

# Environmental Management Information System - a tool for urban planning in developing countries

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The first part of the paper will introduce the concept of environmental management information systems for supporting participatory decision making processes in urban planning. The Sustainable Cities Programme (UN-HABITAT/UNEP) originally developed the system. Further developments aim at the increased use of open source technology and the internet. The second part will present selected city case examples from Africa, Asia and Latin America which are applying and using an environmental management information system.

## 1 CONTEXT AND CONCEPT OF ENVIRONMENTAL MANAGEMENT INFORMATION SYSTEM

During the 1970s, the city of Lagos built an express way through a wetland area. This route was chosen because the costs for the land in that area were low. This new road opened up access to a new whole area in the wetlands, leading to the spontaneous development of that area. Not only that one of the last nature reserves was destroyed, people in that area suffered from flooding and water-borne communicable diseases. The city needed to provide services to the new settlements but infrastructure was difficult, and therefore expensive, to build. When these expenses were added to the initial costs of building the new road, it became a rather expensive undertaking.

Urban managers of fast growing cities in developing countries are confronted with a number of recurrent questions on a regular basis: Which areas are available for city expansion? How can we revive certain parts of the city? How can we improve the health conditions for the citizens? How can flood-prone areas be controlled? How can we stop air pollution in various parts of the city? How could investors be attracted to the city? Where can service delivery be improved and expanded?

In many cases traditional master planning approaches, mostly introduced by former colonial administrations, have not been able to respond to the planning needs for fast growing cities in the developing countries. Those master plans were usually prepared by external experts in a highly sophisticated manner with the result that the insufficient financial and managerial capacities of municipal councils were not able to implement such plans.

Since the seventies the need for new planning approaches evolved with the aim to take people into the centre of strategy development and decision making. Environmental planning using participatory approaches was placed on the world agenda through the Brundtland Report which initiated the subsequent debate on sustainable development during the "Earth Summit" in 1992. With additional focus on urban governance and combating urban poverty, sustainable urban development is key to achieve the global Millennium Goals, further re-enforced during the Rio +10 Conference in Johannesburg.

Among a number of national and international programmes, which promote Local Agenda 21 processes, the UN-HABITAT/UNEP Sustainable Cities Programme started demonstrating a particular environmental planning and management approach in cities around the world in the early nineties. Each city level project was adapted to the particular needs, priorities and circumstances of that city. The approach is 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.

Carefully designed and tested management tools support urban decision makers in applying the individual steps of the environmental planning and management process in their city. They include tools (a) for determining an information base (Environmental Profile), (b) for kicking off a consultative process (City Consultation), (c) for establishing issue specific working groups, (d) for strategy development and action planning, and (e) for institutionalising the process in existing management structures.

Naturally, such a practical planning and management approach requires a solid and sound geographical information basis. In particular the members of the issue specific working groups base their discussions on concrete situations on the ground. Although most municipalities in developing countries have more or less sophisticated cartographic units, those units usually require support in supplying the appropriate information to those working groups. Traditionally, mapping units in municipal structures are highly sectorised and usually deal mostly with large-scale maps (utility maps, cadastral maps, etc.) - compatible to traditional master planning principles.

In order to respond to the new cross-sectoral and participatory planning and management processes, new mapping concepts needed to be developed which supply stakeholders with relevant spatial information. One of those tools, which the Sustainable Cities Programme uses for planning, is the Environmental Management Information System (EMIS). EMIS is a tool for collecting, organizing, and applying information relevant to urban environmental planning and management. It is designed to assist cities in clarifying issues, formulating strategies, implementing action plans, monitoring progress, and updating changes, using mapping and geographic information systems as essential components for presentation, analysis, and modelling.

Experiences from cities around the world have shown, that the use of GIS based environmental management information systems can help to improve transparent decision making in municipalities. However, sensitised high-level decision makers and adequate technical capacities are key to a meaningful implementation of such a sophisticated system. The EMIS approach responds to these capacity building needs and provides the necessary tools for implementation of such a system in municipal councils.

## 2 EMIS STEPS AND TOOLS

The EMIS is part of the environmental planning and management process and it is designed to support every phase of a Local Agenda 21 project cycle. It is, in itself, a tool for better urban governance, 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 management 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, land use, 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 or presenting them effectively on the internet helps tremendously to deliver messages. Saving on outputs jeopardises the usefulness of the EMIS.

The EMIS cycle consists of nine standardised steps. Each step has concrete outputs which is basis for the following steps. The steps are supported by a number of practical tools which are part of a detailed training concept.

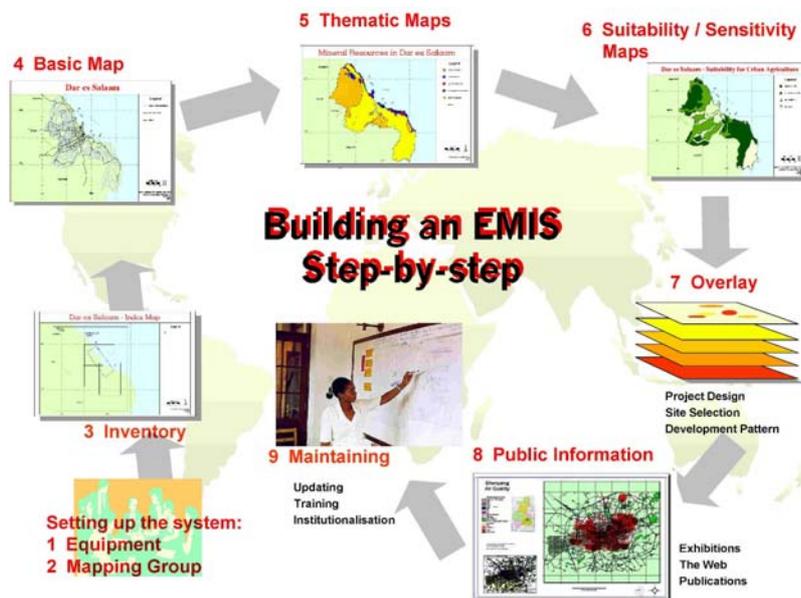


Abb.1: EMIS Steps

### Step 1: Setting up the EMIS

Setting up an EMIS unit takes quite some resources, and must be supported by a high level commitment of key decision makers of the respective institution. Although an EMIS system can be built without technical equipment, it is much easier to use a Geographic Information System to handle the amount of data in the system. The sophistication of technical equipment relates to the scope of the expected work to be done and the necessary human and economic resources. The installation costs for an average system may mount up to EUR 50,000; the annual running cost may vary from EUR 20,000 up to EUR 100,000, depending on the size of the city and the amount of work to be done.

It is often underestimated that the physical location of highly attractive (and status related) computer equipment decides on the success of the system. Experience has shown that an EMIS function is placed in a cross-sectoral department or directly under the head of the institution/municipality.

### 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 layout 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 organises 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.

*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*

Thematic Maps contain factual information and 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 certain rules stored in a database. 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.

*Step 7: Overlaying of fact and policy maps*

Overlaying a variety of maps will simulate the interaction between environment and development issues, meaning the identification of crucial 'hotspots'. Meaningful combinations of overlays will generate the necessary outputs that are relevant for urban environmental management. Typical products include strategy maps, land use maps, zoning maps, and spatial management frameworks such as the Environmental Management Framework (EMF). These documents help to answer routine questions in urban environmental planning and management.

*Step 8: Information Outreach*

Public information outreach 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 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.

### 3 PRACTICAL CASE EXAMPLES

Globally, about 35 cities are directly applying the EMIS steps and using the system for urban planning. Progress and results vary widely also the quality of the outputs. A number of cities built the EMIS function on top of their existing and well-functioning GIS units while newly established EMIS units in other cities got in contact with computers for the first time.

Experiences from those cities resulted in identifying following key challenges:

- Computer-aided mapping and GIS is still conceived as a 'black-box' for many decision makers and hence left to highly sectorised expert thinking rather than mainstreaming the use and production of maps to a wide range of stakeholders;
- Municipalities often make tremendous efforts to purchase a high-end equipment without considering the much higher operating and maintenance costs. Equipment then is used for basic office work and 'white elephants', such as expensive large scale scanners and digitisers left behind;
- Initial and continuous capacity building efforts in both, GIS techniques as well as integrating GIS in an participatory planning process are often underestimated which at some stage leaves a system idle behind;
- And most important: the control of spatial data is equivalent to power. Therefore, transparent processes involving sensitive information (such as the reclassification of land-use) are often not the priority of people having the control over data.

The following three case examples from three continents should give an insight in the practical implementation of a sophisticated environmental management information system.

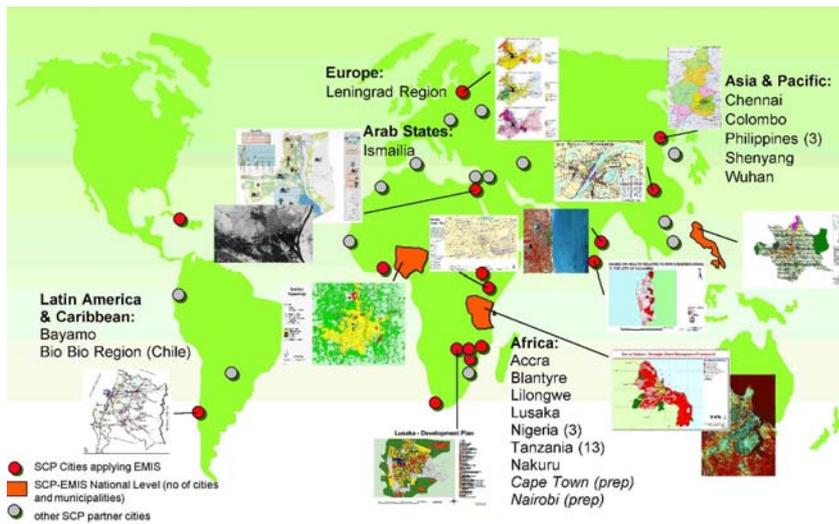


Abb.2: Some 35 cities world wide are applying the EMIS concept

### 3.1 Managing the environment in Tanzanian municipalities

In the mid-nineties the Government of Tanzania had decided to adopt the use of the new Environmental Planning and Management process instead of the traditional master planning approach in the preparation of all urban development plans. This 'revolutionary' decision was based on the good results which the participatory working group approach of the Sustainable Dar es Salaam project could demonstrate. This decision had a much wider impact than just on Dar es Salaam. It affected the planning procedures for all Tanzanian municipalities which have, under guidance of the Ministry of Regional Administration and Local Government - Urban Authorities Support Unit, established 'environmental planning and management' units. The national University College for urban planners integrated this new approach in their curriculum which ensures the education of a new generation of planners.

In the course of the Sustainable Dar es Salaam project the desolate cartographic unit of the city had been successfully revitalised and the use of GIS technology had been introduced. The EMIS concept was used to prepare the Strategic Urban Development Plan (SUDP) - the guiding document for the future development of Dar es Salaam. After completing the preparation of the Draft SUDP, it was noted that there were several contentious issues pertaining to the said plan where different people had different understanding. Such issues included the following:

- What is strategic about SUDP and what implications does this have on its focus, thematic scope, geographical coverage, time horizon and detail?
- Does SUDP have/ need a legal basis?
- Is SUDP a stand alone plan type; does it replace other plans; how does it relate to other urban management instruments?
- In what detail should the SUDP address land use planning and development control issues and is a land use map mandatory?

The Urban Authorities Support Unit in collaboration with the City Commission organised workshop where the participants, drawing on their varying experiences and professions, deliberated upon these issues and came to a common understanding through a consensus based approach. As a result, EMIS units were established in all municipalities. Experience shows that a sustainable continuation of the unit depends strongly on the attitudes of municipal directors regarding the use of information technology in planning and management.

### 3.2 Planning the future of Bayamo, Cuba

Bayamo, capital of the Granma province is a typical example of a medium sized city with rich history but relatively slow development compared to similar cities in Latin America. More than half of the city's population is living in neighbourhoods with unsatisfactory basic services and poor quality of urban space. The water quality of the Bayamo River is poor; the lifeline of the city is seriously polluted, affecting its use for human consumption, recreation, industry and urban agriculture. The solid waste management needs overhauling, while Bayamo's urban transport is constrained by a lack of fuel and spare parts. This is due in part to conflicting views on the traditional horse carts as a central element in the public transport system.

Under the lead of the Institute of Physical Planning (IPP - Instituto de Planificacion Fisica) and the Programme for Human Development at the Local level (PDHL - Programa para el Desarrollo Humano a nivel Local) a team of local experts had documented these topics through the participatory development of an Urban Environmental Profile, which served as the basis for the City Consultation. The consultation offered a forum for animated debate, reflecting the conflicting interests of key stakeholders. It also helped to broaden the ownership of the process and agreed on an Urban Pact. This pact envisions sustainable urbanization for Bayamo and sets out the tasks for thematic working groups whose composition reflects the key stakeholders concerned. These groups are developing project proposals to demonstrate how the issues can be addressed with tangible impact on the daily lives of urban residents. Particular focus is on resource mobilisation and institutional coordination. In parallel with the pilot project in Bayamo, a capacity building centre is being developed in the city of Santa Clara, in the centre of the country, as a mechanism to mainstream innovative urban planning and management concepts at the national level.

The physical planning department of Bayamo invested in a sophisticated GIS system in order to support the Local Agenda 21 process through producing municipal development plans. A well-trained local GIS expert co-ordinates a team of technicians who collect relevant information in the field for up-dating a central database on urban issues. The department has published an environmental profile containing map illustrations of high quality and relevance for the consequent planning process. Technical problems (for example software) or organisational problems (for example acquiring high-end equipment) are usually resolved through an excellent ability of improvisation. More problematic is the inter-institutional co-operation, particularly with the official mapping authority (under the military administration) in the exchange of data and information.

### 3.3 Strengthening institutions for municipal support in Sri Lanka

#### 3.3.1 Environmental initiatives in Sri Lanka municipal authorities

Sri Lanka has a long history in supporting and promoting participatory planning approaches for environmental planning and management. In the early nineties the Worldbank/UNDP funded Metropolitan Environmental Improvement Programme (MEIP) identified through an environmental management strategy in Colombo priorities such as

- loss of natural resources,
- deteriorating quality of surface and ground water,
- flooding and stagnation of water courses,
- pollution from solid waste,
- deteriorating ambient air quality
- concentrated environmental problems in low-income areas, and
- traffic congestion.

These problems were attributed to inadequately planned urban infrastructure and inadequate institutional and financial capacity for management. Strategy and action planning first involved enumerating a set of principles for the sustainable development of Colombo. A full range of qualitative and quantitative environmental quality targets were prepared for priority sectors. A number of concrete activities emerged from this such as institutional development (with setting up a GIS unit to enhance pollution control enforcement), local level initiatives (community based environmental projects) and bankable investment projects (effluent treatment plants).

The UN-HABITAT/UNEP Sustainable Cities Programme introduced additional aspects of participatory planning and management and started the replication process to other municipal councils in the Western Province. The established EMIS unit, although equipped with highly sophisticated technology, did not survive the internal competition on competencies of the different departments of the Colombo Municipal Council.

#### 3.3.2 MILES - technology transfer to support a national EMIS

In 2003, the City of Munich (Germany), the City of Vitoria (Spain) and the Sri Lanka Institute for Local Governance (SLILG) in its capacity as a national training centre for local governments started a European Union co-funded partnership to support the transfer of experiences and know-how in environmental management information systems. The project aims at improving the living conditions in the municipalities, in particular the poor in the low-income settlements as well as guiding investors, especially in emerging industrial areas where environmental permits are required before making investment decisions. The MILES initiative (Managing Information for Local Environment in Sri Lanka) is integrated in the national replication process of the Sustainable Cities Programme and technically supported by Rupprecht Consult GmbH.

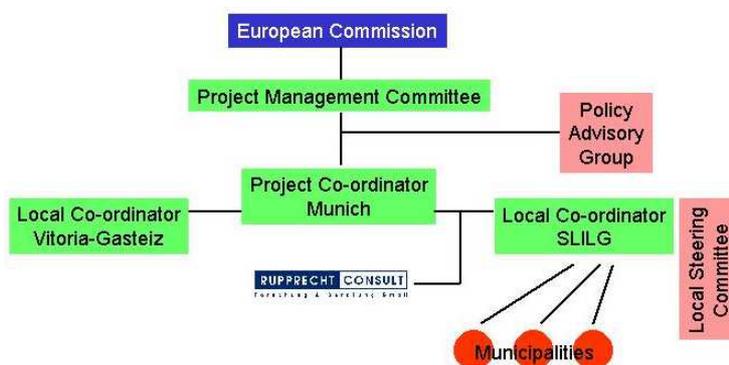


Abb.3: Organisational structure of the MILES project

The initiative adopts and transfers environmental and spatial information management concepts based on Open Source technology which is successfully used by the Health and Environment Department of the City of Munich. This project will integrate the EMIS concept with mapserver technology. Core of the initiative is to build the capacities of the SLILG for supporting and training municipal practitioners and community stakeholders in three municipal authorities in Sri Lanka (Kotte, Kandy and Batticaloa) in environmental planning, information management and spatial analysis.

The selected municipalities will use the EMIS cycle to update their mapping base, to provide spatial information to the environmental working groups and develop environmental management frameworks. The strategic exploitation and further take-up of project results will promote the project results with in the Asian region for further replication.

#### 4 CONCLUSIONS

After analysing the successes and failures of introducing sophisticated spatial information systems to municipalities in developing countries, it becomes evident that attitudes and the political support are the key challenges for sustaining such a system. This requires a fundamental change in perceiving the introduction of such technology: it is not just about equipment, software and data - it is about the institutional integration and the transparent flow of information.

##### *Change of Attitudes*

GIS experts, training institutions and software developers continue to 'demystify' the use of computer technology for producing maps and mainstream spatial thinking beyond plot boundaries. The global exchange of experiences among municipal officers will help them to recognise that the free flow of information will benefit the urban development process and finally their own position.

##### *Political support*

The successful operation of a complex environmental management information system requires forward-thinking leaders with an attitude of supporting transparent planning processes. The EMIS tool is an appropriate instrument to actually demonstrate good urban governance. The recognition of the usefulness of such a system will ensure the financial commitment of an administration to maintain such as system. Political leaders need to receive continuous sensitisation and can be convinced through creative demonstrations of applications of the system.

##### *Capacities*

It is known that building capacities of municipal officers in information technology is prone to brain drain. Continuous efforts are necessary to keep a well-trained pool of experts available. Training is not only about complicated GIS operations. Training relates to the practical knowledge of participatory planning processes and how a tool, such as the EMIS, could support such a process.

##### *Self-reliance*

Particularly the experience of Dar es Salaam has shown, that the development of the Strategic Urban Development Plan through local knowledge and efforts contributed to the self-confidence of the municipal officers in producing such documents. Self-reliance contributes to a better implementation of such plans through effective convincing of decision makers. Using Open Source technology will enable local experts to lessen their dependency from expensive expertise and technology and create market opportunities for new services.

##### *Networking*

Last but not least - the exchange of practical lessons of experiences between practitioners is key to advancing knowledge and concepts. Internet technology allows technicians to communicate and to share information. However, the internet cannot substitute direct working contacts or technology transfers. Initiatives, such as the CORP, ensure the direct exchange and the mutual learning.

#### 5 REFERENCES

- Environment and Urbanisation, Poverty Reduction and Urban Governance, Vol. 11, No. 2, 2000  
UN-HABITAT/UNEP: City experiences and international support, Environmental Planning and Management (EPM) Sourcebook, Vol 2, Nairobi 1997;  
UN-HABITAT/UNEP: Building an Environmental Management Information System (EMIS), The SCP Source Book Series, Nairobi, 2000;  
UN-HABITAT/UNEP: Implementation and Replication of the Sustainable Cities Programme Process at City and National Level, Case studies from nine cities, Nairobi, 2001  
UN-HABITAT/UNDP/Ministry of Housing and Plantation Infrastructure, Tools to Support Participatory Urban Decision Making, Colombo, 2003