil erosion	highly	5	10
Polygon	0.000047	Designated Limestone extraction with mining claims	5	0.000000			0	5
Polygon	0.000331	Designated Limestone extraction	4	0.001238	Flood Prone	moderately	3	7
Polygon	0.000331	Designated Limestone extraction	4	0.020810	Soil erosion	highly	5	9
Polygon	0.000331	Designated Limestone extraction	4	0.000000			0	4
Polygon	0.000066	Illegal Sand extraction	0	0.000361	Beach erosion	highly	5	5
Polygon	0.000066	Illegal Sand extraction	0	0.000000			0	0
Polygon	0.000057	Illegal Sand extraction highly affected	0	0.000000			0	0
Polygon	0.000110	Designated Sand extraction	2	0.001238	Flood Prone	moderately	3	5
Polygon	0.000110	Designated Sand extraction	2	0.000000			0	2
Polygon	0.000041	Illegal Sand extraction	0	0.020810	Soil erosion	highly	5	5
Polygon	0.000041	Illegal Sand extraction	0	0.000000			0	0
Polygon	0.000065	Illegal Sand extraction	0	0.020810	Soil erosion	highly	5	5
Polygon	0.000008		0	0.020810	Soil erosion	highly	5	5
Polygon	0.000828	Designated Limestone extraction	4	0.020810	Soil erosion	highly	5	9
Polygon	0.000828	Designated Limestone extraction	4	0.000000			0	4

ArcView GIS allows you to perform an automatic calculation of the new summary column. First, put your table into the editing mode ('Start editing'), add a new field (with number characteristic) and select all records. Open the field calculator and type the formula which you would like to perform in the new field, for example the following:

Rank_	Area	Name	Name2	Rank	SumMin-Haz
2	0.000361	Beach erosion	highly	5	7
2	0.001238	Flood Prone	moderately	3	5
2	0.000000			0	2
2	0.001238	Flood Prone	moderately	3	6
					3
					8
					10
					5
					7
					9
					4
					5
					0
					0
					5
					2
					5
					0
					5
					5
					9

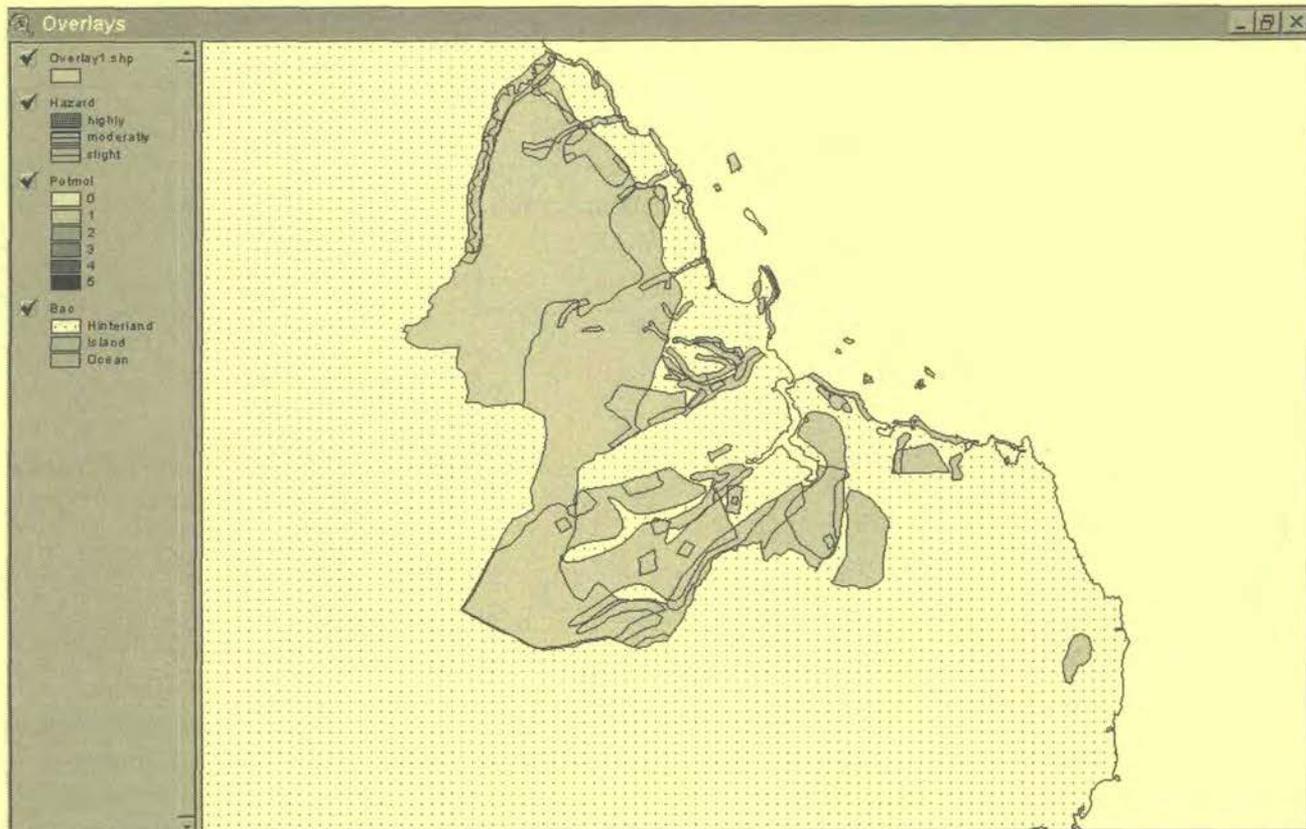
Field Calculator

Fields	Type	Requests
[Area_]	<input checked="" type="radio"/> Number	*
[Name_]	<input type="radio"/> String	+
[Rank_]	<input type="radio"/> Date	-
[Area]		..
[Name]		/
[Name2]		<
[Rank]		<=

[SumMin-Haz] =

[Rank_] + [Rank]

Press OK and the sum of the columns Rank_ and Rank will be calculated for each record in the new column. The new overlay map will use the new column to show areas of high conflict.



Tool 23: Environmental Management Frameworks

How to develop a map showing the future structure of the city

Case study of the Strategic Urban Development Planning Framework (SUDPF) in Dar es Salaam

Strategic Urban Development Planning Framework (SUDPF) in Dar es Salaam

(note: all maps mentioned within the text relate to the document: Strategic Urban Development Plan - The Stakeholders Edition, UASU, Dar es Salaam, 2000)

The Development of SUDPF in Dar es Salaam

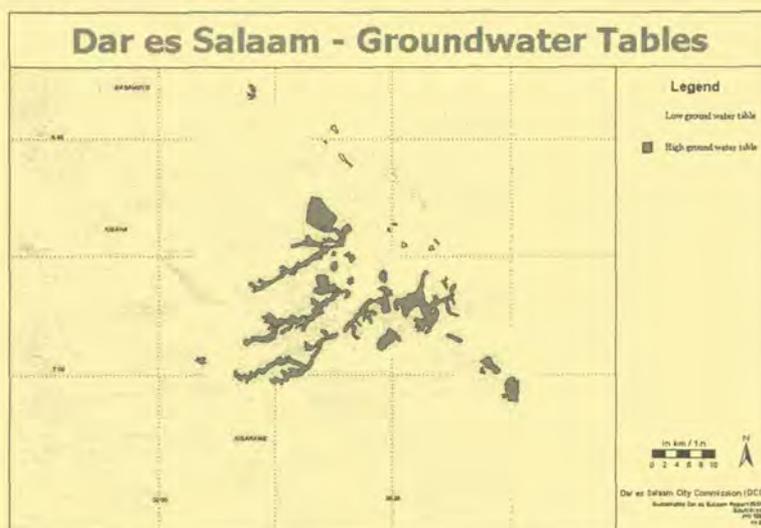
Developing the SUDPF was among the key objectives of the Sustainable Dar es Salaam Project (SDP). From 1992 the city council has had a strong interest, in developing a city wide SUDPF.

In the absence of any comprehensive practical experience in the other SCP cities, in developing participatory process-led SUDPF, the working groups in Dar es Salaam had no choice, but to meddle through. They analysed and processed the huge stock of issue-specific information collected by the working groups into layers of areas with varying degree of suitability for different activities. It was not an easy task to generate a composite land use pattern developed on the basis of coherent rules and principles. The aggregation of the strategies and the development of the SUDPF for Dar es Salaam followed more or less the steps outlined in this chapter.

The development of the SUDPF took about two years and is based on local experiences and expertise. The SUDPF is well documented in six volumes and in a 'Stakeholder's edition'.

STEP I: Preparation of Suitability Maps (city-wide)

They started with preparing suitability maps for issues, which were pertinent in determining urban expansion and growth in Dar es Salaam, such as urban agriculture, hazard lands, coastal resources, built up areas, transportation networks and ground water table.



Then suitability maps, which integrate two issues in one, at a time were prepared. This was a permutation exercise, which involved the above issues and their suitability maps. All suitability maps for each environmental issue in relation to city expansion were compiled, such as

1. Urban Agriculture
2. Hazard lands
3. Coastal resources (Building materials)
4. Built up areas and transportation network
5. Ground water table

STEP II: Ranking the overlapping landuse

Overlay the above maps (1-5) and rank the overlapping land uses. The ranking criteria depend on the level of conflicting uses to each layer. The higher the conflicting area the higher the rank or number and the fewer the conflicting area the less the number as shown hereunder:

No	Environment Issue	Characteristic	Classification & Ranking
1	Hazard lands	Erosion prone	3 - Highly erosion prone 2 - Moderate erosion prone 1 - Slightly erosion prone
		Flood prone	3 - Highly flood prone 2 - Moderate flood prone 1 - Slightly flood prone
		Beach erosion	3 - Highly beach erosion 2 - Moderate beach erosion 1 - Slightly beach erosion
2	Urban Agriculture	Availability	4 - Highly available 3 - Moderately available 2 - Less available 1 - Not available
3	Building Materials	Potentiality	5 - Highly potential sand & limestone (quality) 5 - Highly potential sand & limestone (quantity) 4 - Potential mining (under exploitation) 3 - Potential mining (future) 2 - Potential mining built up
4	Ground Water Table	Level of ground water	6 - Area with high water table 0 - Area with low water table

The exercise of overlaying the environmental issue suitability maps was done step by step by overlaying two maps in turn as indicated below:

- Agriculture with building materials (mining) Map 1
- Mining with Hazard Lands Map 2
- Agriculture with Built up areas Map 3
- Built up with Hazard Lands Map 4
- Built up with Mining Map 5
- Agriculture with Hazard Lands Map 6



The level of suitability was graded into six categories as indicated in the table below:

LEVEL OF SUITABILITY	OVERLAID ENVIRONMENTAL ISSUES					
	A + M 1	M + H 2	A + B 3	B + H 4	B + M 5	A + H 6
6						
5	X	X		X	X	X
4	X		X	X	X	
3	X		X	X	X	X
2	X		X	X	X	
1	X				X	X

Key:A = Agriculture

B = Built up areas

H = Hazard lands

M = Mining (building materials)

By overlaying the above six maps one composite map was generated on which areas were prioritised for development based on the degree of conflicts pertaining to them. For ease of classification weights were given to degree of conflicts: the higher the number of issues prevailing in an area, the more constrains for development and the more rules were required to regulate existing or future activities.

STEP III: Production of Priority Area Map

The maps produced in step II were again overlaid to produce one layer comprising of all six environmental issues. In this layer areas with total weight ranging between 1 - 5 were considered as less conflicting and were identified as areas suitable or potential for city expansion. The output is Priority Area map (map No. 7)

STEP IV: Environmental Zoning

In order to qualify the suitability of the potential areas identified for city expansion, map no. 7 was overlaid with ground water table map in order to identify limitations of urban development due to ground water table. Areas with low ground water table are identified as most suitable for development. This exercise refined map no. 7 as environmental zoning map (map No. 8).

STEP V: Land available for city expansion

This stage further refines map no 8 by overlaying it with the existing land use map to eliminate the already committed areas (land). For example major public institutions like hospital sites, army, schools and colleges, etc. were identified. These sites might otherwise cause conflicts and hinder future development or may even not be easily acquired for city expansion. This overlay produces the final with suitability level ranking between 1 -5 as land available for city expansion map (map No. 9)

STEP VI: Utilities

It was necessary to overlay the map resulting from step V (showing free land for city expansion and with potential for development) on utilities (power and water) map, and later on road accessibility map to qualify areas with adequate utilities and accessibility as most suitable for city expansion and development. The ranking of areas was based on weights attached to the

different levels of adequacy in utilities and accessibility.

As a rule of the thumb, city expansion cannot take place in a co-ordinated manner in the absence of utility supply. Therefore the extent, quality and quantity supply of main utilities are analysed to further support the potentiality of areas identified in map no 9 for future expansion. The main utilities considered here with their classification criteria and map numbers are:

Map No	Utility	Classification & Ranking
Map No 10	Water Supply	2- Areas with adequate supply under phase I rehabilitation & upgrading 1- Areas with inadequate supply & under phase II service expansion 0- Areas without formal supply system and no immediate plans
Map No 11	Electricity	2- Areas with adequate supply 1- Areas with inadequate supply with proposal coverage to year 2000 0- Areas with no power and no immediate plans

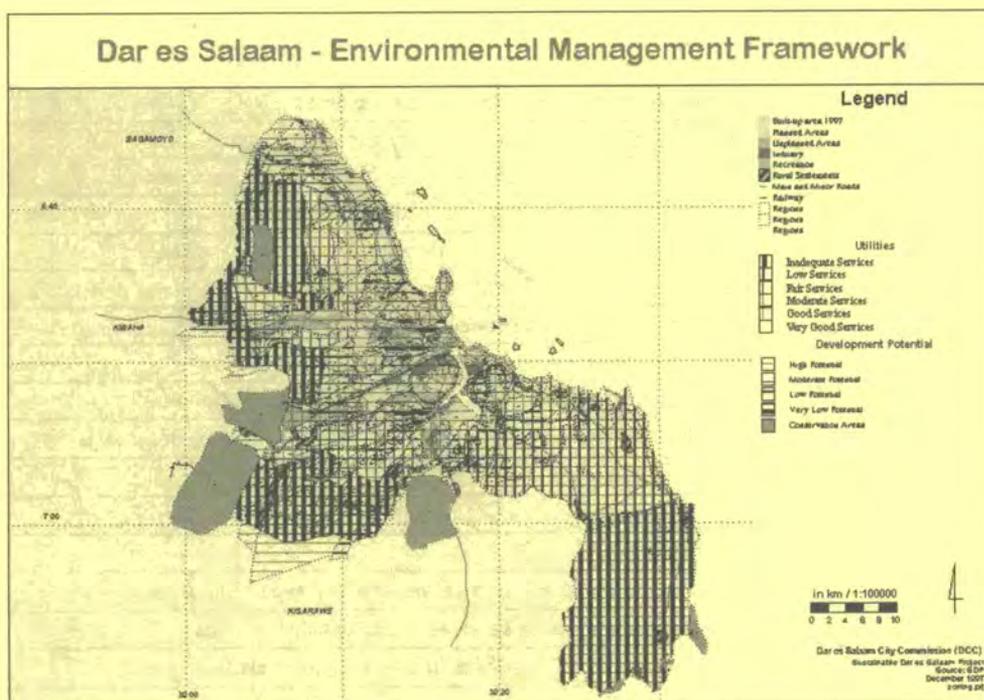
The overlay of the two issues (water and electricity) was again overlaid with accessibility situation map that was graded as follows:

Accessibility: 2 - Areas with good roads
1 - Areas with fair roads
0 - Areas with poor or no roads

After overlaying the three maps a utility map was produced indicating level of services (Map No. 12).

STEP NO.VII: Overlay of Utility Map with City expansion Map

The following step now was to overlay the utility map no 12 with map no. 9 (Land available for city expansion) in order to see the suitability of the potential land in terms of service availability. The result of this overlay is Map No. 15 (final map) which shows the potential areas for future development and investment with fewer conflicts and the level of utility supply in each area.



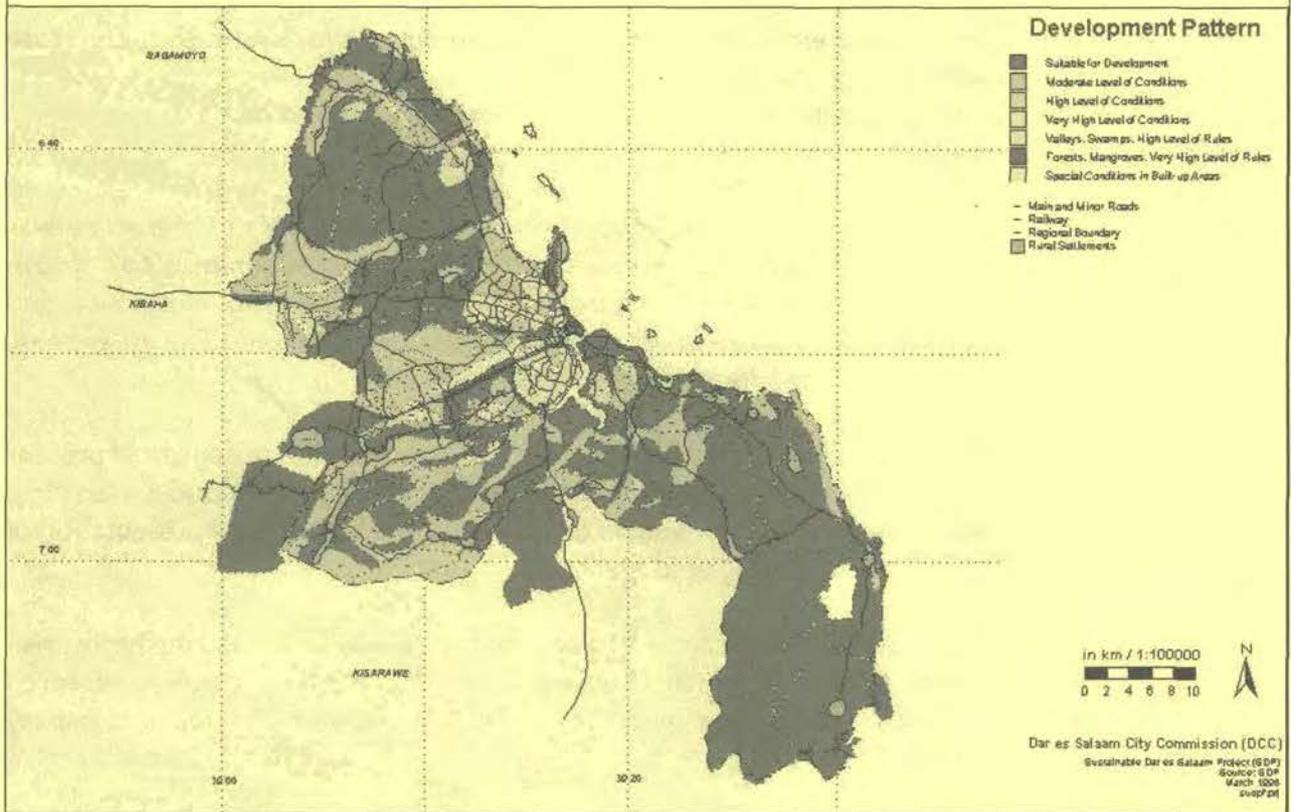
STEP VIII: Zoning

Once areas were prioritised for city expansion and development, they were then sub-divided into zones. The city of Dar es Salaam was divided into 21 zones and 41 sub-zones, which were characterised by the level of services, existing or planned

After producing map no. 12 the potential areas for city expansion were classified into zones. The zone were then categorised and level of service potentiality as the main characteristics of the identified potential areas as indicated below:

ZONE	CATEGORY/area	CHARACTERISTICS
1	a	High potential + very good services in possible city expansion areas
	b	High potential + very good services in built up areas
	c	High potential + very good services in planned areas
	d	High potential + very good services in unplanned areas
	e	High potential + very good services in industrial areas
2	a	High potential + good services in possible city expansion areas
	b	High potential + good services in built up areas
	c	High potential + good services in planned areas
	d	High potential + good services in unplanned areas
3	a	High Potential + Fair/moderate services in city expansion areas
	b	High Potential + Fair/moderate services in built up areas
	c	High Potential + Fair/moderate services in planned areas
	d	High Potential + Fair/moderate services in unplanned areas
4	a	High potential + low services in city expansion areas
5	a	High potential + inadequate services in city expansion areas
6	a	Fair potential + Very good services in city expansion areas
	b	Fair potential + Very good services in built up areas
	c	Fair potential + Very good services in planned areas
	d	Fair potential + Very good services in unplanned areas
	e	Fair potential + Very good services in industrial areas
7	a	Fair potential + Good services in city expansion areas
	b	Fair potential + Good services in built up areas
	c	Fair potential + Good services in planned areas
	d	Fair potential + Good services in unplanned areas
8	a	Fair potential + fair services in city expansion areas
	b	Fair potential + fair services in built up areas
9	a	Fair potential + low services in city expansion areas
10	a	Fair potential + inadequate services in city expansion areas
	b	Fair potential + inadequate services in built up areas
11	a	Low potential + very good services in city expansion areas
	b	Low potential + very good services in built up areas
12	a	Low potential + good services in city expansion areas
13	a	Low potential + Fair services in city expansion areas
14	a	Low potential + Inadequate services in city expansion areas
15	a	Very low potential + Very good services in city expansion areas
16		Conservation areas
17		Recreation areas
18		Villages
19	b	Very low potential + Good services in city expansion areas
20	a	Low potential + Good services in city expansion areas
21	a	Low potential + Fair services in city expansion areas

Dar es Salaam - Strategic Urban Management Framework



Tool 24: The Cities Environment Reports on the Internet (CEROI)

How to use environmental indicators and maps for monitoring the state of the environment

Examples from the UNEP/GRID-Arendal CEROI Programme

The Cities Environment Reports on the Internet (CEROI) Programme was established to increase awareness about the urban environment, to improve environmental policy making by providing better access to information, and ultimately to improve the cities' and the world environment. The programme works within the framework of Local Agenda 21.

CEROI provides city authorities with an efficient tool to produce and present a report of the cities' environment on the Internet. This tool includes a template with standard indicators and a tailor-made software for easy presentation of graphs, maps, photographs and text.

The pilot phase of the project has been supported by UNEP and the Norwegian Industrial and Regional Development Fund through a public research development contract with the Norwegian software developing company Uglund Publikit.

The state of environment (SoE) report will:

- 1 give an overview of human-induced impact on the environment for a number of selected thematic topics;
- 2 indicate the present state of the environment and current trends;
- 3 show political responses to these trends;
- 4 indicate the degree to which these responses have been attained; and,
- 5 allow the end user to compare the environmental situation in different cities.

The reports will be physically - and conceptually - accessible to practitioners at the national level and in international assistance programmes, politicians, administrators, non-governmental organisations (NGO), schools and other interested individuals and organisations.

The following documentation is available under: <http://www.ceroi.net>

- State of the Environment (SoE) Indicators
- CEROI Indicators Resources
- CEROI Indicators Encyclopedia
- CEROI Core Indicators
- Understanding the CEROI template: a manual (PDF)
- Developing and Publishing SoE Reports
- Cookbook for SOE Reporting, GRID-Arendal
- On-line reporting resources
- Publikit on-line publishing software



CAPE METROPOLITAN AREA
State of Environment



What is reporting on the state of the environment?

This **Year One 1998 State of the Environment Report** brings together available information about the present state of the urban, social, physical, ecological and economic components of the CMA environment, and serves as a tool to identify priorities to guide an Integrated Metropolitan Environmental Policy (IMEP) process.

Web links

- [CEROI](#)
- [SOE in S.A.](#)
- [IMEP](#)
- [Grid-Arendal](#)
- [UNEP](#)
- [Upland Publikit](#)

the CMA's Environment

natural Built Socio-econom

The key **ISSUES** in the CMA are described under the following themes:

Air Quality	Urbanisation	Economy
Water	Infrastructure	Environmental Health
Soil	Transportation	Education
Biota	Energy	Safety and Security
	Waste	Environmental Governance

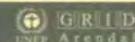
See also the summary list of [ALL ISSUES](#)

- [What's NEW III](#)
- [Site Structure](#)
- [All Issues](#)
- [All Indicators](#)
- [Context info](#)
- [Maps](#)
- [Glossary](#)
- [Responses](#)
- [Sources](#)
- [Legislation](#)

About this SOE

- [Foreword](#)
- [Purpose](#)
- [Sustainability](#)
- [Process](#)
- [Assumptions](#)

Hardcopy
This website represents the first SOE Report for the Cape Metropolitan Area, produced by the Cape Metropolitan Council. The report is also available in a hardcopy format from the CMC. Contact envis@cmc.gov.za



[CEROI home page](#)

City Environmental Indicators

[Indicators encyclopedia](#)

Data browser: Cape Town, South Africa

Data are available from 1999 to 1999

Click the name of the indicator to view its definition	1999
Access to drinking water	
Households with access to water (%)	81,00
Air emissions	
CO2 (tones/capita/year)	
Nox (tones/capita/year)	
SO2 (tones/capita/year)	
Air quality	
Carbon Monoxide (CO) (days/year)	
Nitrogen Dioxide (NO2) (days/year)	19,00
Ozone (O3) (days/year)	10,00
Sulphur dioxide (SO2) (days/year)	2,00
City product	
City product per capita (US\$/capita)	4 119,00



contextual
info

State of Environment



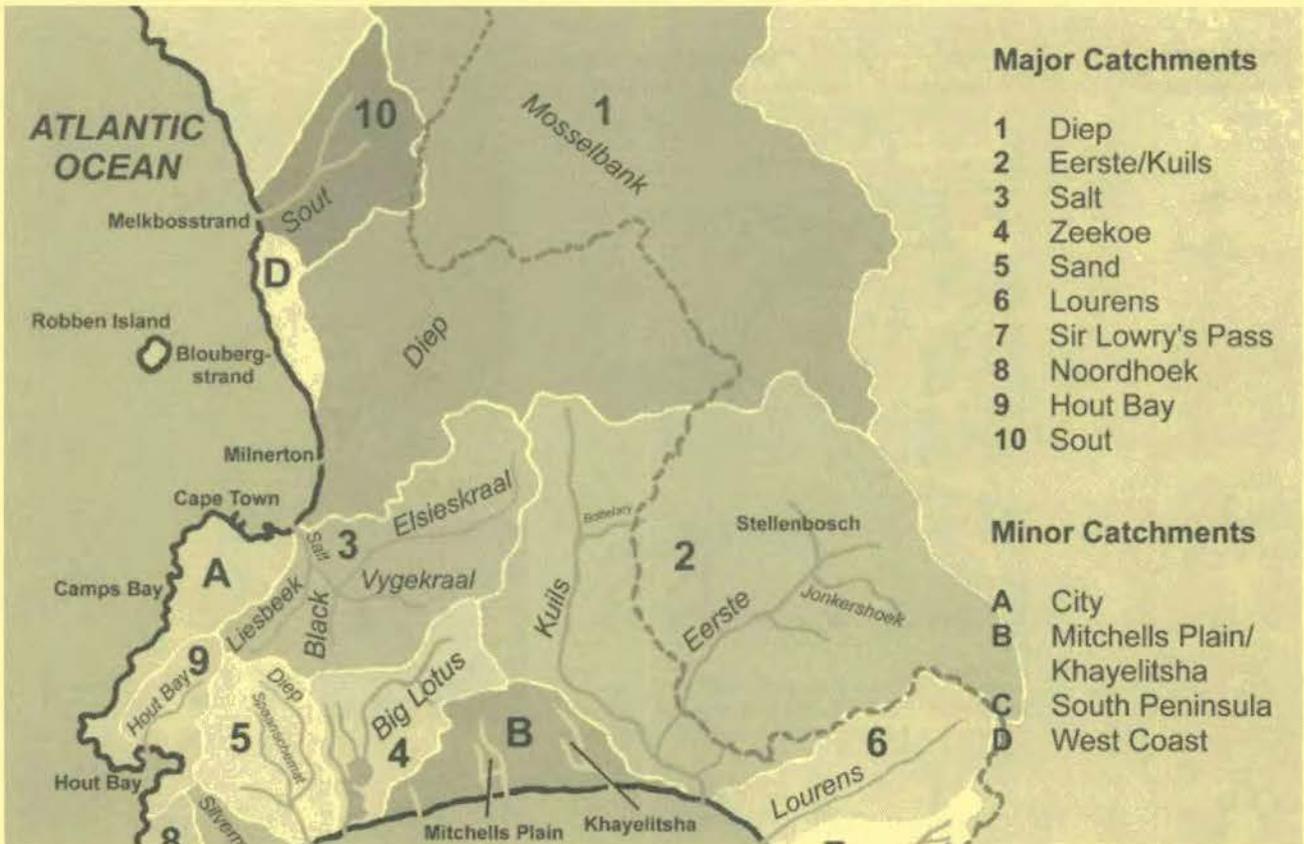
Water: Map

Catchments in the CMA

Return to [Contextual Information: Water](#)

See [All Maps](#)

[[SoE Home](#) | [Issues](#) | [Sources](#) | [Contextual Info](#) | [Indicators](#) | [Responses](#) | [Glossary](#)]



Information Outreach

- Tool 25** EMIS Web Site
- Tool 26** Posters

Tool 25: EMIS Web Site

How to create an EMIS Web Site

Web Site Development, Sitemap, Standard Layout, Clickable Map

Web Site Development

Web Site Goals

Before you start, you must decide whether or not it would be helpful for the project to have a web site in the first place. Make a quick analysis of what is feasible and what is not possible and decide on who you want to reach and how.

Gather Information

The next step is to collect data and information. Compile notes, maps, reports, charts, pictures, basically everything you think you will need for the web site. Discuss the content of the site with the Mapping Group and with the EPM team. You will probably find a wide range of opinions and ideas, which is why it is particularly important to remember just what a web site needs, and can and cannot offer in terms of maintenance needs and outreach ability.

Material Checklist

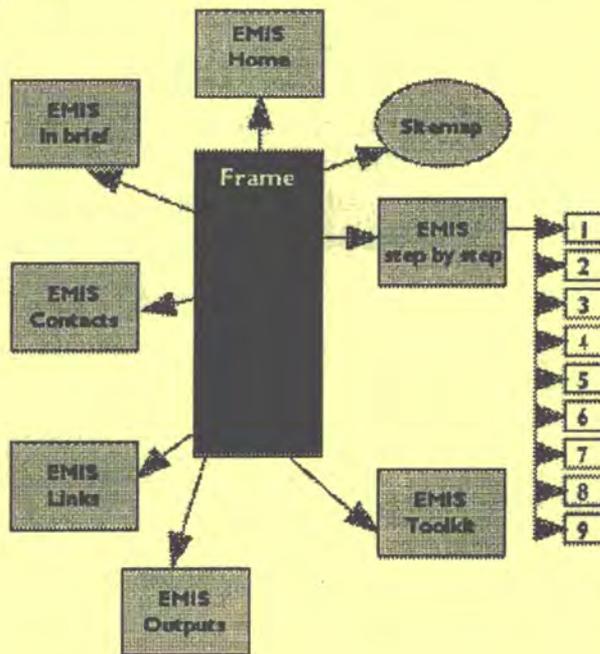
Gather the materials necessary for designing, and administering the site. Also, have all the data you gathered close at hand.

- Pencils
 - Paper
 - HTML editing software (for example, Netscape Composer or HTMLed)
 - Image editors (Adobe PhotoShop, MS Photoeditor or others)
 - Browsers (for example, Netscape or Internet Explorer)
 - Flowchart programmes (for example, in MS PowerPoint)
-

Sitemap

There are several ways to go about designing a site layout. An effective way is to rough the site out on paper. Making a flowchart-like-layout is quite useful. It allows you to view the site as a whole and identify any structural problems. Next, you rough out the actual content of the web pages. You may find yourself going back and forth between this and the overall layout design in order to make everything work well. You lay out where information goes and how it looks as well as positioning images, charts, graphs, etc. You should have a good idea of the structure before you do any coding so make sure the layouts are thorough. Remember that the information has to be easy for a casual reader to navigate through, and that download time must be kept to a minimum. A slow and confusing site does not get many return visits.

This flowchart indicates the site layout of the EMIS Tool on the Sustainable Cities Website.



Standard Lay-Out

While you design the site, you should keep in mind that the overall look of the site should reflect the public face of the project. The Internet is a new kind of information medium, and you will have to adapt the project's image to fit into the World Wide Web. Image is not everything, but it is the key ingredient in getting somebody's attention.

HTML Coding

HTML stands for Hypertext Mark up Language. It is a coding language, where the information about the appearance of the webpage is written inside 'tags'. These tags define how the text looks and where graphics and paragraphs appear in the web page. For example, ` hello ` appears on the screen as **hello**.

You can prepare webpages using two different types of editors, WYSIWYG and text-based. WYSIWYG stands for 'What You See Is What You Get' e.g. the Netscape Composer or saving a MSWord document as HTML. These editors that let you make an HTML document without having to write any HTML coding yourself. What you see on the screen as you work looks like what your webpage will look like. However, WYSIWYG editors generally produce bulky code and can be harder to use when creating complex pages. But you can use them for a start and later on clean up the coding with a text editor.

Text-based editors such as HTMLed Pro, on the other hand, deal with the actual HTML coding. You must have HTML knowledge in order to use the text-based editors. The good thing about text editing is that you have considerably more power over web page layout and positioning.

Testing

An important test is browser compatibility. Different Internet Browsers

interpret HTML in different ways, so you should make sure the web site looks good in each of the browsers and on different screen sizes (today, 600x800 screen pixels is commonly used).

Images

As well as text, you will need to create and edit images for use on the web site. These images must be saved in GIF or JPEG format and the files must be as small as possible. It is generally accepted that the combined size of a webpage should not exceed 60 or 70 kilobytes. Refer also to Tool 22: Poster.

Example

This is an example of the main structure of the EMIS website, which uses two frames. Frames means that the website appears on the screen in two parts, in this case a sidebar with links to all relevant pages and the main part where the information can be read. An HTML document is always divided in two parts: the head and the body. In the head, starting with <head> and ending with </head>, information about the webpage is stored like the name, which can be seen at the top of the browser. The body part of the document contains the information, which appears in the main window of the browser.

```

<!doctype html public "-//w3c//dtd html 4.0 transitional//en">
<html>

<head>
  <meta http-equiv="Content-Type" content="text/html;
    charset=iso-8859-1">
  <meta name="Generator" content="HTMLed32 Version 2.0d">
  <meta name="Keywords" content="urban, geographic
    information system, gis, management, environment">
  <meta name="Description" content="Frame file for Tool EMIS">
  <meta name="Author" content="Karin Buhren">
  <meta name="GENERATOR" content="Mozilla/4.6 [en] (Win95;
    I) [Netscape]">
  <title>Environment Management Information System</title>

<frameset cols=117,*>
<frame name="frame-1" src="sidebar.htm" frameborder="no">
<frame name="frame-2" src="main.htm" frameborder="no">
</frameset>

<noframes>
</head>

<body>
Your browser cannot read frames, please go to
the <a href=" ../UGC Website/main.htm">text only page</a></
  noframes>
</body>

</html>

```

Clickable Map

An image map is a graphic which has various 'hot spots' that can act as links to other parts of the web. The image map description given below is client based. These image maps need quite some preparation, and so they are only useful for showing some examples of the EMIS Maps.

When making the map section of an image map it is necessary to have the image already completed, so that you have all the shape areas that you would like to have active for the image map. There are three shapes that can be used: a rectangle, a circle and a polygon.

1. **Open** an image editor
2. **Load** the image you want to use
3. Measure the **pixel co-ordinates** for the areas you want to have active
4. Next thing is to **open a text editor**
5. Open the html file where you want to insert your clickable map
6. **type** the html code:

```
<map name="name">
<area>
[shape="shape"]
coords="x,y,.. ."
[href="url"]
[nohref]
[alt="alternate text"]>
<area ...>
...
</map>
```

This is an example used in the EMIS section of the Sustainable Cities programme website (<http://www.unchs.org/scp/>).

```
<p><map name="contact">
<area shape="circle" coords="124,280,4" href="http://
www.unchs.org/scp/conindex.htm" alt="La Concepcion">
<area shape="circle" coords="304,90,4" href="http://www.unchs.org/
scp/conindex.htm" alt="Katowice">
...
href="http://www.unchs.org/scp/conindex.htm" alt="Dar es Salaam">
<area shape="circle" coords="353,220,4" href="http://
www.unchs.org/scp/conindex.htm" alt="Zanzibar">
</map>

<center><img SRC="emisnetsmall.jpg" usemap="#contact"
height=347 width=600>
```

Tool 26: Posters

How to prepare posters for an exhibition

Save maps as images, Image compression, Prepare posters in ArcView GIS

Save maps as images

You can export a map layout to a graphic file so that you can use it in other programmes. ArcView GIS and Map Maker Pro support several output formats, such as *.jpg, bitmap and *.eps. To export a map in Arc View GIS, do the following:

1. In the layout mode choose **export** from the file menu
2. In the dialog box that appears, choose the **file format** you want
3. Use the option button to **change the resolution** (according to your needs, highest quality for posters and EPS format for printing in publications)
4. Press OK

Another possibility for saving maps as images is to make a screen shot, especially if you do not need high resolution files, for example when preparing presentations onscreen or very small pictures. This possibility is also useful for showing the different steps in preparing a map.

1. If the screen shows what should be in the picture, **press the Print Scrn button**. The view of the screen will be saved on the computer's clipboard.
 2. Open PhotoShop, MS Photo Editor or MS Word
 3. Choose **new file**
 4. Edit > Paste or **press ctrl V**
 5. Now you can clip the part of the image you need and **save** the file as in JPEG format
-

Image compression

When you scan an image, it is usually saved in "Tagged Image File Format" or TIFF format (*.tif). However, you also have the option of saving it in formats that occupy less memory.

The JPEG format (*.jpg) is used for gradient colours, such as photos, while GIF (*.gif) format is used for flat colours, such as logos. When changing an image from *.tif format to *.jpg or *.gif format you lose some quality, but this is usually not noticeable.

To save space you can also change the properties of the image. For example, using Microsoft Photo Editor you can access the properties from the File menu. In the properties dialog box you can change the colour format (True Colour, 265 Colours, etc.) and the resolution (pixels per inch).

The difference between 256 and True Colour is hardly noticeable, but it is advisable to use 256 Colours because it saves a lot of memory.

By reducing the resolution you also decrease the size of the image file.

Prepare a poster exhibition using maps produced in ArcView GIS

- **Decide on your audience and context**
 - The exhibition part of a consultation, e.g. a City Consultation,
 - The exhibition is part of an Issue-Specific Mini-Consultation,
 - It is a stand-alone exhibition, e.g. in the entrance of the town hall.

- **Decide about the message you wish to send**
 - E.g. "participate in working groups"
 - "Your neighbourhood will be upgraded and this will happen"
 - "The great achievements of project x"

- **Decide on the content of the exhibition**
 - Which maps will be helpful to underline the message?
 - Which additional illustrations such as photos, drawings, pictures can illustrate the message?
 - Write the text for more detailed information.
 - Who is to credit?

- **Make a draft of the posters**

Prepare a draft of the posters showing how the different parts of the posters will be arranged

- **Define the layout pages**

Define characteristics such as units, page size, orientation and margins in ArcView GIS

- **Add a view**

Add other cartographic elements as you wish. You can also copy an existing map layout and place it in your new layout.

 1. Open existing layout
 2. Select all elements
 3. Group them
 4. Copy or **Ctrl** **C**
 5. Go to your new layout
 6. Paste or **Ctrl** **V**

- **Add other graphics to the layout**

Add any graphic elements like boxes or borders. Place the text you want in the text boxes. Assign patterns, colours and fonts to the graphics by double-clicking any graphic in the layout. Choose the style you like from ArcView's Symbol Window.

- **Arrange the layout graphics as needed**

When all the graphics you want are present in the layout you can use a number of different tools to arrange them as needed. Among the actions you can perform on layout graphics are the following: align, bring to front, group.

Please refer to an example of a poster in Tool 31: Sample Maps

Maintaining the System

- Tool 27** Backing Up the EMIS
- Tool 28** Training
- Tool 29** Further Readings
- Tool 30** Links to the Web

Tool 27: Backing Up the EMIS

How to save the EMIS

Backup, Media, Backup schedule

Why backup data?

Your data in the EMIS is valuable. It will cost you time and effort to recreate it, and that costs money; sometimes it cannot even be re-created. Since it is an investment, you should protect it and take steps to avoid losing it.

Computers are fast, accurate, and indispensable; however, this is an imperfect world, and things can still go wrong to endanger your data. There are basically four reasons why you might lose data: hardware failures, software bugs, human action, or disasters, such as fire.

It is recommended that you backup the entire EMIS regularly. When a backup is performed, an exact copy of the system is copied onto a backup medium in compressed format (depending on the backup system). Like everything else that is related to the physical world, backups will fail sooner or later (physical depletion of the backup media over time).

What media to use for backup

The most important decision regarding backups is the choice of backup medium. You need to consider cost, reliability, speed, availability, and usability. There are several media that can be used for backup:

- **Hard disks**
are generally used for backup in networked systems; the data is copied from the workstation's local hard disk to a file server. You can also install a second hard disk (slave) in your computer and copy your files from the master hard disk to the slave.
Size: up to 40 GB
 - **Floppies**
are the cheapest medium, fairly reliable, very available, but unsuitable for large amounts of data. The software used is the MS Windows internal Backup System.
Size: up to 1.4 MB.
 - **Zip-Drives**
Work like floppy drives but use media with more storage space. Media is fairly expensive. Usually, the accompanying software includes backup schedulers. Size: up to 250 MB.
 - **Tapes**
are cheap to somewhat expensive, very reliable, quite available. The access to individual files is slow. Internal and external tape drives are available. Usually, the accompanying software includes backup schedulers. Size: up to 3 GB.
 - **CD-ROM**
are becoming more popular as backup media. Recordable CD-ROMs are cheap and easily available. Internal and external CD-ROM writers are available. The rate of copying failures is still quite high (approximately 30%, depending on the copied files, network interruptions of hard disc activities during copying). Size: up to 700 MB.
-

Backup schedule

You want to backup as much as possible. The major exception is software that can be easily reinstalled, but even software may have configuration files that it is important to backup, lest you need to do all the work to configure them all over again. The obvious things to backup are user files and system configuration files.

A simple backup scheme is to back up everything once, then back up everything that has been modified since the previous backup. The first backup is called a full backup, the subsequent ones are incremental backups. A full backup is often more laborious than incremental ones, since there is more data to write to the tape and a full backup might not fit onto one tape (or floppy). Restoration can be optimised so that you always back up everything since the previous full backup; this way, backups are a bit more work, but there should never be a need to restore more than a full backup and an incremental backup.

If you want to make backups every day and have six tapes, you could use tape 1 for the first full backup (say, on a Friday), and tapes 2 to 5 for the incremental backups (Monday through Thursday). Then you make a new full backup on tape 6 (second Friday), and start doing incremental ones with tapes 2-5 again.

Note: *You do not want to overwrite tape 1 until you have got a new full backup, in case a disaster happens while you are making the new full backup. After you have made a full backup to tape 6, you should keep tape 1 somewhere else, so that if your other backup tapes are destroyed in the disaster, you still have at least something left. When you make the next full backup, you use tape 1 and leave tape 6 in its place.*

For more heavy-duty use, multilevel backups are more appropriate. The method has two backup levels: full and incremental backups. This can be generalised to any number of levels. A full backup would be level 0, and the different levels of incremental backups levels 1, 2, 3, ... At each incremental backup level you back up everything that has changed since the previous backup at the same or a previous level.

The purpose for doing this is that it allows a longer backup history. In the example given in the previous section, the backup history went back to the previous full backup. This could be extended by having more tapes. A longer backup history is useful, since deleted or corrupted files are often not noticed for a long time. Even a version of a file that is not very up to date is better than no file at all.

With multiple levels, the backup history can be extended. For example, if we buy ten tapes, we could use tapes 1 and 2 for monthly backups (first Friday each month), tapes 3 to 6 for weekly backups (other Fridays; note that there can be five Fridays in one month, so we need four more tapes), and tapes 7 to 10 for daily backups (Monday to Thursday).

Further readings:

<http://electron.phys.dal.ca/SAG/node96.html>

<http://www.iesco.com/backup.htm>

Please also consult the manual of your backup system or refer to the tutorial or help function of the installation software.

Tool 28: Training

How to organise and structure Training for EMIS

Training structure in Ibadan, Agenda for one-week course in Chennai, Agenda for four day course for EMIS Experts, Addresses

I. Example of a training organised by the Project Team of the Sustainable Ibadan Project:

Training Structure

The introduction of Geographic Information Systems to management practices requires a training programme that is comprehensive and that pays significant attention to issues of technological and personnel development. Such a training programme should also address issues of decision making and the allocation of responsibilities.

Three proposals on workshops and training targeted at two broad classes of persons were made for sensitisation and for initial capacity building. The first class of persons were senior level government officials who needed awareness of the role of GIS in decision making and who could be in influential positions to assist in its adoption. The second group of persons to whom a workshop was targeted consisted of middle level manpower and of persons for whom a GIS facility might actually be set-up. On the other hand, training for capacity building was targeted at those considered most likely to need to install GIS facilities within the next couple of years.

First Sensitisation Workshop

The aim of the Workshop was to sensitise the interest of top level management of government offices, parastatals, and international donor agencies on the role of GIS in the management of the urban environment and thereby stimulate their interest in developing GIS facilities in relevant offices of government. The objectives were:

1. provide a down to earth description of what GIS is and show the relationship between it, the formulation of action plans and the attainment of a sustainable management of the urban environment
2. to demonstrate potential uses of GIS in local level planning in the development of action plans for environmental management.

The Workshop was a one-day event. It was attended by sixty participants drawn from a cross-section of the stakeholders in the Ibadan environmental development process.

Second Sensitisation Workshop

A two-day sensitisation workshop on Geographic Information System (GIS) was organised by the Sustainable Ibadan Project. It was a follow up to the previous workshop. Participants consisting mainly of people selected from the staff of the eleven Local Governments in Ibadan Metropolis, Oyo State and federal government parastatals and people from the private sector were invited for the Workshop. All in all 54 participants attended this Workshop.

The aim of the Workshop is to demonstrate and stimulate the interests of potential operators and users of the GIS facility. In order to do this, the

following objectives were defined:

1. provide a down to earth description of what GIS is and show the relationship between it, the formulation of action plans and the attainment of a sustainable management of the urban environment
2. demonstrate potential uses of GIS in local level planning in the development of action plans for environmental management
3. teach basic principles of using GIS for the purposes of map production, illustration and decision-making.

The Workshop was organised on the basis of four major themes that pervade the use and application of GIS. The themes were

- (a) The Creation for Spatial Databases
- (b) Map Making
- (c) Analysis involving Overlays and Queries and
- (d) Planning Applications.

Each theme ran for two days and participants were to have acquired a reasonable grasp of the issues involved in the pursuit of the themes in particular and in GIS in general. A discussion of the themes was preceded by an introduction to the scope and content of GIS.

The approach adopted by the Workshop involved meetings at plenary sessions and in smaller groups. For the smaller group meetings, participants were divided into four groups and each group was assigned to the themes in sequential order. During the two-day Workshop, the themes were pursued in four presentations, each of approximately two hours. The method of presentation of topics involved first the description and explanations of the theoretical and conceptual basis of the theme. This was then followed by a demonstration of how the theme could be made operational. Some time was then given to participants to try their hands on carrying out these issues.

In order to facilitate the interaction of participants with the facilitators and GIS equipment, four computer systems were provided, all of them equipped with GIS peripherals such as digitisers and printers. Different GIS software were also loaded into these computers for practical demonstrations of the utilities of GIS in decision-making and planning.

Initial Training and Capacity Building

The objective was to train a small group of key core people from the SIP, the UNICEF Zonal Office and certain key government offices, who would be able to operate the system. The focus was to train the trainers. The Workshop was organised for period of one week. The audience was made up of sixteen persons from various agencies of government.

The aim was to provide core persons who would become knowledgeable in the application of Geographic Information Systems. Given the newness of GIS in the planning and development horizon, such training as presently practicable within the SIP can at best be described as basic. However, the training is basic from two perspectives. First, it is necessarily an elementary introduction to what GIS is and secondly, it can only strive to teach just the basic principles. The area of GIS is a constantly expanding subject that continues to benefit from developments in information technology, computer science,

geography and spatial analysis. Furthermore, much longer periods of training and practice are required than are ordinarily available for this type of exercise. Consequently, this training programme cannot supplant more formal training programmes.

2. Example of a training schedule provided by the SCP core team in a SCP partner city

Training on Environmental Management Information System (EMIS) Chennai, India, 13 to 17 November 2000

<p>Mon 13/11/00</p>	<p>Introduction to EMIS: EMIS Concept as a tool for EPM</p> <ul style="list-style-type: none"> • Short introduction of the overall purpose. Maps are essential for decision-making; integrated in a system which allows: <ul style="list-style-type: none"> Environmental evaluation Project design Site-selection Landuse planning • Context of EMIS • EPM Process and project cycle • Technical requirements • Outputs of an EMIS <p>Brief introduction to mapping techniques and GIS operations</p> <ul style="list-style-type: none"> • GIS concepts, Components of GIS, GIS applications • Spatial data attributes • Linking spatial and non-spatial data • Map projection systems and datums, coordinate systems, coordinate transformations • Data sources – maps and map scales, photographs and digital images • Data formats and data exchange
<p>Tue 14/11/00</p>	<p>Getting started manually</p> <ul style="list-style-type: none"> • Establishing a Mapping Group • Inventory of existing maps and other issue specific information (including filing techniques and structures) • Collecting information <ul style="list-style-type: none"> Determining relevant information for thematic maps • Preparing thematic maps related to priority environmental issues, based on a common basic map <ul style="list-style-type: none"> Mapping techniques • Preparing suitability and sensitivity maps <ul style="list-style-type: none"> Determining relevant thematic maps and converting into suitability and sensitivity maps Determining rules, regulations and conditions for suitability areas Developing consistent and logical pattern • Environmental Management Framework through overlays <ul style="list-style-type: none"> Introduction to an EMF How to do an EMF? How to apply an EMF?

<p>Wed 15/11/00 and Thur 16/11/00</p>	<p>Building an EMIS by using GIS software (ArcView GIS and Map Maker Pro)</p> <ul style="list-style-type: none"> • Inventory of existing maps and other issues specific information by using a database programme (including filing techniques and structures) • Collecting information and preparing thematic maps <p>Determine relevant maps according to priority environmental issues</p> <ul style="list-style-type: none"> Techniques of data acquisition Database query using structured query language Linking database tables to maps <ul style="list-style-type: none"> • Preparing suitability maps through GIS analysis procedures – hands on practice <ul style="list-style-type: none"> Selecting relevant thematic maps for conversion into suitability maps Determining rules, regulations and conditions of suitability areas (building database) Overlay analysis and other operations • Strategic management framework through overlays
<p>Fri 17/11/00</p>	<p>EMIS Sensitisation for Department Officers, Working Group Co-ordinators and relevant stakeholders</p> <p>A two-hours presentation and discussion aim to sensitise relevant Department Officers, Issue-Specific Working Group Co-ordinators and other relevant stakeholders (e.g. research institutions, NGO representatives and community representatives) in the concept and context of EMIS. Aim is to reach better understanding for a new decision-making tool and to gain political support for operating and maintaining an EMIS.</p> <p>Consolidation and wrapping-up</p>

One week is a fairly short time in order to do a combined EMIS/GIS training. The mission will assess the level of the trainees during the first day and adjust the training content accordingly. If time allows, the following training modules will be considered during the training.

GIS operations

- Preparing a basic map:
 - Agreeing on standard map; Sources for basic maps; Introduction to airphoto interpretation, map reading, satellite imagery; Introduction to map digitisation techniques (digitiser, on-screen from scanned images); Preparation of maps for digitising; Geo-referencing images; Hands on practice; Practising basic digitising operations; Digital map editing procedures.

Overview of database management systems – basic principles

- System requirements assessment
- Database design principles
- Database implementation using MS Access – hands on practice by

developing an inventory for maps, reports, etc.

Database tables

Database entry forms

Design and implementation of database report forms

3. Example of a training provided by the SCP core team at UNCHS (Habitat) headquarters

Agenda for four days course for EMIS experts

This Training was provided in October 1999 for 10 EMIS experts from the various SCP Cities. The course was held in a little lab providing five computers all equipped with MapMaker Pro, ArcView and Access.

First Day

Welcome and Introduction

Morning

Introduction to the EMIS context and contents - Powerpoint presentation

Cities Experiences in EMIS – short presentations by EMIS experts

Afternoon

Introduction to ArcView - onscreen

Introduction to MapMaker Pro - onscreen

Second Day

Practical Training of Tools along the steps to build an EMIS

Morning

Inventory – map coding for filing

Inventory – using an access database to gather information about existing maps

Afternoon

Basic Map – digitising onscreen

DXF to shapefile conversion

Unzip or zip files

Third Day

Practical Training of Tools along the steps to build an EMIS

Morning

Linking external data to create a Thematic Map

Afternoon

Suitability/ Sensitivity Maps – overlay of several Thematic Maps to create a Suitability Map

Fourth Day

Outputs of the EMIS

Morning

Strategic Management Framework

Afternoon

EMIS and ways forward - discussion

Addresses for GIS and EMIS training courses

International Institute for Aerospace Survey and Earth Sciences (ITC),
Hengelosestraat 99, P.O. Box 6, 7500 AA Enschede, The Netherlands;
Tel: +31 (0)53 4874 444; Fax: +31 (0)53 4874 400; E-mail: pr@itc.nl
<http://www.itc.nl/>

ITC provides a wide range of GIS training courses, both short-term and long-term. Sponsorships are available.

UCLAS – The Geo-Information Centre (GIC), P.O.Box 35176, Dar es Salaam,
Tanzania; Tel: +255-22-2775004; Fax: +255-22-2775448 or 2775479;
mtalo@uclas.ud.co.tz or mtalo.e.g@mailexcite.com, or ihsbr@uclas.ac.tz
UCLAS provides standard and tailored training courses in GIS and EMIS for people from the Eastern and Southern African region. Limited sponsorships are available.

Web addresses for on-line training courses in GIS in general

ESRI Virtual Campus, self-paced GIS Education in the World-Wide Web; several courses are for free, <http://campus.esri.com/>

ESRI Software Training; contact local providers.

<http://www.esri.com/training/index.html>

ESRI E-mail lists offer you support from fellow ESRI users. E-mail Lists-ArcView-L and ESRI-L are available.

<http://forums.esri.com/community/community.cfm>

Tool 29: Further Readings

Helpful books on GIS and EMIS

The most important and valuable documentation are the handbooks accompanying your GIS software. E.g. ArcInfo, ArcView GIS and Mapmaker Pro software contains very elaborated handbooks explaining GIS in general and the specific programmes in particular.

More books:

Bannur, A.B.B. (1995): *Designing a Geo-Information System to Support City Planning and Management Functions in Dar es Salaam City Council*, Tanzania; Enschede.

Campbell, H.; Masser, I. (1995): *GIS and Organisations*; Paperback; Taylor & Francis; ISBN: 0748402055.

Dawson, N.A. (1996): *Site Selection for the Relocation of Squatters: A Case of the Msimbazi River Valley Dar es Salaam*; Enschede.

Editors of ESRI Press (Editor) (1999): *Getting to Know ArcView GIS* Paperback; Bk & CD-ROM edition, ESRI Press; ISBN: 1879102463.

Heholt, D. (1996): *A Community Based Approach to Urban Data Gathering and Monitoring in Dar es Salaam, Tanzania*; Enschede.

Hohl, P. (Editor) (1998): *GIS Data Conversion: Strategies, Techniques, and Management* 1st Edition OnWord Press; ISBN: 1566901758.

Kaiser, E.J.; Godschalk, D.R.; Klosterman, R.; Esnard, A.-M. (1999): *Hypothetical City Workbook: Exercises, Spreadsheets and GIS Data to Accompany Urban Land Use Planning*; Fourth Edition Paperback 4th Bk&Dk edition; University of Illinois Pr; ISBN: 0252067711.

Kennedy, M. (1996): *The Global Positioning System and GIS: An Introduction* Hardcover Bk&Cd Rom edition; Ann Arbor Pr Inc; ISBN: 1575040174.

Korte, G. B. (1997): *The GIS Book: Understanding the Value and Implementation of Geographic Information Systems* Paperback; 4th edition; OnWord Press; ISBN: 1566901278.

McDonald Jampoler, S. (Editor) (1999): *GIS in Practice*; Paperback; OnWord Press; ISBN: 1566901928.

Mitchell, A. (1999): *The ESRI Guide to GIS Analysis Volume 1: Geographic Patterns & Relationships*; Paperback; 1st edition Vol 1; ESRI Press; ISBN: 1879102064.

Ormsby, T.; Alvi, J. (1999): Extending ArcView GIS: with Network Analyst, Spatial Analyst and 3D Analyst; Paperback Bk & CD-ROM edition; ESRI Press; ISBN: 1879102056.

Plewe, B. (1997): GIS Online: Information Retrieval, Mapping, and the Internet; Paperback; 1 Ed edition; OnWord Press; ISBN: 1566901375.

Ramrop, S. (1995): GIS Support for Upgrading Drainage and Road Networks in Unplanned settlements: Hanna Nassif, Dar es Salaam, Tanzania; Enschede.

Razavi, A.H. (1999): ArcView GIS/Avenue Developer's Guide; Paperback 3rd Bk&dsk edition; OnWord Press; ISBN: 1566901677.

Razavi, A.H.; Warwick, V.; Razavi, A.H.; Alexander, J. (1997): ArcView GIS/Avenue Programmer's Reference: Class Hierarchy Quick Reference and 100+ Scripts; Paperback 3rd edition; OnWord Press; ISBN: 1566901707.

Sumberg, J. (1996): A Bibliography on Peri-Urban and Urban Agriculture in Africa - with Particular Reference to Livestock and Tanzania; Norwich.

Tafesse, A.G. (1995): Service Level Assessment of Public Health Facilities in Dar es Salaam Urban Area; Enschede.

Timothy, H. (1995): Unplanned Urban Development: Spatial Growth and Typology of Unplanned Settlements; Enschede.

Zabrano Gild, E.A. (no year): Utilisation of Public Health Care Facilities in Dar es Salaam, Tanzania; Enschede.

Tool 30: Links to the Web

Where to find more information about EMIS and GIS

The most relevant entry point for information on EMIS is the EMIS web site on the Sustainable Cities Programme homepage:

<http://www.unchs.org/scp>

The EMIS web site contains all the relevant EMIS documents and informs about new tool development. Example maps will also be available from this site.

The Sustainable Cities Programme maintains a list server which connects EMIS experts world-wide. The list server is used for exchange of experiences, trouble shooting and information on new developments:

emisinfo@unchs.org

Please note: the following web sites are subject to frequent changes without notice. The authors have been trying to list web sites which have been fairly stable in the past.

Maps and digital data from the Web

GRID

Arendal GRID is an UNEP Project on GIS. This site provides a search engine for maps in the web.

<http://www.grida.no/>

The African office of GRID provides data on African cities.

<http://www.unep.org/unep/eia/ein/grid/web/document/grid.htm>

GISdatadepot is a data search engine for free digital data.

<http://www.gisdatadepot.com/>

Digital Chart of the World

Contains all countries in their boundaries of 1992 in ArcInfo e00 exchange format.

<http://www.maproom.psu.edu/dcw/>

<http://www.libraries.psu.edu/crsweb/docs/dworld.htm>

<ftp://ortelius.maproom.psu.edu>

EROS homepage

<http://edcwww.cr.usgs.gov/eros-home.html>

Map related homepages

http://www.lib.utexas.edu/Libs/PCL/Map_collection/map_sites/map_sites.html

Africa Search WoYaa – Africa on the Internet

<http://www.woyaa.com/>

Images



The CEOS (Committee on Earth Observation Satellites) information locator system
<http://cils.unep.org/home.pl>

WWWVirtual Library on Remote sensing with many links to more information about images.

<http://www.vtt.fi/aut/rs/virtual/>

Links to info on satellite images: Spot images, Landsat images <http://www.spot.com/spot/home/present/welcome.htm>
<http://landsat7.usgs.gov/>

Search engine for earth observation data.

<http://edcimswww.cr.usgs.gov:80/~imswww/pub/imswelcome/index.html>

GIS Software



Map Maker Pro is a low-cost map making and Geographical Information System for Windows. The software is available free for evaluation for 21 days. Extensive tools, data and further links.

<http://www.mapmaker.com/>



GIS Solutions: ESRI's geographic information system (GIS) provides different software packages depending on the needs. Extensive additional information about GIS.

<http://www.esri.com/>

GIS Hardware

For scanners and digitising boards

<http://www.gtccocalcomp.com/calcomproducts/default.htm>

Plotters can be found by Hewlett Packard or Calcomp

<http://www.hp.com>

<http://www.budde.com/calcompsupplies/index.htm>

This Website will provide you with all information and links about GPS.

<http://joe.mehaffey.com/>

GIS links

GeoCommunity: listing hundreds of GIS related web links. <http://www.geocomm.com/links/>

Over 8650 Cartographic Links at Oddens bookmarks.

<http://oddens.geog.uu.nl/index.html>

Absolute Authority on Maps: A complete collection of content, community, and tools available on the subject of Maps.

<http://www.absoluteauthority.com/maps/>

infomine - scholarly internet resource collection on GIS & Maps

<http://infomine.ucr.edu/search/mapssearch.phtml>

Bill Thoen's GIS Notebook: short trips into the web researching various subjects related to Geographic Information Systems (GIS).

<http://www.gisnet.com/gis/notebook/index.html>

GIS links stored in the netscape search engine.

[http://directory.netscape.com/Science/Earth_Sciences/GIS -
_Geographic Information Systems](http://directory.netscape.com/Science/Earth_Sciences/GIS_-_Geographic_Information_Systems)

The World Wide Web Virtual Library: Remote Sensing

<http://www.vtt.fi/aut/rs/virtual/>

Tutorials

Short reference to GIS Terms

<http://www.esri.com/library/glossary/glossary.html>

Tutorials

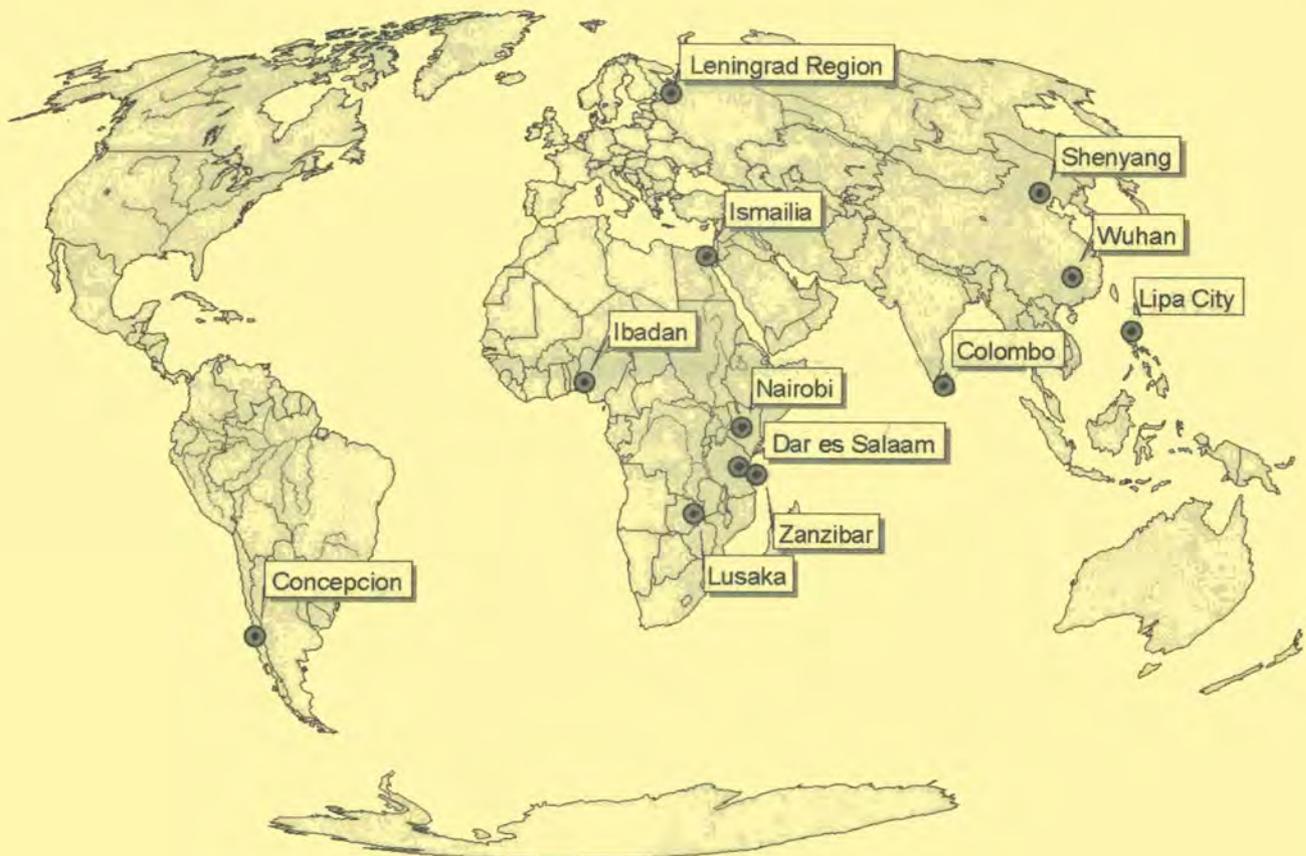
<http://campus.esri.com/index.cfm?theme=india>

Sample Maps

- Tool 31** Sample Maps from SCP Partner Cities
- Tool 32** Samples for Manual Overlays

Tool 31: Sample Maps from SCP Partner Cities

Tool 31 is a small collection of sample maps generated by the EMIS Units of various partner cities of the Sustainable Cities Programme from all over the world:



Map 1: Ibadan Base Map

The EMIS Unit of the Sustainable Ibadan Project (Nigeria) developed the Ibadan Basemap from old topographic maps in the scale of 1:25000 and updated them with satellite imagery (SPOT Image). A regional remote sensing institute provided the technical expertise in satellite interpretation and helped to convert the raster data into vector maps. The Basemap shows typical features such as the built-up areas, the agricultural areas, rivers, road network and other features. The EMIS Unit is using ArcView GIS software on stand alone office computers.

Map 2: Zanzibar Municipality – Base Map

The EMIS Unit of the Sustainable Zanzibar Project (Tanzania) developed the base map by digitising existing topographic maps in the scale of 1:10000. The Unit is in the process of using recent aerial photographs for updating parts of the base map relevant to specific action plans. The Unit applies a simple orthorectification process to fit the imagery together with the existing base map. The EMIS Unit is using ArcView GIS and Map Maker on a stand alone office computer.

Map 3: Nairobi Basic Map

A team of consultants developed the Nairobi Basic Map (Kenya) from an existing road map in the scale of 1:20000 and a topographic map in the scale of 1:100000. The source material is fairly outdated, however it served the purpose in illustrating the sample points for river water testing. The maps were produced in ArcInfo and ArcView GIS.

Map 4: Lipa City – Slope Map

The EMIS Unit of the Sustainable Lipa Project (Philippines) used information from the Bureau of Soils in order to derive a thematic map on slopes. The legend shows the intensity of sloping in percentage. The EMIS Unit is using ArcView GIS.

Map 5: Wuhan – Surface Water Function Division and Water Plant Distribution Chart

The GIS Unit of the Environmental Protection Bureau and the Sustainable Wuhan Project (China) developed a number of thematic maps showing the monitoring stations for air, the groundwater situation and surface water issues. The GIS unit is well equipped with server based ArcInfo, ArcView, image processing software and various database programmes.

Map 6: Concepción

The GIS team of the Sustainable Concepción Project developed simple, easily readable maps for the working group process. The project used MapInfo software on a stand alone computer.

Map 7: Shenyang – Air Quality

The EMIS Unit of the Sustainable Shenyang Project (China) developed a pollution map from point data (air quality monitoring stations). The data from the monitoring station was analysed, aggregated and converted into levels of pollution. The map shows additional information on the location of Shenyang within the province, an insert map showing the location of industries and bar charts showing the type of chemicals measured in the air. The EMIS Unit is using ArcView GIS software on a stand alone office computer.

Map 8: Issues on Health related to Non-Sewered Areas in the City of Colombo

The EMIS Unit of the Sustainable Colombo Project (Sri Lanka) performed overlays of environmental issues during a training course. This map shows the relationship between areas prone to water-borne diseases and the quality of the sewerage system. The areas in dark red are critical hotspots. The EMIS Unit is using ArcView GIS software.

Map 9: Sustainability Issues in the Leningrad Region

The project on Sustainable Development of Human Settlements in Leningrad Region developed a large number of basic, thematic, suitability and sensitivity maps for illustration of the Environmental Profile of the Leningrad Region. The maps have been produced with a high level of creativity.

Map 10: Lusaka – Development Plan

The Lusaka City Council (Zambia) contracted an external consulting firm to develop the Lusaka Development Plan. This map shows some draft layers which are being consolidated into a tool for the Forward-Planning Unit of the

Council. However, the Development Plan lacks close, local and long-term consultation and was not developed in an Issue-Specific Working Group approach.

Map 11: Dar es Salaam – Environmental Management Framework

The Sustainable Dar es Salaam Project used an intensive consultative process for the development of the Strategic Urban Development Plan (SUDP). The Environmental Management Framework is part of the SUDP and combines information on existing built-up areas, service delivery and development potential. The maps for the SUDP have been produced in Atlas GIS software and are being converted into ArcView GIS format.

Map 12: Dar es Salaam – Gerezani

This type of detailed maps are used for specific action plans, for example the upgrading of a certain settlement. The EMIS Unit in Dar es Salaam (Tanzania) uses the digital basemap from the Mapping and Survey Department for further integrating them into the EMIS.

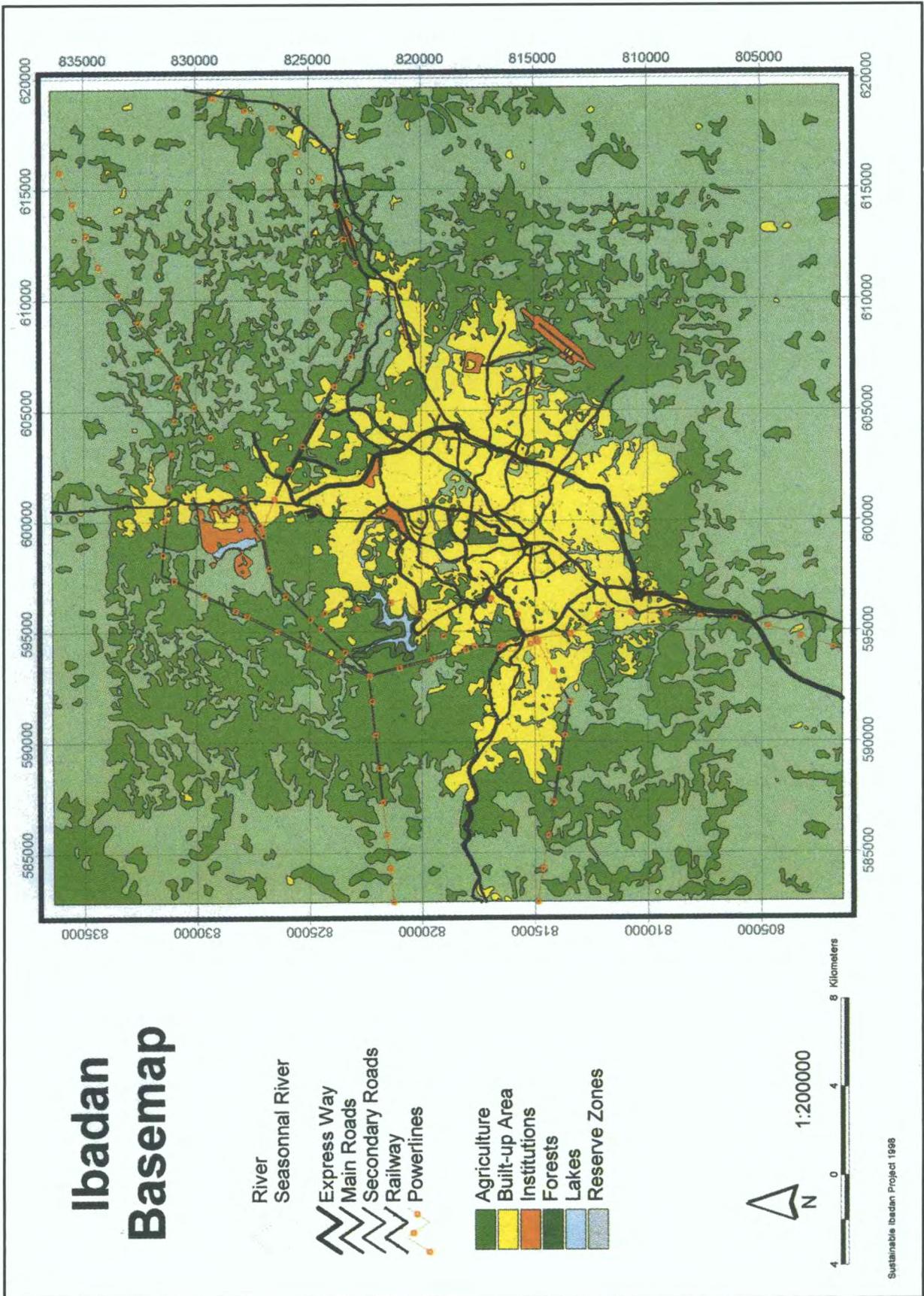
Map 13: Industry in Ismailia

This map is part of an Atlas of Ismailia. The EMIS Unit of the Sustainable Ismailia Governorate Programme (Egypt) developed the Atlas as an information tool for decision-makers. The EMIS Officer used COREL Draw software for the design of the Atlas in which he imported the map files. The well-chosen illustrations allow easy reading of the maps even for people who do not read Arabic language. The EMIS Unit uses AutoCad software and started converting maps into ArcView GIS format.

Database: Nairobi Rivers Pollution Database

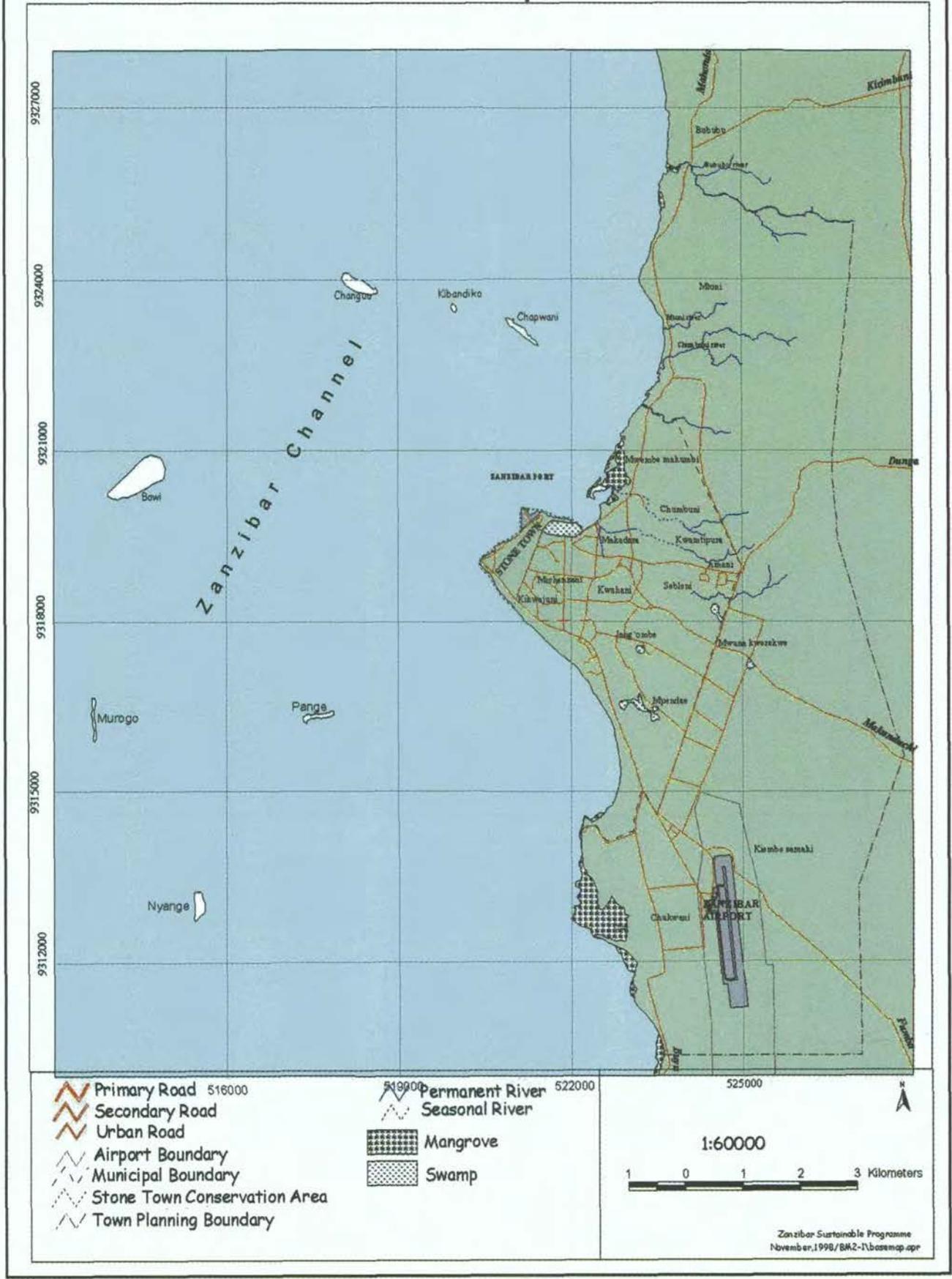
A non-governmental organisation developed a database structure for the Nairobi River Basin Project (Kenya) which contains a variety of information on the Nairobi rivers catchment areas. The database will serve as a basis for a Nairobi Rivers Management Information System. The database was designed in Microsoft Access software.

Map I



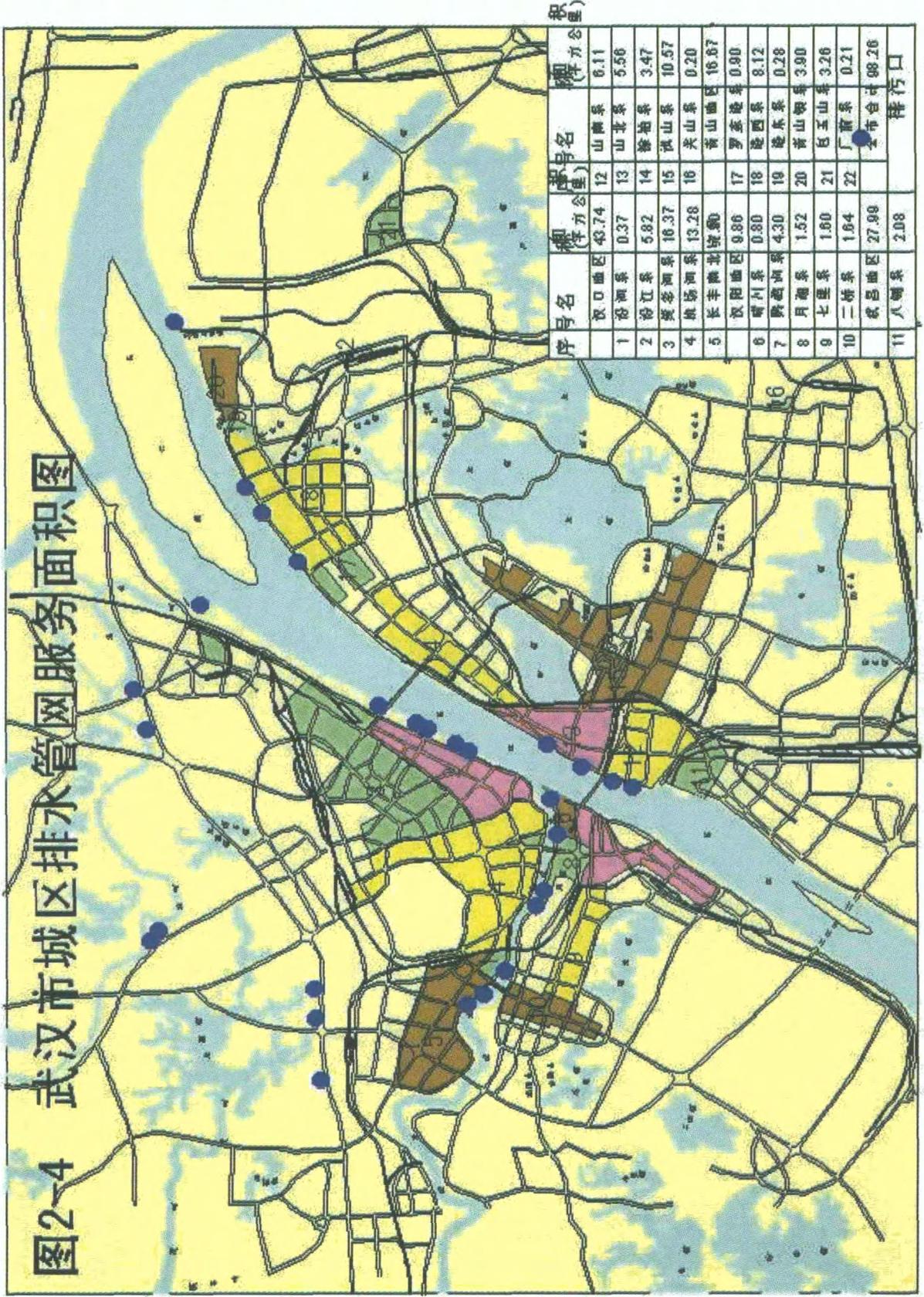
Map 2

ZANZIBAR MUNICIPALITY Base Map



Map 5

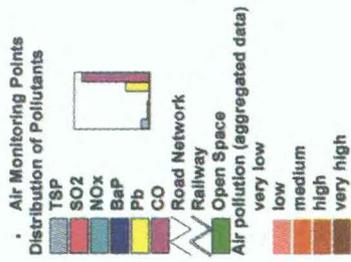
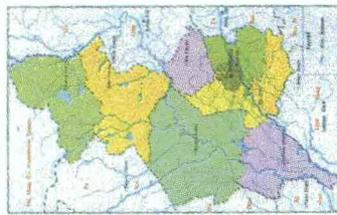
图2-4 武汉市城区排水管网服务面积图



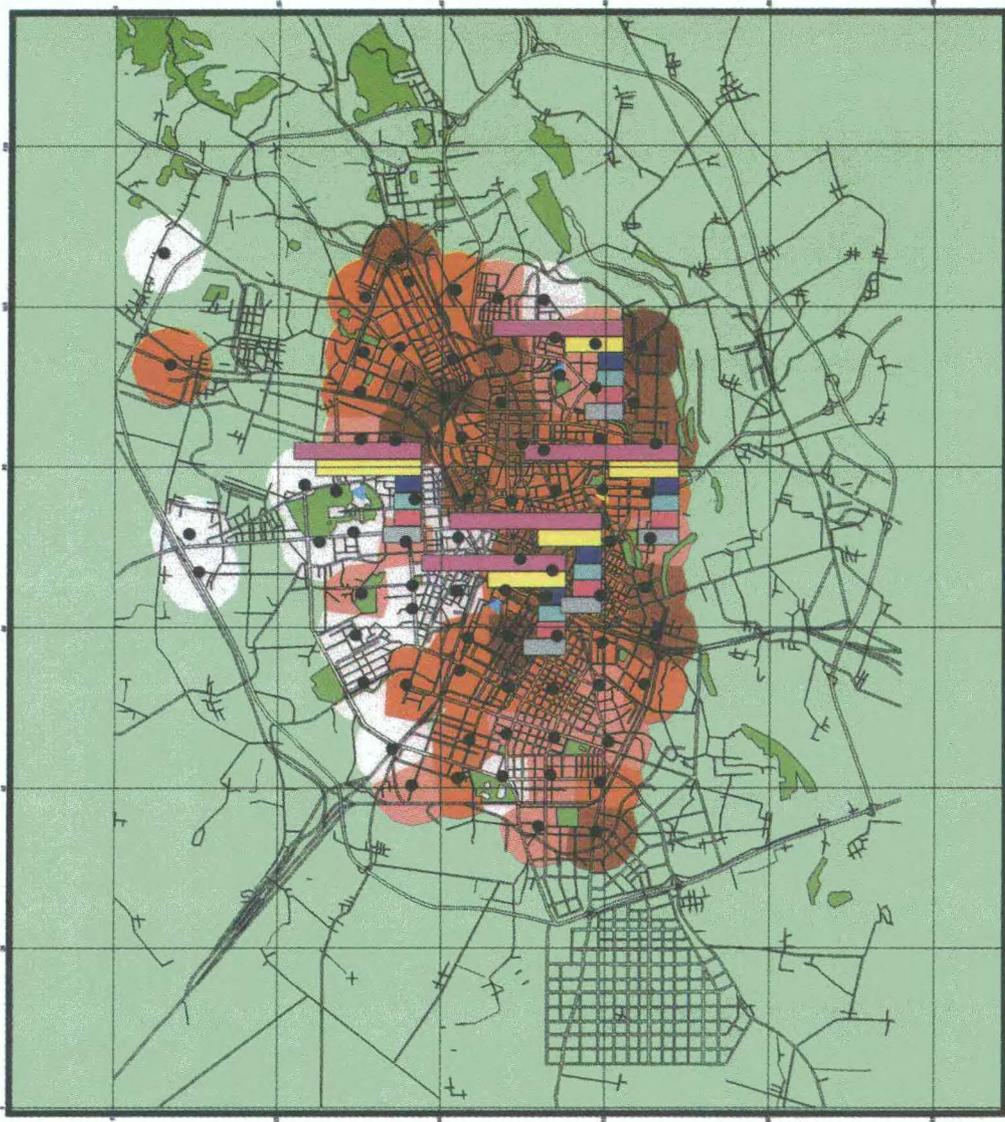
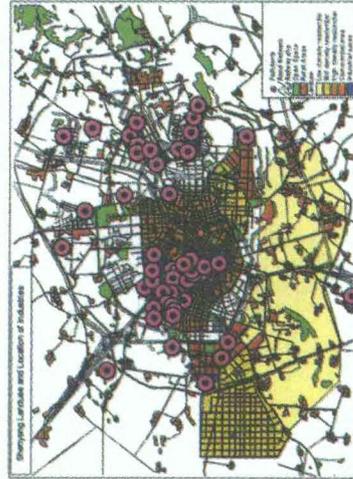
武汉市环境信息中心绘制

Map 7

Shenyang Air Quality

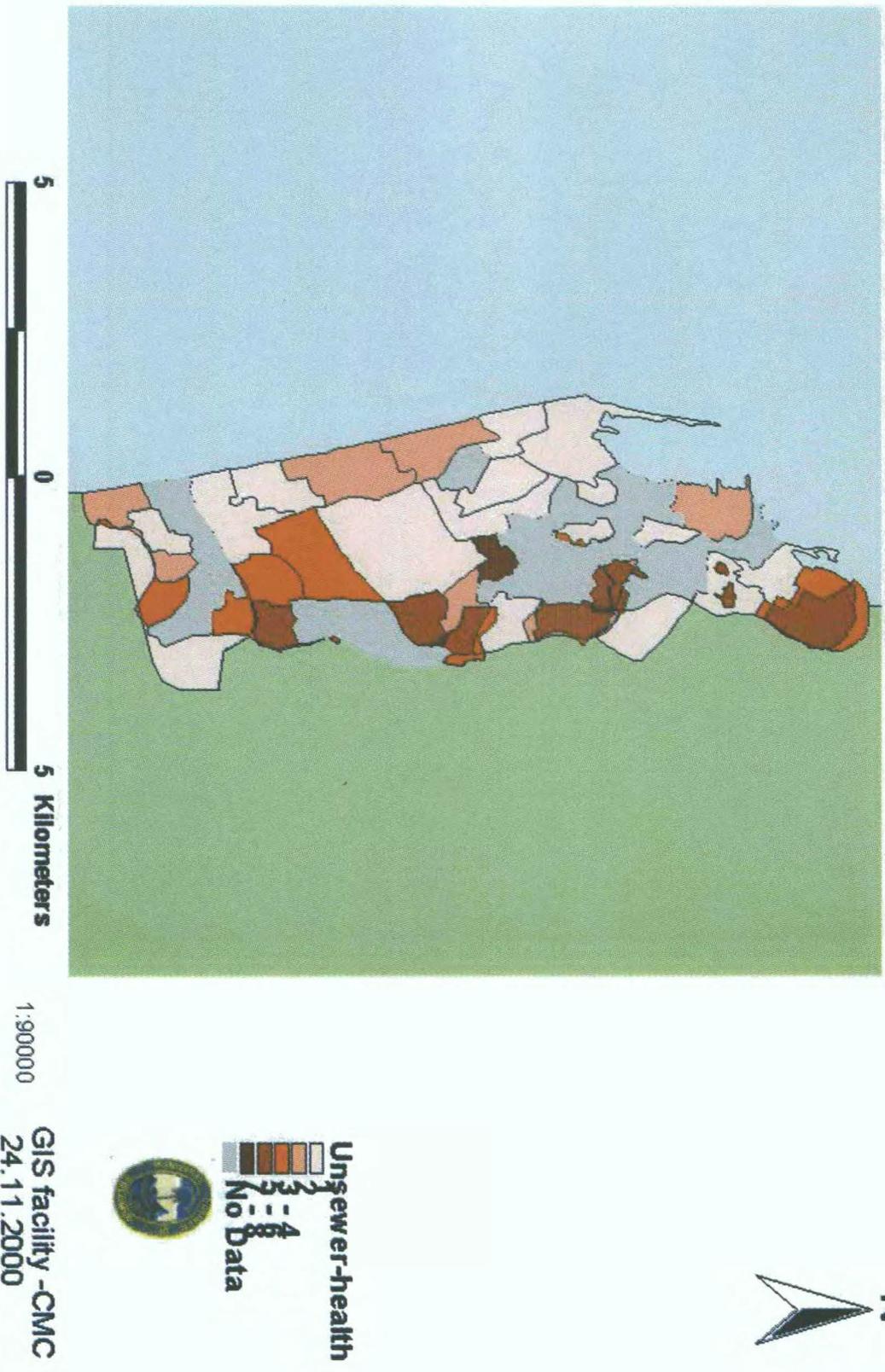


Please. This map was produced for testing purpose only. The data presented here do not reflect the actual tested situation in Shenyang. Source: Sustainable Shenyang Project (SSP)



Map 8

ISSUES ON HEALTH RELATED TO NON SEWERED AREAS IN THE CITY OF COLOMBO



5 0 5 Kilometers

1:90000

GIS facility -CMC
24.11.2000



Unsewer-health
1
2
3
4
5
6
7
8
No Data

Map 9

71a

DISTRICTS RANKING BY THE LEVEL OF SOCIAL SUSTAINABILITY



Social sustainability level

- Above medium
- Medium
- Low
- "Hot spots"-
Mass unemployment
of personalized programme
for new job opportunities
is necessary

DISTRICTS RANKING BY THE DEGREE OF ECOLOGICAL TENSION



Degree of ecological tension

- Highest
- High
- Medium
- Low
- "Hot Spots"
Zones of ecological
hazard
- Zones of higher
ecological risk

COMPARATIVE EVALUATION OF MUNICIPAL UNITS BY THEIR SUSTAINABLE

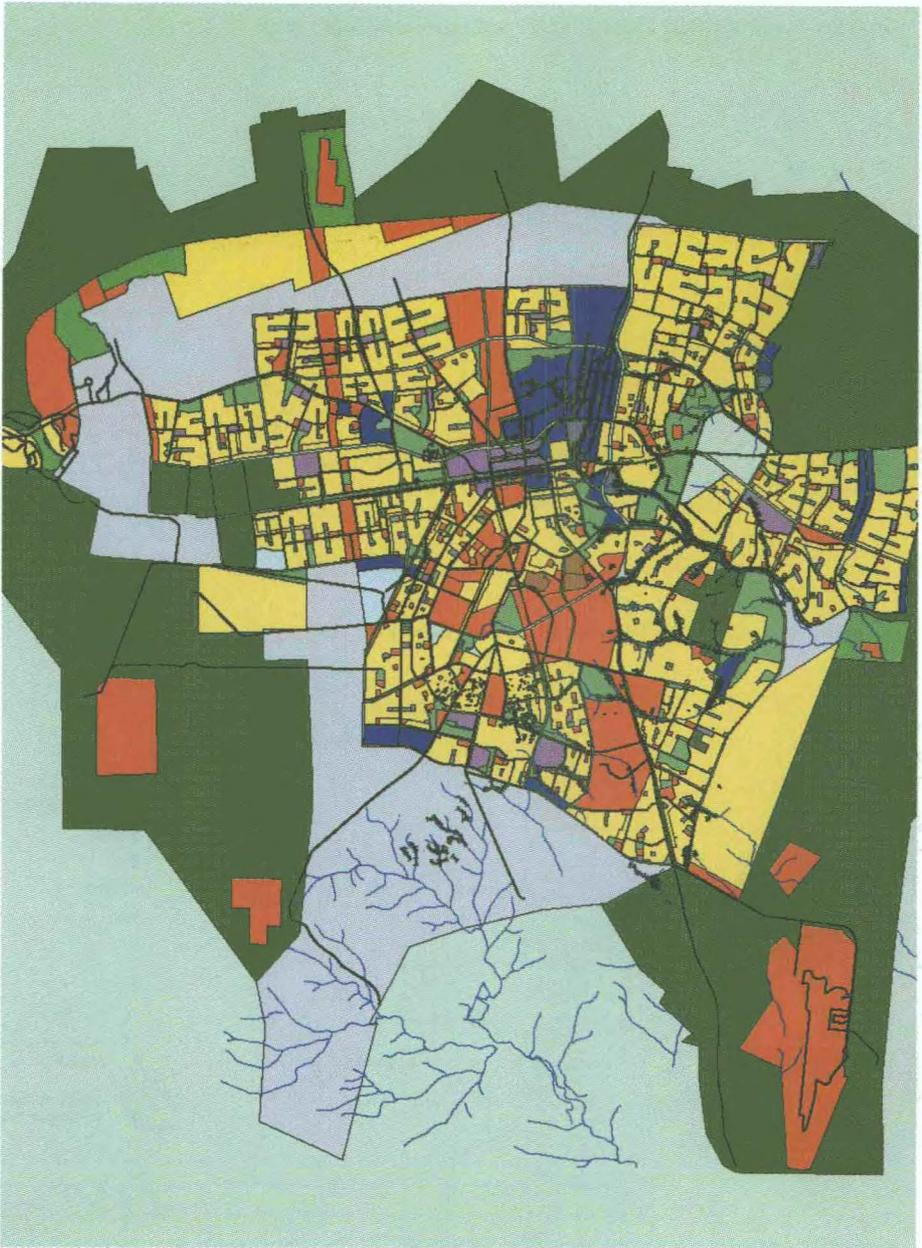


Degree of sustainability

- Above medium
- Medium
- Low
- "Hot Spots" of:
social tension
- ecological tension
- zones of ecological
hazard

Map 10

Lusaka - Development Plan



- Roads
- Rivers
- Railway
- Lusaka Development Plan
- ADMINISTRATION
- AGRICULTURE
- BUSINESS
- CAMP AND CARAVAN SITE
- CEMETERY OR CREMATORIUM
- COMMUNICATIONS
- DRIVE IN CINEMA
- EDUCATIONAL INSTITUTIONS
- ELECTRICITY
- FIRE STATION
- GENERAL AGRICULTURAL
- GENERAL INDUSTRY
- HEALTH INSTITUTIONS
- HEAVY INDUSTRY
- HOSPITAL
- INDUSTRY
- INSTITUTION
- INSTITUTIONS
- LAND COVERED BY WATER
- LIGHT INDUSTRY
- MENTAL HOSPITAL
- MILITARY USES
- MOTEL
- NOT COVERED BY DEVELOPMENT PLAN
- NURSERY AND MARKET GARDEN
- OFFICES
- OPEN SPACES
- POLICE STATION AND CAMP
- PRIMARY SCHOOL
- PRISON
- PRIVATE GOLF COURSE
- PRIVATE PLAYING FIELDS, TENNIS COURTS
- PRIVATE RACE TRACK
- PUBLIC BUILDINGS AND CULTURAL USES
- PUBLIC OPEN SPACES
- PUBLIC PLAYING FIELDS, TENNIS COURTS
- PUBLIC RACE TRACK, STADIUM, SHOWGROUND
- RAILWAY RESERVATIONS
- RESIDENTIAL
- RURAL
- SECONDARY SCHOOL
- SEWAGE DISPOSAL
- SPECIAL RESIDENTIAL
- UNIVERSITY
- UNIVERSITY
- WATER
- WATER PROTECTION AREA



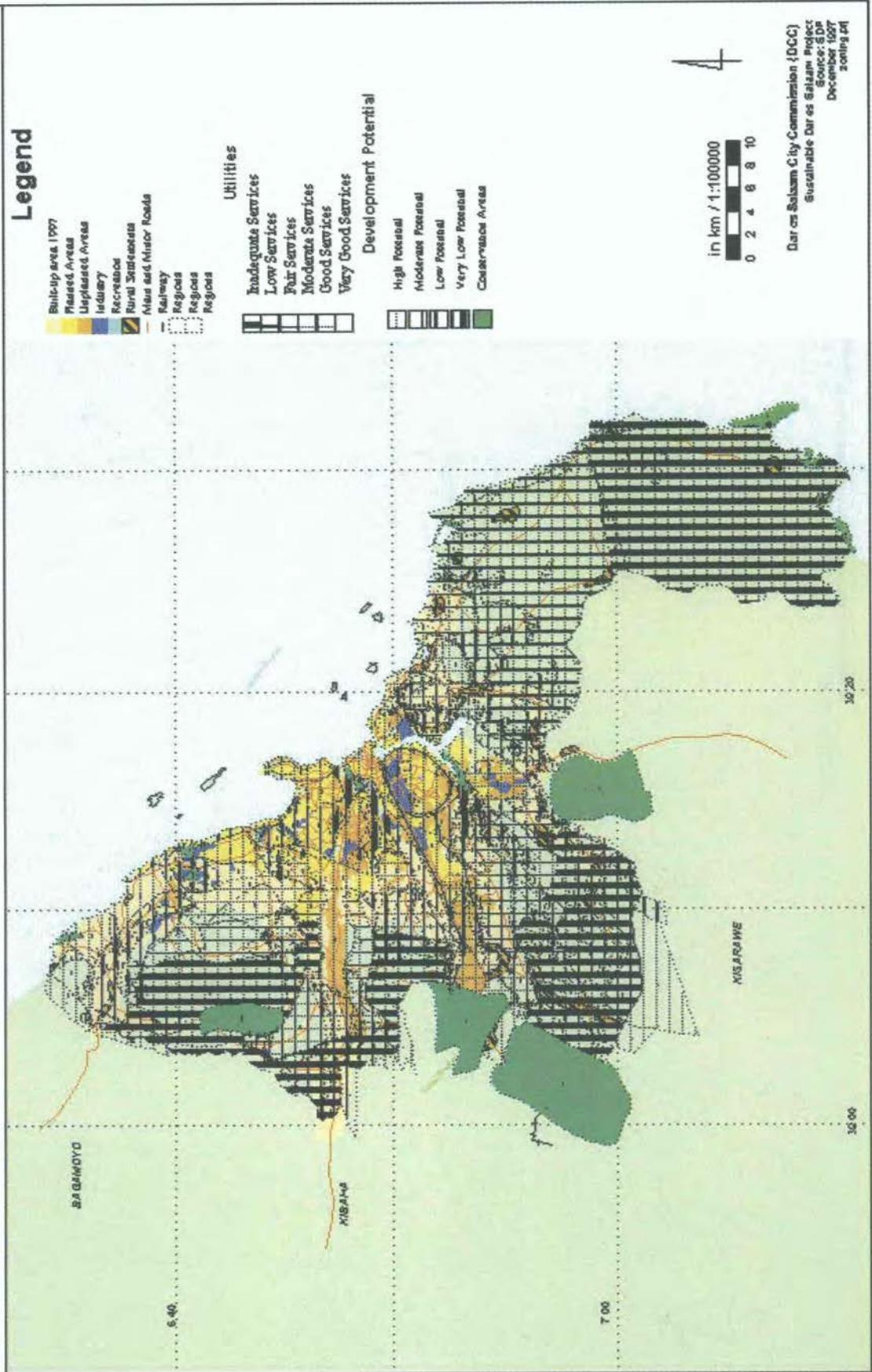
1:200000



Lusaka City Council - 1996

Map 11

Dar es Salaam - Environmental Management Framework





Map 12

Map 13



Database

MAINMENU : Form

NAIROBI RIVERS POLLUTION DATABASE

MAIN MENU

Please select one of the following options:

- Nairobi River Information
- Ngong River Information
- Mathare River Information
- QUIT!**
Quit the Database

nbiwatertable

NAIROBI RIVER WATER QUALITY TABLE

SITE	CHIROMO	YEAR	1995	MONTH	JANUARY
pH	7.6	TDS%	0	BOD5	48
Cond:	0.00	Cl%	0	BOD5%	0
Cond	0.00	Cl	0	Coli	0
TDS					

Record: 1 of 28

Save Record
Add Record
Delete
Delete previous
main menu

map1 : Form

Watershed

Kajiado District

Nairobi

Record: 1 of 1

Tool 32: Samples for Manual Overlays

Sample layers in A4 format

For copying and overlaying

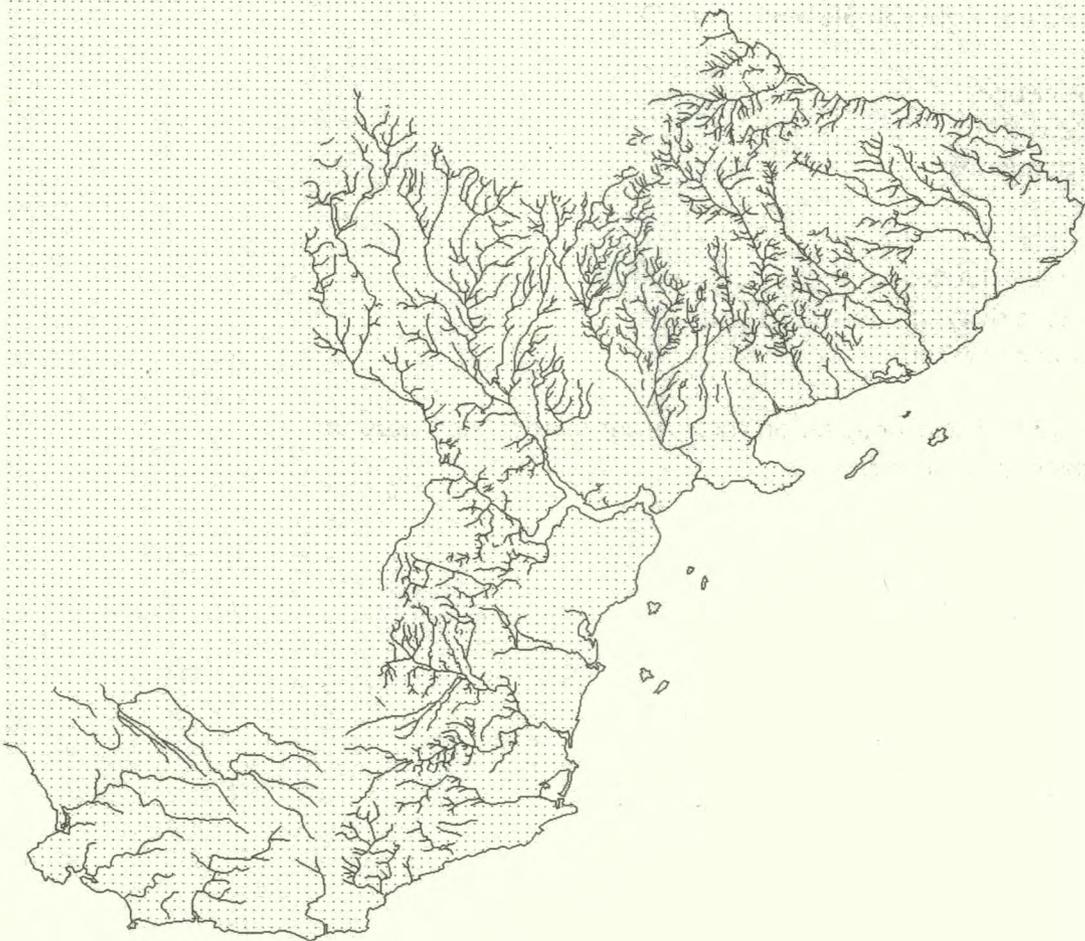
This tool contains eight sample maps from Dar es Salaam, Tanzania:

1. River Network
2. Road Network
3. Ward Boundaries
4. Soilmap
5. Landuse
6. Suitable Mining Areas
7. Hazard Sensitivity
8. Population per Ward

These maps can be photocopied on transparent material and used for practising overlaying manually.

Map I

1. DSM - Rivers

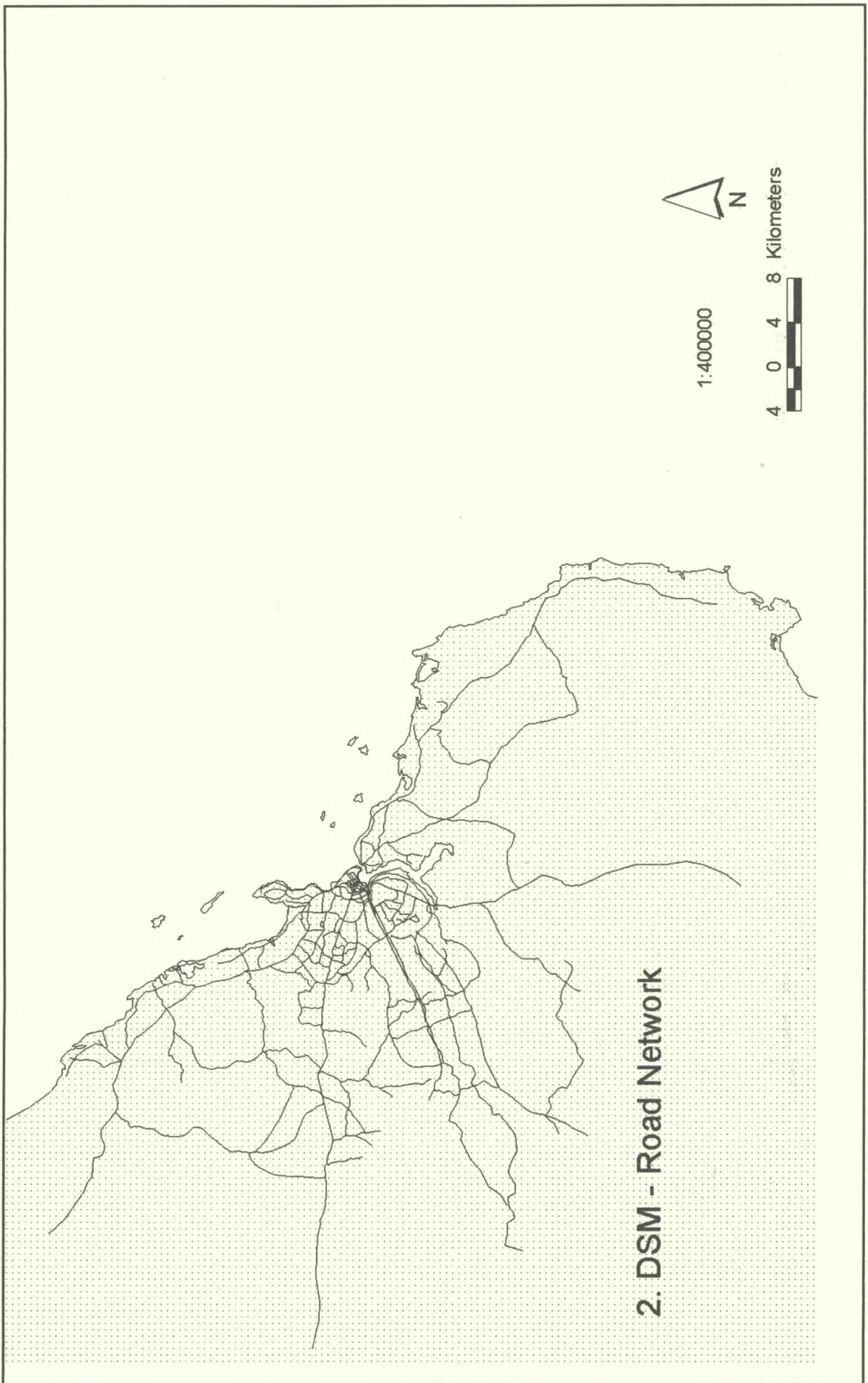


1:400000

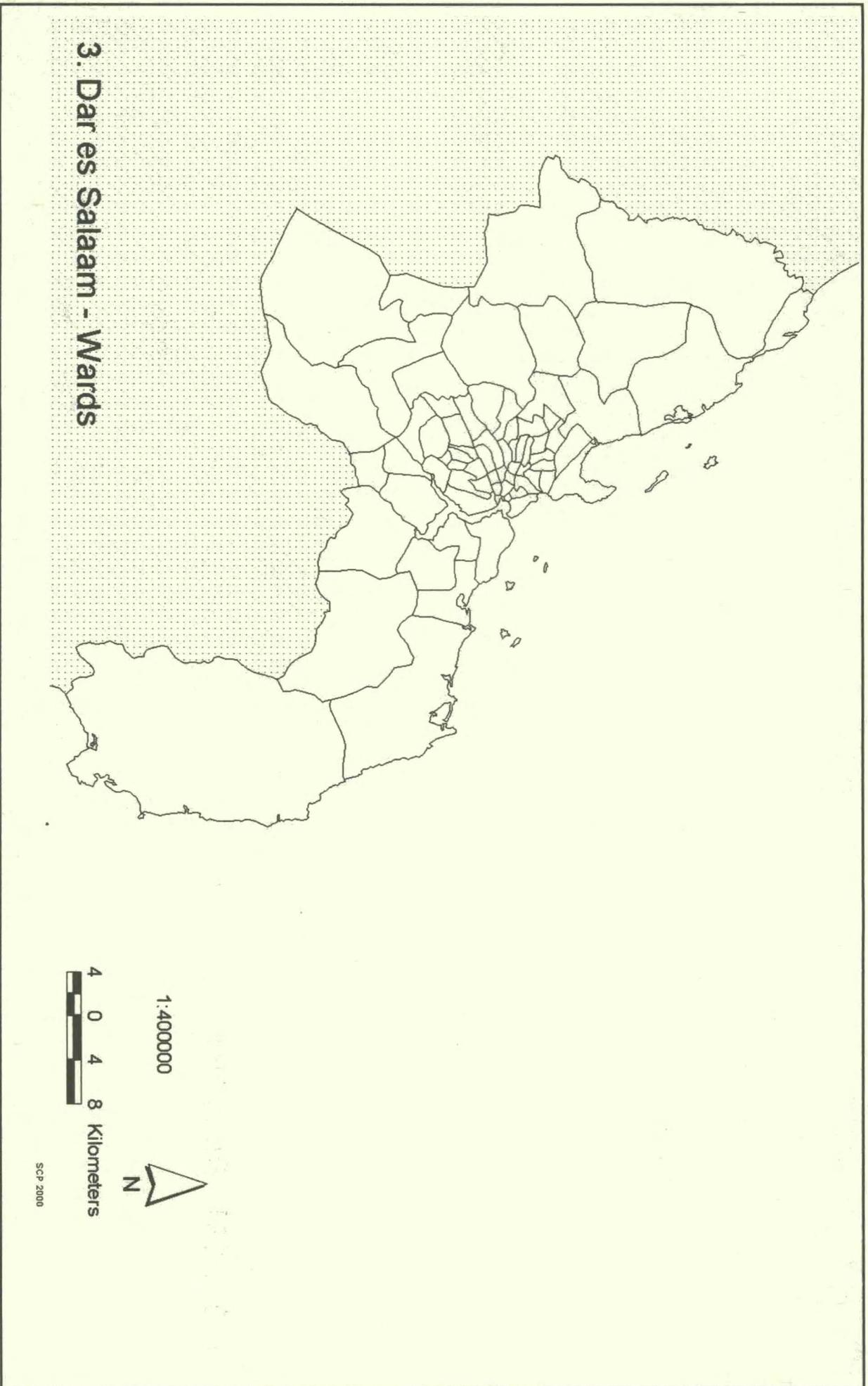


SCP 2000

Map 2



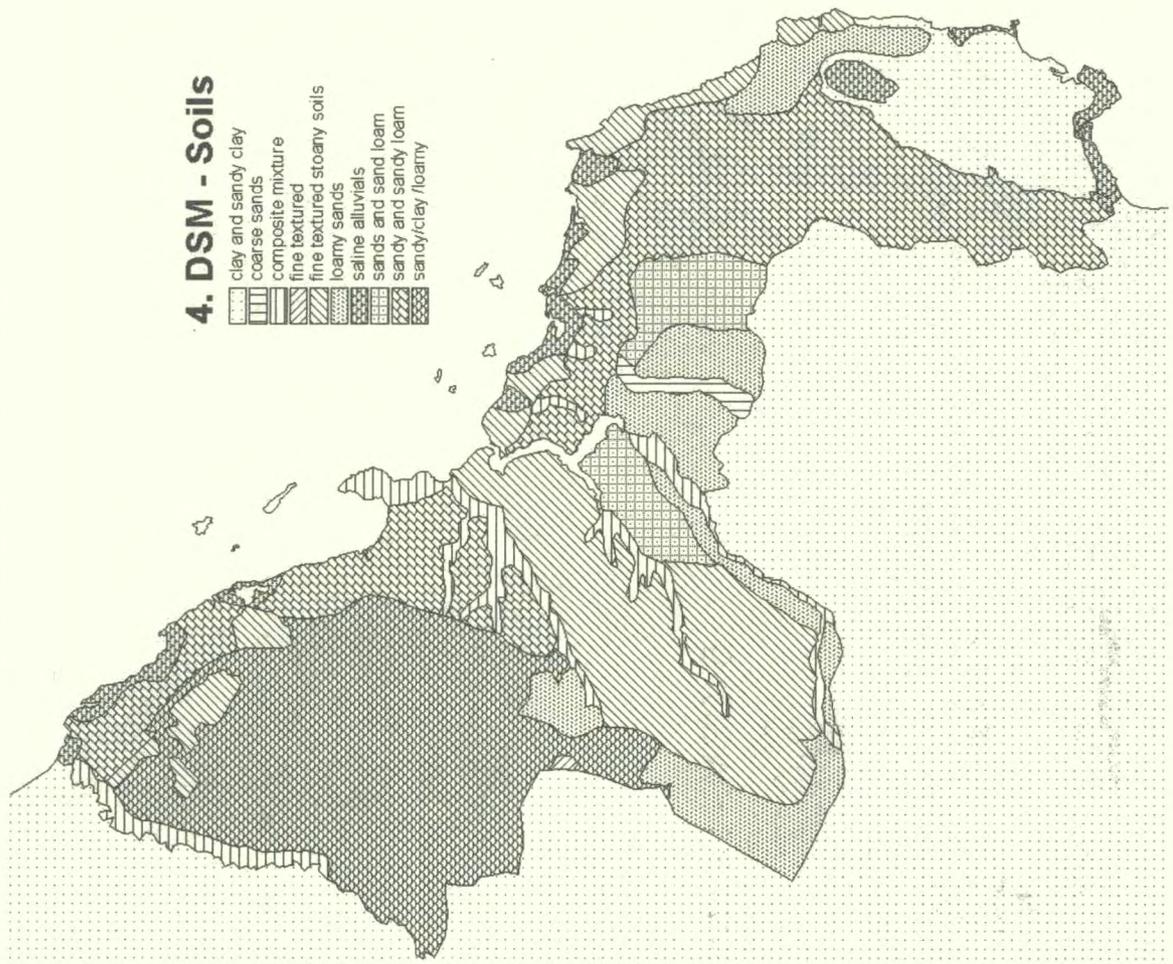
Map 3



Map 4

4. DSM - Soils

-  clay and sandy clay
-  coarse sands
-  composite mixture
-  fine textured
-  fine textured stony soils
-  loamy sands
-  saline alluvials
-  sands and sand loam
-  sandy and sandy loam
-  sandy/clay /loamy



1:400000



4 0 4 8 Kilometers



SCP 2000

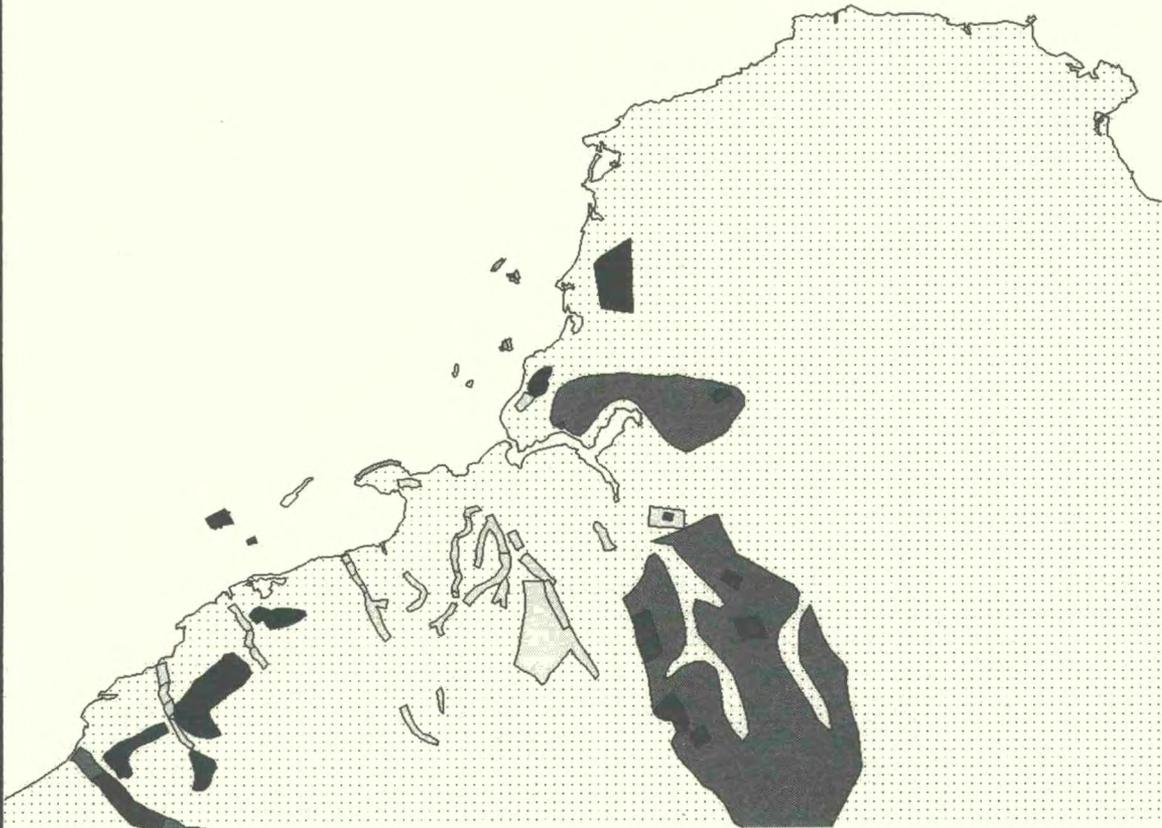
Map 5



Map 6

6. DSM - Suitable Mining Areas

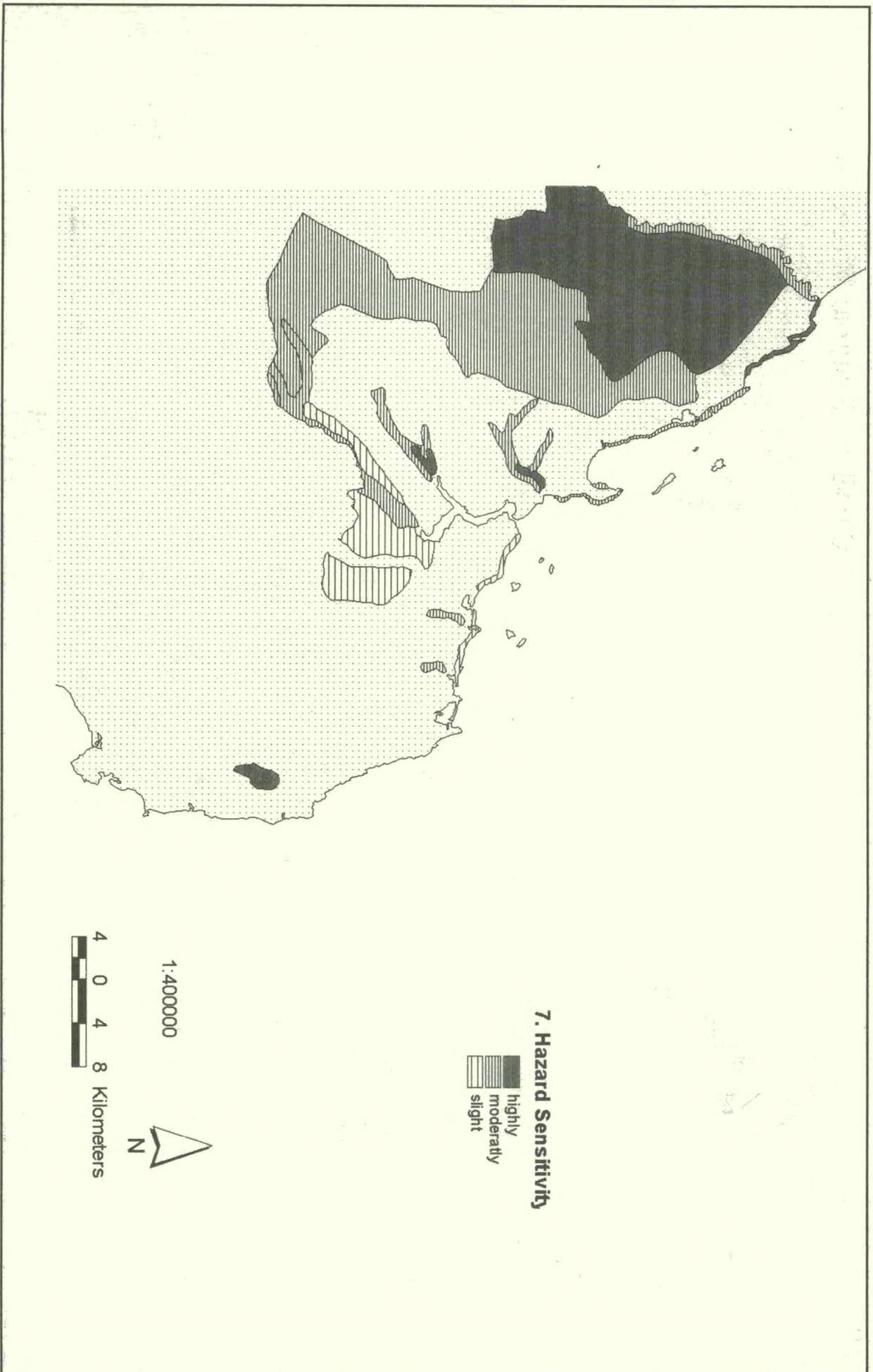
-  Designated Limestone extraction
-  Designated Limestone extraction with mining claims
-  Designated Sand extraction
-  Designated Sand extraction with mining claims
-  Illegal Limestone extraction
-  Illegal Limestone extraction with mining claims
-  Illegal Sand extraction
-  Illegal Sand extraction highly affected



1:400000



Map 7



Map 8

