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INTEGRATED CADASTRE (INVENTORY SYSTEM) FOR POLLUTION SOURCES IN THE DANUBE BASIN IN YUGOSLAVIA

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ABSTRACT

The state of the art approach to environmental protection and management calls for the implementation of major multipurpose environmental protection systems and a wide scope of preventive measures. Since environmental protection falls within the scope of problems collectively known as "externalities" which justify government intervention, i.e. the implementation of the required measures, it is the responsibility of the government to ensure that adequate data is collected and analyzed prior to any decision making pertaining to environmental protection. It is this responsibility of the Government and the constitutional right of the people to live and work in a healthy environment that are the basis of the development of a Federal Integrated Cadastre of Polluters.

The integrated approach requires a substantial increase in the amount of information and data on which the planning decisions of the future will be based. It is this need for information and data necessary for the implementation of the state of the art forecasting, planning and management (decision making) that brought about the development of the Integrated Cadastre (Inventory) of Polluters in the Danube basin in Yugoslavia.

This paper presents the methodology used in the development of the integrated cadastre and gives a brief review of the structure of the information system used to manage the integrated cadastre.

KEYWORDS

Cadastre of polluters; GIS; information systems; non-point sources; point sources; water pollution.

INTRODUCTION

Rapid growth and development, usually accompanied by irrational land use and pollutant generation along with a lack of adequate pollution control measures have resulted in the degradation of the environment in the Danube basin and in the need for immediate and prompt action. The typical conflict that existed in the past between the need for environmental protection on one hand and development on the other, accompanied by an increase in production throughput rather than an increase in efficiency and conservation, finally resulted in an integrated approach to the planning of growth, development and environmental pollution control and management. The state of the art approach to environmental protection and management calls for the implementation of major multipurpose environmental protection systems and a wide scope of preventive measures. Since environmental protection falls within the scope of problems collectively known as "externalities" which justify government intervention, i.e. the implementation of the required measures, it is the responsibility of the government to ensure that adequate data is collected and analyzed prior to any decision making pertaining to environmental protection. It is this responsibility of the government and the constitutional right of the people of Yugoslavia to live and work in a healthy environment that are the basis of the development of a Federal Integrated Cadastre of Polluters.

Historically, data about polluters have been collected by different institutions using different methodologies and to a different extent. It was not uncommon for the same kinds of data to be collected at different places and stored and managed by different organizations using different methodologies. This inefficient system of data collection and management was first identified when carrying out projects to establish a cadastre of point sources of water pollution for the provinces of Vojvodina and Kosovo and the Republic of Serbia. The Integrated Cadastre of Polluters was to overcome these inefficiencies and establish a precedent by ensuring complete, efficient and timely data collection and its dissemination to all decision makers involved in environmental management. The integrated approach required a substantial increase in the amount of information and data on which the planning decisions of the future would be based. It was this that brought about the development of the Integrated Cadastre (Inventory) of Polluters in the Danube basin in Yugoslavia. This paper presents the methodology used to develop the integrated Cadastre and gives a brief review of the structure of the information system used to manage it.

BASIC DEFINITIONS

A clear set of definitions established at the very beginning of the project is fundamental to the establishment of an Integrated Cadastre of Polluters. This is because different professions have often used identical terms to explain completely different things. The term "Cadastre" was used as early as 4000 BC (Hellenic plates found at Telohu used the term for an inventory of land at the village of Dunghi). Records of land cadastres (inventories) were also found in Ancient Egypt. Persian Czar Darius issued an order for a land cadastre to be made of the occupied Greek territory in Asia so that a tax could be imposed on the landowners. The Greeks established their first land cadastres 2000 years BC. The first Roman land cadastres were established during the reign of Servius Tulius only to be extended during Julius Caesar's and Octavian's rules. The first land cadastre in Yugoslavia was established in 1919 based on the Law of Land Cadastres (Adonovic and Vlajkovic). It was to establish official records of all the existing property and provide data on all the physical and legal characteristics. It was also to keep records of all the changes that occurred so that correct information about any given property could be obtained at any time and could serve as the basis for bond acquisition, for tax calculations and for the development and publication of different kinds of maps of Serbia (Zivkovic, 1970).

As can be seen from literature the term "cadastre" has most often been used to denote a written register of data about objects (property) and subjects (property owners). In the legal sense, a Cadastre is an official and public inventory of facts about a specific property and its owner, containing data that can be used for technical, economic, statistical and financial analyses. It is also safe to conclude that such records date back to very early times in history and that the degree of development of a given society or country can often be seen from the complexity and extent of its cadastral systems. The cadastre of polluters or sources of pollution is a new development and was first introduced into legal practice in Yugoslavia only recently. The term "Integrated Cadastre of Polluters (sources of pollution)" was introduced for the first time in the Environmental Policy of Yugoslavia by Dr. P. Marjanovic, then Deputy Minister for the Environment in charge of Environmental Policy Development.

Since the term "Integrated Cadastre of Polluters" was a recently defined term and since "cadastre" implied an official record about property and its owners, it was important to introduce a whole new set of terms and definitions within the methodology for an Integrated Cadastre of Polluters. The first thing that needed to be done was to establish a legal differentiation between the definition of a "polluter" (the owner of a property causing pollution) and that of "polluting substance" (a substance causing pollution). A review of literature showed that these two terms were often used interchangeably in many countries of the world. This was not acceptable if a cadastre (an official public record) was to be established. Other terms defined for the first time in a legal sense included source of pollution, environmental pollution, pollutant emission, cadastre of hazardous wastes, cadastre of special wastes, hazardous waste, solid waste, environmental quality indicators, integrated information system, etc. A full list of terms and their definitions is available from the authors. To summarize, the Integrated Cadastre of Polluters (sources of pollution) is a public record of all the polluters and it contains all the relevant data necessary for the efficient monitoring of the state of the environment, forecasting, planning and management of environmental protection activities and the implementation of preventive measures to protect the environment of a given territory or country. An Integrated Cadastre of Polluters (sources of pollution) establishes a consistent system for overall, timely and factual information extraction and dissemination to be used for informed and participatory decision making. The cadastre is also the basic source of information for reporting on the "state of the environment", issuing permits, research, land use planning, education, public relations, etc.

CATEGORISATION OF POLLUTERS AND CLASSIFICATION OF DATA

There are two major categories of polluters: natural and anthropogenetic. Natural "polluters" (floods, volcanic eruptions, earthquakes, etc.) are not included in the cadastre since no owner of the property causing pollution can be identified. However, anthropogenic polluters (sources of pollution) are divided into two major categories: point sources and non-point sources. A further general categorization and classification is summarized in Figure 1.

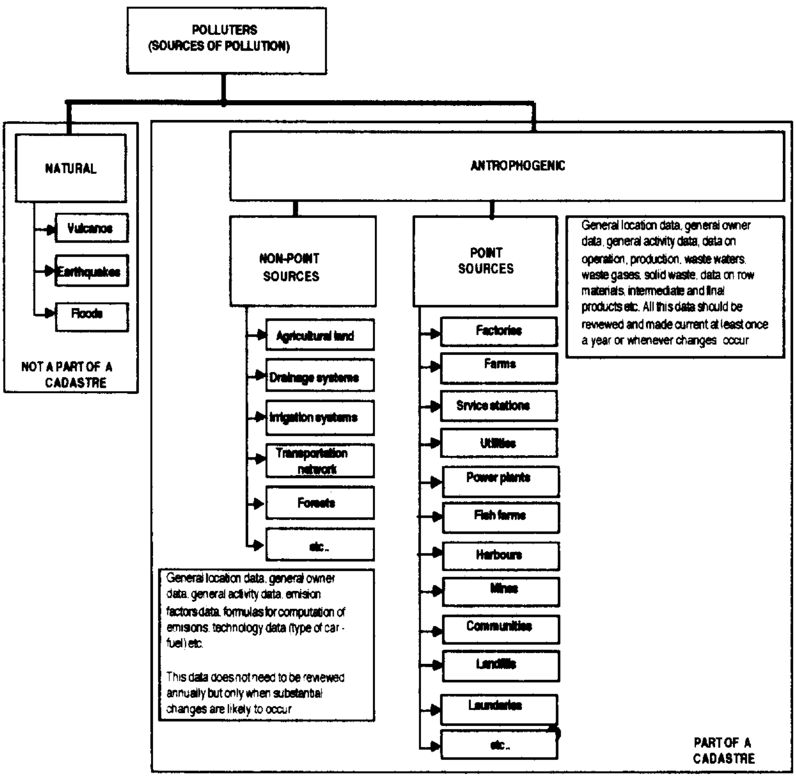

Figure 1. Categorisation of polluters and classification of the data.

MAJOR LEGAL ASPECTS PERTAINING TO AN INTEGRATED CADASTRE OF POLLUTERS

A cadastre is an inventory of facts. A cadastre entry does not entitle anyone to any rights whatsoever. It is merely an inventory of facts. A cadastre is a public document. It supports a constitutionally defined obligation of the government with respect to the state of the environment and its protection. Everyone has the right to access the information and data contained in a cadastre and obtain data summary reports from it. Data entered in a cadastre is considered correct until proven otherwise. This implies that only data collected by authorized and trained staff using standardized procedures, thoroughly checked for errors can be entered into the cadastre. The data collection system relies on the authority of organisations and individuals authorised to collect and enter data about the property of the polluter into the cadastre. This authority should be provided by law.

IMPLEMENTATION OF A CADASTRE IN FEDERAL SYSTEMS

The allocation of authority for the establishment of an Integrated Cadastre of Polluters, data accessibility and collection in a federal system of government introduces complexities based on the analysis of the following factors.

- The elements and content of the cadastre in accordance with the methodology for its establishment.
- The constitutional role of the federal government.
- Level of authority at which the federal laws and regulations are implemented.
- Mode of implementation (centralised or decentralised).

The possible desegregation of the above factors for more detailed analysis is presented in Table 1. The implementation of an Integrated Cadastre of Polluters relies on laws and regulations. Laws such as the Clean Water Act, the Clear Air Act and others are common in most countries, but discussion of these is beyond the scope of this paper. However, a list of regulations would be necessary for the effective implementation of the cadastre. These are as follows.

- Principles and methodology for establishing a cadastre and its maintenance.
- Initial state evaluation.
- Data maintenance and updating.
- Quality control and error checking procedures.
- Data retrieval and access.
- Institutions responsible for implementation.
- Data collection plans and methodology.
- Laboratory qualification scheme.
- Funding of the Integral Cadastre of Polluters.

TYPE AND AMOUNT OF REQUIRED DATA

Bearing in mind that the Integrated Cadastre of Polluters is to be implemented primarily for the efficient planning, forecasting and management of the environment in a given country (decision making with respect to the environment), the type and amount of data to be collected must satisfy certain methodological norms. Without going into detail, a description follows of the general categories of data to be collected, the frequency of collection and the scale at which data in certain categories needs to be collected. A list of data categories is presented in Table 2. Note that this is not a complete description of the data going into the cadastre - it is rather a summary of the data. More detailed information can be obtained from the authors.

Table 1. Implementation of a Cadastre in a federal system – factors to be considered

Level 1	Level 2	Level 3
1. The elements and content of the cadastre	Types of polluters	Industry; agriculture; communities (cities, towns, villages, etc.); other
	Location of a polluter; technological process; production inputs; production outputs	
	Waste streams	Waste waters; waste gases; solid waste; special waste; hazardous waste; radioactive waste
	Waste treatment plants	Place of treatment; treatment technology
	Permits and authorizations; natural phenomena as sources of pollution	
2. The constitutional function of federal government	Information collection and dissemination	Information collection
	Data collection and analysis	Information dissemination; collection
	Building public awareness; empowerment	
	Legislative	Policy determination; laws; regulations
	Executive	Monitoring; information extraction from the data; research and development; cadastre management
	Enforcement	Monitoring; quality control; inspection
3. Level of authority at which the federal laws and regulations are implemented	Federal; provincial; regional; municipal	
4. Mode of implementation (centralised or decentralised)	Direct	Centralised; decentralised
	Provincial delegated; regional and municipal delegated	

Table 2. Integrated Cadastre of polluters A. non-point sources

Element of Cadastre	Data Category	Frequency of Collection	Scale at which Collected
Non-point sources	Land-use category	Once and when changed	Cadastre unit
	Owner	Once and when changed	Cadastre unit
	Area	Once only	Cadastre unit
	Soil type	Once only	Cadastre unit
	Slope	Once only	Cadastre unit
	Location	Once only	Cadastre unit
	Cultivar	Annually	Cadastre unit
	Soil moisture	Seasonally	Municipality
	Fertilizer applied	Annually by type of fertilizer	Cadastre unit
	Pesticides applied	Annually by type of pesticide	Cadastre unit
	Herbicide applied	Annually by type of herbicide	Cadastre unit
	Irrigation	Seasonally	Cadastre unit
	Drainage	Seasonally	Cadastre unit
	Productivity	Seasonally by product	Cadastre unit
	Soil quality	Once in five years	Cadastre unit
	Landfills	Annually	Municipality
	Septic tanks	Annually by tank type	Municipality
	Non-sewered communities	Annually	Municipality
	Mobile sources	Annually by emission categories	Municipality
Point sources cadastre	General data	Once and when changed	Discharge point
	Data on operation	Annually	Technological process
	Production data	Inputs - average daily	Technological process
		Intermediate products - average daily quantities	Technological process
		Final products - average daily quantities	Technological process
		Waste production	Average daily by type - liquid, gas, solid
Waste waters	Source-type	Annually	Technological process
	Discharge - location, type, recipient, quantity & quality	Annually, seasonally, monthly, quantity & quality	Technological process + point of discharge
	Measurement of quantity & quality	Annually, seasonally, monthly, quantity & quality per unit product - list of parameters	Technological process + point of discharge
Waste gases	Source-type	Annually	Technological process
	Discharge - location, type, recipient, quantity & quality	Annually, seasonally, monthly, quantity & quality	Technological process + point of discharge
	Measurement of quantity & quality	Annually, seasonally, monthly, quantity & quality per unit product	Technological process + point of discharge
Solid waste	Source-type	Annually	Technological process
	Discharge - location, type, recipient, quantity & quality	Annually, seasonally, monthly, quantity & quality	Technological process + point of discharge
	Measurement of quantity & quality	Annually, seasonally, monthly, quantity & quality per unit product	Technological process + point of discharge
Waste Stream Treatment	Type of waste	Annually by technology, capacity & efficiency	Treatment plant or its component

SYSTEM DESCRIPTION

At the core of an efficient Integrated Cadastre of Polluters is the Information System used to manage the data in the cadastre. An example of a module developed for the point sources of pollution (Point-Source Polluters) demonstrates how information technology can be used for efficient cadastre management and use. Unfortunately, as is always the case, the advances in information technology cannot be presented on plain paper but the authors can supply those interested with a disk containing the demonstration of a system at work (US $10 – cost recovery basis). The following aspects are of vital importance in the design and implementation of such a system: analysis of the available information; installation of consistent standards, format and quality in the data collection programmes; determination of information needs related to the Integrated Cadastre of Polluters; development of methodology and standards for data collection and storage; data reduction to forms suitable for use by different categories of users and adaptable to new technology for data sharing; conceptual design; physical design; pilot study; prototyping; implementation; operational maintenance.

The system must accommodate diverse data entry methods and provide for the automatic logical control of data in certain data categories. Reports and outputs must be simple and understandable to novice users and in the form of tables, graphs, reports, sound and video. Data retrieval procedures must be easily developed by users not familiar with computer programming and computer science. The user interface must be based on Geographic Information System (GIS) technology and menu systems and the process of running the system must be properly guided. The system must allow for the retrieval of subsets of the data in the database. With this in mind it was decided to implement a GIS-based interactive controller for data management and analysis. All the data in the Integrated Cadastre of Polluters for a given territory can be accessed from the map of the territory displayed on the screen. Through a system of drop-down menus and active/inactive fields and buttons the user can instruct the DMS (data management system) to extract the data from the databases in accordance with the criteria specified and to report it either back to the screen or to another output device. All the data is stored in a relational database which allows for the synthesis and processing of the data in accordance with the user needs. The extracted data can be presented in the form of thematic maps, graphs, tables, sound, video or combinations of these. The system allows for mass balance and loading calculations for a given point, recipient, territory, etc. External modules to the system allow for the use of mathematical and other models for "scenario analysis". The sequence of figures (Figures 2 to 6) which follows is a typical abbreviated session of data analyses by the decision maker using the Integrated Cadastre of Polluters.

The capacity to combine all of the elements of state of the art information technology provides potential users of the cadastre with capabilities that before did not exist. The idea of one central database that is efficiently stored and available to all users is becoming more of a reality. Geographic databases can now be maintained on distributed networks and those users that are responsible for their particular map and database components can still maintain those maps and administer them on their own file servers; yet individual users or multiple users wishing to use the data can share the databases across the network. Technology like this offers unique stimulation to achieve a common goal through co-operation and communication. Once implemented, it may have profound integrative socio-political impacts we may not be fully aware of yet.

A word of caution is necessary since technology alone does not bring success. Although technology is available for implementing GIS across distributed architecture, this is not necessarily the panacea that organizations require to make their information processing effective. At least as important, if not more important, than the actual hardware and software are the issues of methodology for the system design and implementation, and database design and implementation. The organisational structure and management that support the Integrated Cadastre of Polluters are also critical to making it a success. Putting this aside an additional requirement must be met. It is related to the preconditions necessary for the successful implementation, and these are mostly related to the decision-making process and are in the domain of policy analyses and political decision making. Although it may be difficult to fully comprehend the implementation process, it is important to stress its dynamic nature. The desired goals can be achieved if:

- Clear and consistent policy formulation and objectives are put forward.
- The enabling legislation incorporates a sound theory identifying the principal factors and causal links affecting policy objectives.
- The enabling legislature structures the implementation process so as to maximize the probability that the implementing officials and target groups will perform as desired.

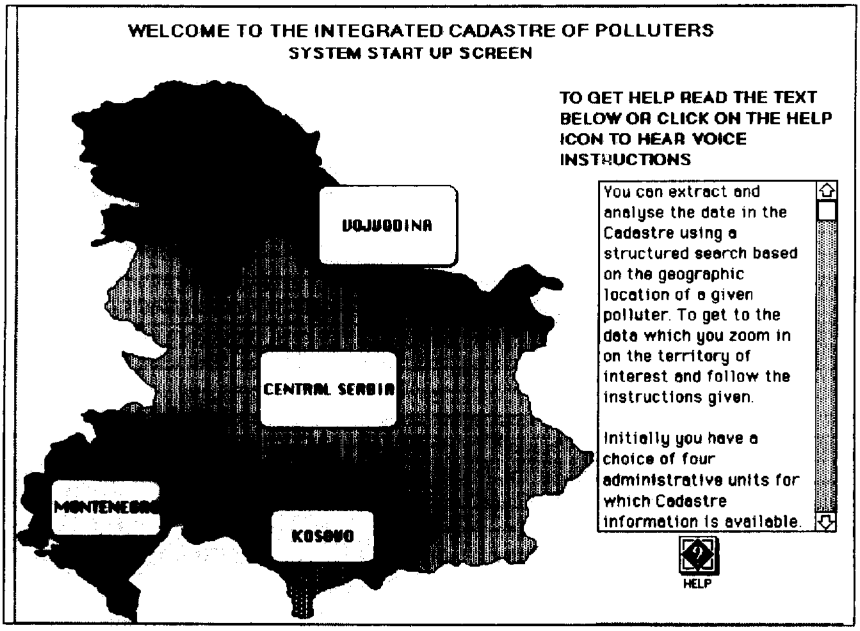

Figure 2. Step 1 – startup screen.

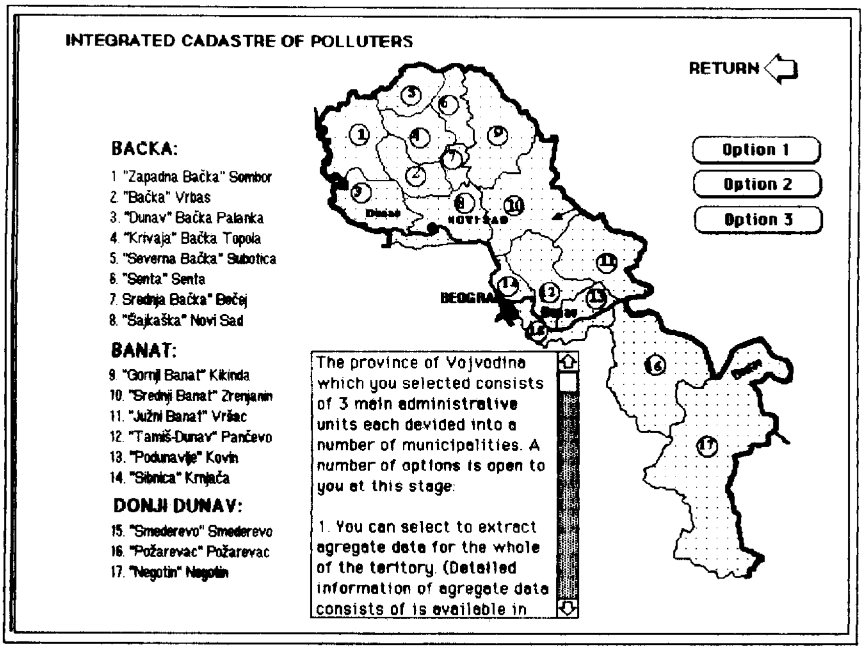

Figure 3. Step 2 – regional screen – interactive controller.

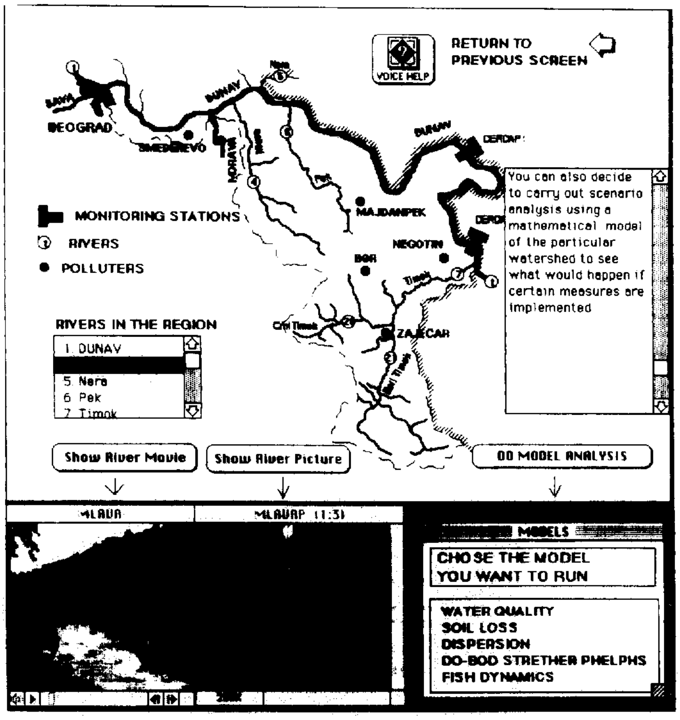

Figure 4. Step 3 – data reporting screen – multimedia data extraction tools at a level of a receiving body, a polluter or a community in a given area.

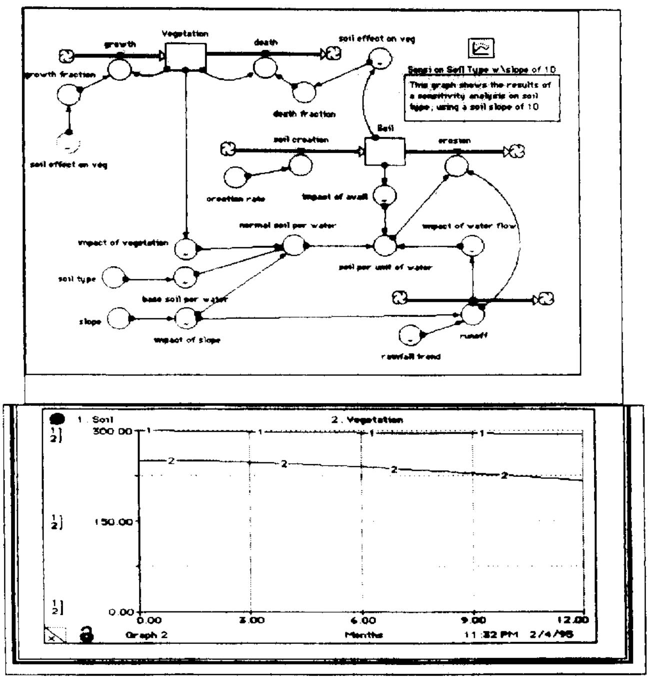

Figure 5. Step 4 – Interactive use OD system dynamics models for forecasting, planning and management.

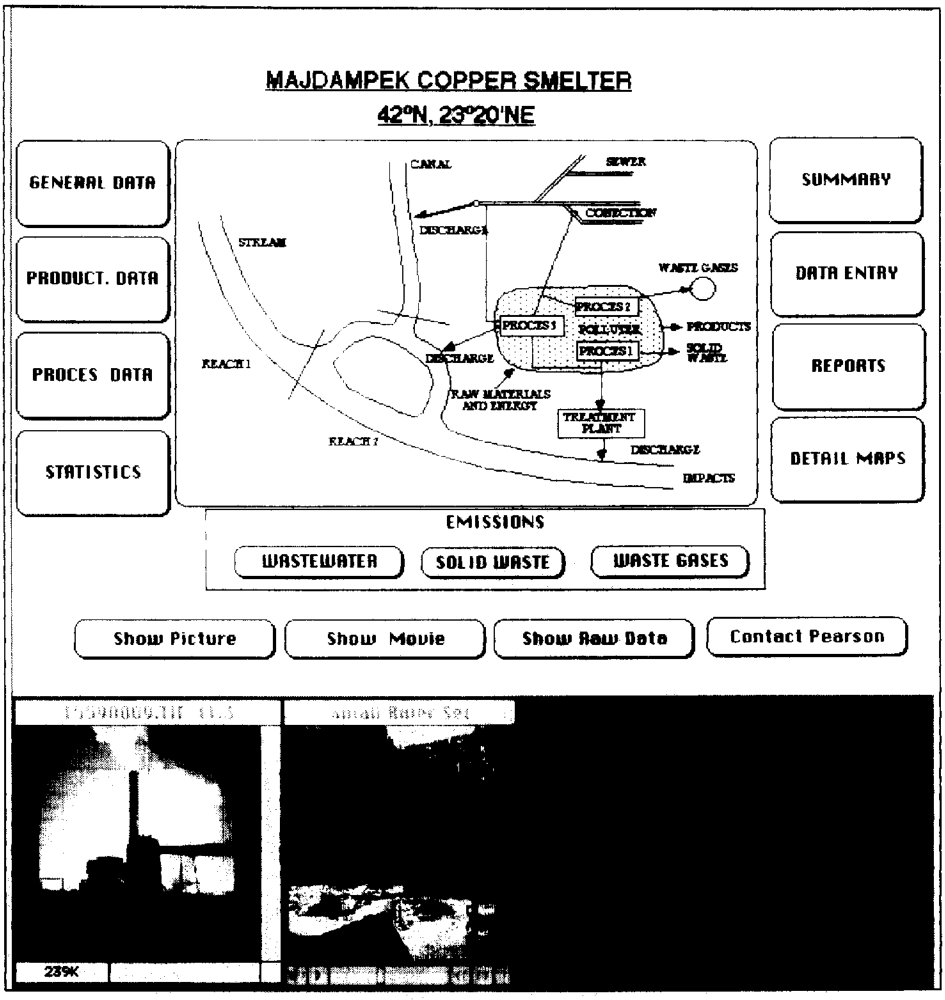

Figure 6. Step 7 – data extraction by type for a given polluter.

- The leaders of the implementing agency possess substantial managerial and political skill and are devoted to statutory goals.
- The programme is actively supported by organised constituency groups and by a few key legislators throughout the implementation process, with the courts being neutral or supportive.
- The relative priority of statutory objectives is not undermined over time by the emergence of conflicting public policies or by changes of relevant socio-economic conditions which weaken popular and political support.

The authors stress that appropriate training programmes are needed for the five major groups of users of the Integrated Cadastre of Polluters: policy makers, planners, programmers, technicians and educators. Different courses should be organized to cater to the specific needs of different users. Policy makers should be made aware of the uses and limitations of a cadastre as a factual public record. They should be informed of the developing trends in information technology and the kind of resources needed to make these technologies work. Planners in the field should have a general understanding of data, models and relational data structures, and the use of the cadastre in different stages of planning, forecasting and management. A higher level of technological competence is needed for training programmers. They need to be trained to manage the system and develop application modules to meet local needs. Technicians need to be trained for data collection and entry, particularly in the technical processes involved and the likely types of errors. Educators should be kept informed of the latest technological developments. Universities and higher educational institutions should put more investment into information technology (IT) training and research in GIS to develop local expertise.

CONCLUSIONS

In working on developing a methodology for an Integrated Cadastre of Polluters and a functional module for point source polluters, the following important aspects emerged.

"System applications must drive the system design" philosophy must be adopted if the cadastre is to be functional and widely used. Overall, the design philosophy is then straightforward if one follows the rules of the game: keep it as simple as possible, do not make it a caricature of reality unless you have to, make sure that the end users are the most important people of all and that they set the rules and do not forget that cheap is not always bad. We need simple solutions to complex problems and IT is mature enough to allow this to happen.

After procurement and the transition into the IT-based Integral Cadastre of Polluters occurs, the ultimate success and ability of the system to provide the decision makers with quality information depends to the most significant level on the quantity, quality and usability of the data in the system.

A systematic approach to the implementation of the Integrated Cadastre of Polluters involves access to user needs and requirements, the development of the database design based on these needs, and the testing of the design in a pilot study before its full implementation in practice.

By far the most difficult and expensive part is ensuring that all the necessary data is collected in accordance with the requirements of the designed system.

A gradual development and progress must be implemented. New technologies like GIS offer an analyst the opportunity to view a problem in a new light and this can often create feelings of excitement, fear and frustration in all those involved.

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