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STATISTICAL COMPARISON OF TREATMENT PLANTS ALONG THE RHINE AND DANUBE

Ferenc KISS GUBA

Department of Water Resources Engineering
Technical University of Budapest
H-1111 Budapest, Müegyetem rkp. 3.

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Abstract

The collection of the municipal sewage treatment plants' data of the Rhine and the Danube basins, initiated by the RBA-Centre, Delft University of Technology, was continued with the development of a database manager. The name of the program is 'Information on Municipal Sewage Treatment Plants', IMST. The main goal of the IMST was to make the continuation of the collection of waste water treatment plants possible without significant knowledge of informatics and to provide a tool to compare the municipal sewage treatment plants from the Rhine and the Danube basins.

The IMST is a user friendly, menu driven system with easily accessible modular system. Besides the data entry, list and simple, statistical and integrated query of the treatment plant data a map system is included to demonstrate the geographic location of the plants and to give a visualisation possibility of the main characteristics (country borders, watersheds, main rivers and their tributaries, etc.) of the two river basins.

The system is opened and can be extended. Please bear in mind that IMST has been developed and is being maintained as a non-profit project form and educational and research institution. We are always pleased to hear feedback concerning your use of the system and any suggestions for improvement, additions and the like. Much of the nature of the system has to be derived from user suggestions. Please keep in touch!

Keywords: GIS, Rhine, Danube, comparision.

Introduction

A work to collect the municipal sewage treatment plants' data of the Rhine and the Danube basins, initiated by the RBA-Centre, Delft University of Technology, had to be continued with the development of a database manager. The name of the program is 'Information on Municipal Sewage Treatment Plants', IMST. The main goal of the IMST is to make the continuation of the collection of waste water treatment plants possible without significant knowledge of informatics and to provide a tool to compare the municipal sewage treatment plants from the Rhine and the Danube basins.

There is another reason that determined mainly the form of IMST. This is the educational need. Eleven Universities from the Rhine and the

Danube basins cooperate in a joint European project called TEMPUS. To fit into the objectives of this TEMPUS JEP the IMST has got a quite detailed help and term system, where lot of explanations can be found. The geographical allocation of the data which can be managed with the help of the IMST vector map system helps the orientation of the plants and makes possible to see spatial relations as well, that might be useful even for the experts of the environmental engineering, too. This article gives a brief insight of the capabilities of IMST. Though *Fig. 1* demonstrates the IMST's structure no further details of the computational background is discussed here. Getting deeper information on this aspect of IMST see 'Information on Municipal Sewage Treatment Plants' working paper Nr. 3, RBA Series on River Basin Administration.

The basic characteristics of IMST are as follows:

- Menu driven, which means that the possible activities are always written on the screen and the user can select from them.
- Fully interactive, the user only has to read the questions written on the screen and answer them to continue the running of the system.
- There is a built in help and term system that can be activated at any stage of the program running to get the necessary explanation what to do or how to interpret the results, etc.
- There is a user manual discussing IMST almost screen by screen to get enough information even if the user is very inexperienced in using computers.
- IMST has got a modular system that facilitates the further development in case of need. The data structure is general and transportable to the majority of the available systems.
- Wherever it was possible a graphical demonstration is included as well. The map system has got certain Geographic Information Systems' (GIS) functions and allows the user to see the Rhine and Danube basins' river networks, watershed boundaries, countries, lakes and sees digitized maps with a user defined scale and overlaying.

IMST is not a single computer program, but a collection of almost 80 program modules that are linked by a unified menu system. Using independent modules linked by a simple data structure, the system allows users to develop their own modules with minimal regard for the internal working of IMST modules in the core set. Furthermore, these modules can be developed in any computer language, and still maintain a simple compatibility.

The quick reference presented below concentrates on the analyzing parts of IMST. The order of the modules mentioned here is as they are incorporated into the menu system structure (see *Fig. 1*).

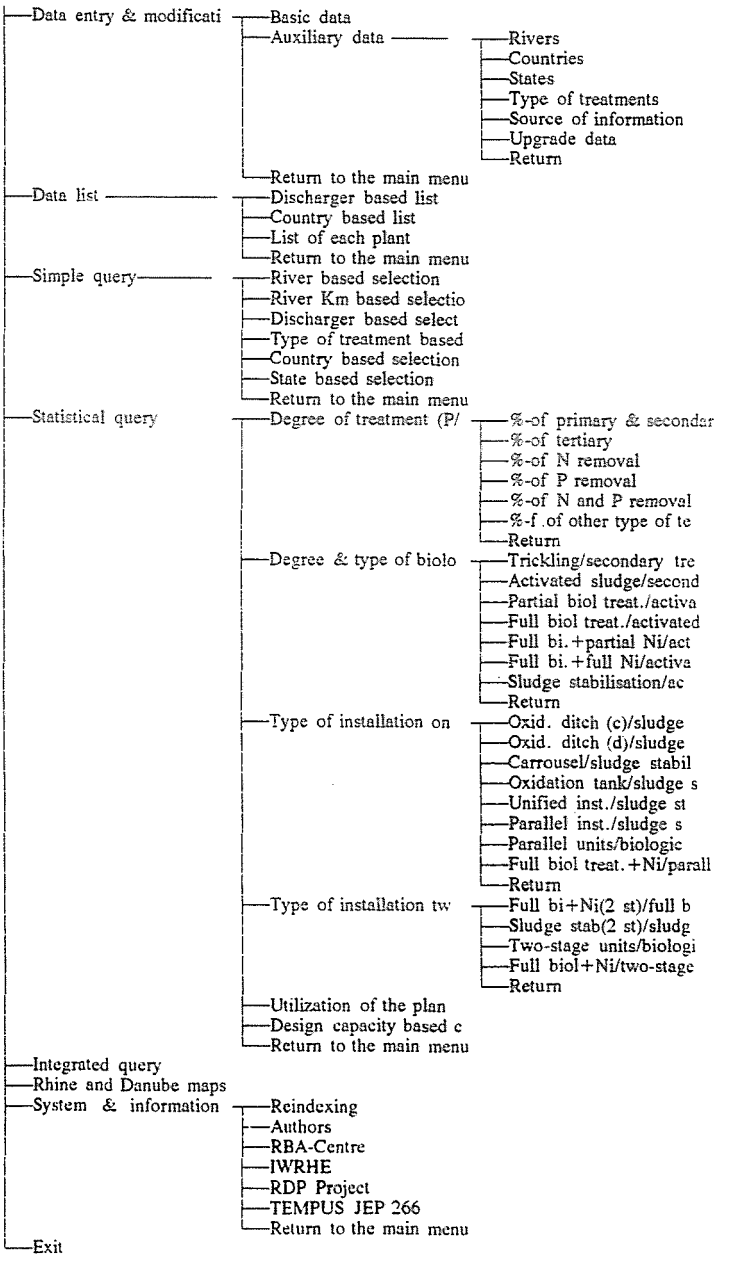

Fig. 1. Structure of the program modules

1. Data List

The list of the entered data can be printed according to the following options:

- Discharger based list: which means that the user first has to select a discharger from the offered window and the list of the data belonging only to the chosen plan are going to be printed.
- Country based list: which means that the user first has to select a country from the offered window and the list of data belonging to the chosen country is going to be printed.
- List of each plant: this option is going to result a vast list of the plant data consisting of more than hundred pages according to the actually available data.

2. Simple Query

Simple query is the name of the queries[1] where only one type of constraint can be chosen like country, river or treatment type. The simple query includes the following six parts:

- River based selection: the user can select first a river (from an offered window) and then the data belonging only to the chosen river will be selected and demonstrated on the screen.
- Discharger based selection: this means the list of a user selected discharger's data to the screen. The selection of the discharger can be managed from a window where the dischargers are offered in alphabetic order.
- Type of treatment based selection: in this case the user can select from the available treatment type collection of the plants and only the plants using the selected treatment types will be printed to the screen. The selection from the treatment types is again facilitated with an offered window containing every possible types occurring in the practice of the collected plants.
- Country based selection: the user can select first a country (from an offered window) and then the data belonging only to the chosen country will be collected and demonstrated on the screen.
- State based selection: in the case of Germany the river basin is divided into states. This type of selection gives an opportunity to the user to

[1] Query in the case of database management is the collection of the questions that can be answered using the developed database program. Usually the query has a certain standard function for example the simple list of the data or the condition dependent selection of the records. To facilitate these standard queries there is a tendency to use standard type of query languages (SQL).

see only those plants' data that belong to one state of Germany. In the case of state based selection the country is a priori Germany.

3. Statistical Query

This is the most elaborated query. Here the ratios of the different treatment types can be calculated. The statistical part of the query is divided into the following units:

- Degree of treatments. In this branch of the menu the different groups (primary, secondary and tertiary) of treatments are related to the total treatment capacity. This comparison is divided into the following points:
  - percentage of primary and secondary treatments: here the percentage is understood as a comparison to the total amount of the sewage water. The user first has to select a country and the results will belong to the chosen country. As a marginal result the total capacity of the primary and secondary treatment is displayed.
  - percentage of tertiary treatments: the tertiary treatment capacity[2] is related to the total purification capacity. The results will belong to a predefined country. The total capacity of the plants and the total tertiary capacity of the plans together with the number of the plants belonging to both categories are calculated as well.
  - percentage of the nitrogen removal: the N removal is related to the total treatment capacity. This statistical number is related to one user selected country. Number and sum of the total capacities of plants of the country and that of the plants using N removal is calculated, too.
  - percentage of the phosphorous removal: the P removal is related to the total treatment capacity. This statistical number is related to one user selected country. Number and sum of the total capacities of plants of the country and that of the plants using P removal is calculated, too.
  - percentage of the nitrogen and phosphorous removal: the N and P removal is compared to the total capacity of the treatment plants. The results are belonging to one user selected country. The number and the sum of the total capacities are calculated, too.

[2]The capacity is meant as the sewage load and not the designer capacity of the treatment plants. The actual load can even be bigger than the designed capacity.

- percentage of the other types of tertiary treatments: other types in this case mean every tertiary treatment that are not N or P removal. The other tertiary treatments are compared to the total treatment capacity of a user selected country. The numbers and sum of the total capacity are calculated as well.

- Degree and type of biological (secondary) treatments. In this branch of the menu the different methods of the biological treatment are related to the total biological treatment capacity. The following options are given:
  - trickling filter over secondary statement: the result is the ratio of trickling type of secondary treatment and the total secondary treatment. The ratio is given according to the plants' capacities as well as the number of plants. The comparison can be managed on a user selected country base.
  - activated sludge over secondary treatments: here the plants using the activated sludge method are compared to the ones using other types of secondary treatments. The ratio is given according to the plants' capacities as well as the number of the plants. The comparison can be managed on a user selected country base.
  - partial biological treatment over activated sludge treatment: this ratio shows the application of partial biological treatment related to the plants using activated sludge methods. The result is given according to the plants' capacities as well as according to the number of plants. The comparison can be managed on a user selected country base.
  - full biological treatment over activated sludge: this ratio shows the application of full biological treatment related to the plants using activated sludge methods. The result is given according to the plants' capacities as well as according to the number of plants. The comparison can be managed on a user selected country base.
  - full biological treatment and partial nitrification over activated sludge: this ratio shows the application of full biological plus the partial nitrification treatment related to the plants using activated sludge methods. The result is given according to the plants' capacities as well as according to the number of plants. The comparison can be managed on a user selected country base.
  - full biological treatment and full nitrification over activated sludge: this ratio shows the application of full biological plus the full nitrification treatment related to the plants using activated sludge methods. The result is given according to the

plants' capacities as well as according to the number of plants. The comparison can be managed on a user selected country base.
  - sludge stabilisation over activated sludge: here the plants using the sludge stabilisation method are compared to the ones using activated sludge treatments. The ratio is given according to the plants' capacities as well as the number of plants. The comparison can be managed on a user selected country base.
- Types of installation in case of one stage methods. The ratios that can be calculated in this branch of the menu show the frequency of applying the different one stage installation biological treatments. They are as follows:
  - C type of oxidation ditch over sludge stabilisation: this ratio shows the application of C type of oxidation ditch related to the plants using sludge stabilisation methods. The result is given according to the plants' capacities as well as according to the number of plants. The comparison can be managed on a user selected country base.
  - D type of oxidation ditch over sludge stabilisation: this ratio shows the application of D type of oxidation ditch related to the plants using sludge stabilisation methods. The result is given according to the plants' capacities as well as according to the number of plants. The comparison can be managed on a user selected country base.
  - Carrousel type of installation over sludge stabilisation: this ratio shows the application of carrousel type of installation related to the plants using sludge stabilisation methods. The result is given according to the plants' capacities as well as according to the number of plants. The comparison can be managed on a user selected country base.
  - oxidation tank type of installation over sludge stabilisation: this ratio shows the application of oxidation tank type of installation related to the plants using sludge stabilisation methods. The result is given according to the plants' capacities as well as according to the number of plants. The comparison can be managed on a user selected country base.
  - unified installation over sludge stabilisation: this ratio shows the application of unified installation related to the plants using sludge stabilisation methods. The result is given according to the plants' capacities as well as according to the number of plants. The comparison can be managed on a user selected country base.
  - parallel installation over sludge stabilisation: this ratio shows the application of parallel installation related to the plants using

sludge stabilisation methods. The result is given according to the plants' capacities as well as according to the number of plants. The comparison can be managed on a user selected country base.

- parallel units over biological treatments: here the ratio between the parallel units and the total biological treatment can be calculated. The result is given according to the plants' capacities as well as according to the number of plants. The comparison can be managed on a user selected country base.
- full biological treatment and full nitrification over parallel installation: here the plants using full biological and full nitrification treatment compared to those ones that use parallel installation. The result is given according to the plants' capacities as well as according to the number of plants. The comparison can be managed on a user selected country base.

- Types of installation in case of two stage methods. The ratios that can be calculated in this branch of the menu show the frequency of applying the different two stage installation biological treatments. They are as follows:
  - full biological treatment and full nitrification (two stage installation) over activated sludge and full biological treatment and full nitrification: here the plants using full biological and full nitrification treatment in two stages are compared to those plants that use activated sludge and full biological treatment plus full nitrification. The result is given according to the plants' capacities as well as according to the number of plants. The comparison can be managed on a user selected country base.
  - sludge stabilisation (two stage installation) over sludge stabilisation: here the capacities of plants using two stage sludge stabilisation are compared to the total sludge stabilisation. The result is given according to the plants' capacities as well as according to the number of plants. The comparison can be managed on a user selected country base.
  - two-stage units over biological treatments: here the capacities of plants using two-stage units are compared to the total biological treatment. The result is given according to the plants' capacities as well as according to the number of plants. The comparison can be managed on a user selected country base.
  - full biological treatment plus full nitrification over parallel units: here the capacities of the plants using the full biological treatment plus full nitrification are compared to the total parallel treatments. The result is given according to the plants' capaci-

ties as well as according to the number of plants. The comparison can be managed on a user selected country base.

- Utilization of the plants. This menu element gives the possibility to select those treatment plants of one chosen country, that are fallen into a user define interval of the utilization of the plants. The utilization is measured as the percentage of the actual load and the designed capacity of the plants.
- Designed capacity based classification. Here the user can classify the plants according to their designed capacities. The user can define the number of the classes and their limits as well. As the result the number of plants falling into the defined classes and the total capacity are calculated. The calculation is managed on a user selected country base.

4. Integrated Query

The integrated query offers an opportunity to the user to select from the treatment plants using different combinations of the data. For example to list the treatment plants of a given country is a simple query because it uses only one requirement. Adding to this filter[3] another tag like treatment plants of a given section of a river makes the query to be integrated. The following data can be used in creation of complex filters:

1. rivers
2. countries
3. river km
4. design capacity
5. designed percentage of household load
6. actual load
7. actual percentage of household load
8. type of treatments

[3]The meaning of filter in this sense is a combination of the conditions related to the database. A condition could be, for example, that the code of the country in the record has to be 4 (meaning the Netherlands). Filtering means the selection of the data records satisfying a simple or a complex filter (conditions).

The combination of the above data can be OR[4] type or AND[5] type. The result is given in a screen window containing only those records that satisfy the filter.

5. Rhine and Danube Maps

The IMST mapping system can display the river networks, lakes, seas, country borders, watershed borders and the location of the treatment plants of the Rhine and the Danube basins. The digitized data are stored in different coverages and can be overlapped freely. The scale of the maps, the colour of the lines and the overlapping of the coverages are user defined. The content of the screen can be saved and retrieved later adding it to the actual screen content. For the better understanding of the usage of IMST map system *Figs. 2–5* explain certain capabilities.

Fig. 2. Rhine & Danubian wathersheds and tributaties together

Fig. 2 shows an example where four layers, the Rhine and Danubian watersheds and the Rhine and Danubian tributaries are superimposed.

[4] The OR operation in the Boolean algebra means that the results is a true value unless both arguments have a false value. With other words the record here will be selected in case of OR type of combination if it satisfies at least one of the conditions.

[5] The AND operation in the Boolean algebra gives false result unless both arguments have true value. With other words the record in the query will be selected only if it satisfies every condition.

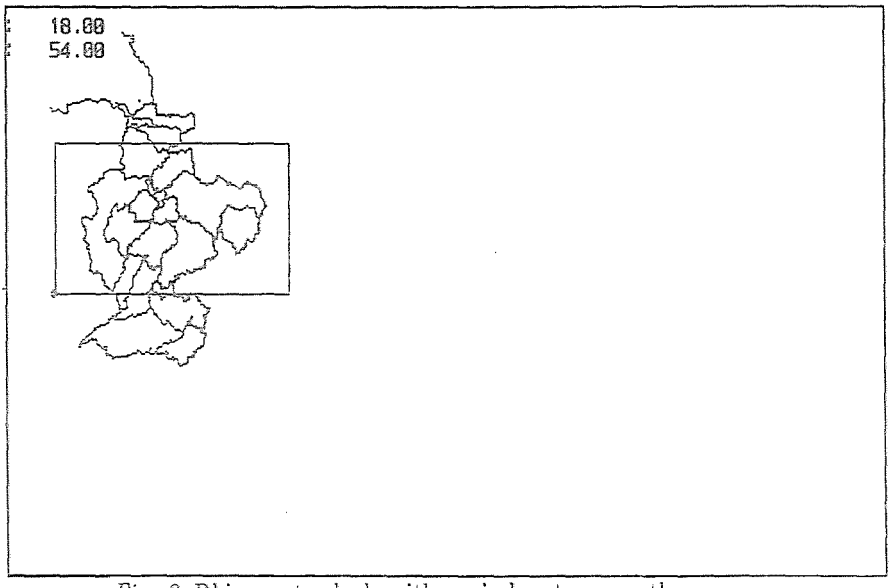

Fig. 3. Rhine watersheds with a window to zoom the map

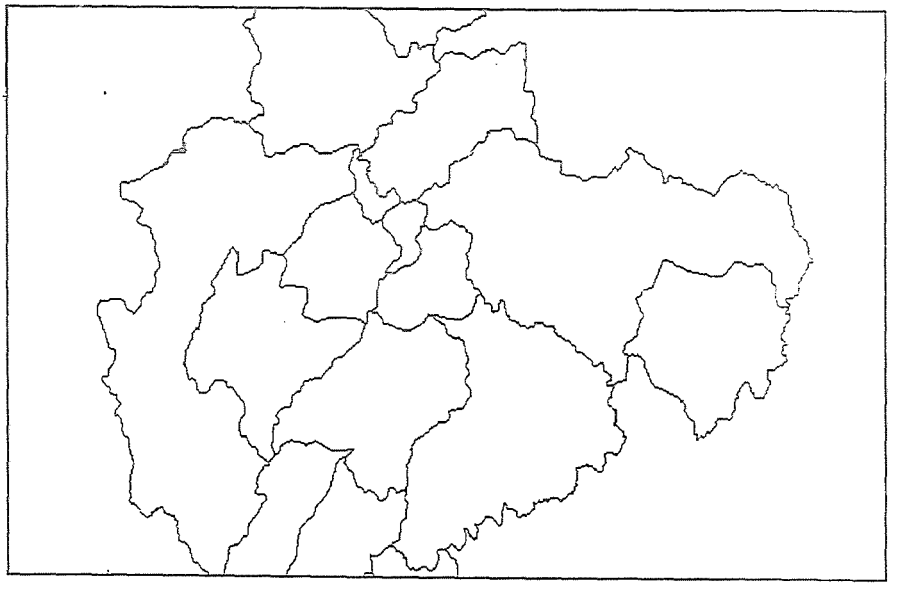

Fig. 4. Zoomed Rhine watersheds

Fig. 3 shows an example of zooming. The indicated window can be seen on *Fig. 4* with a bigger scale. An application of shading sample can be seen on *Fig. 5.*

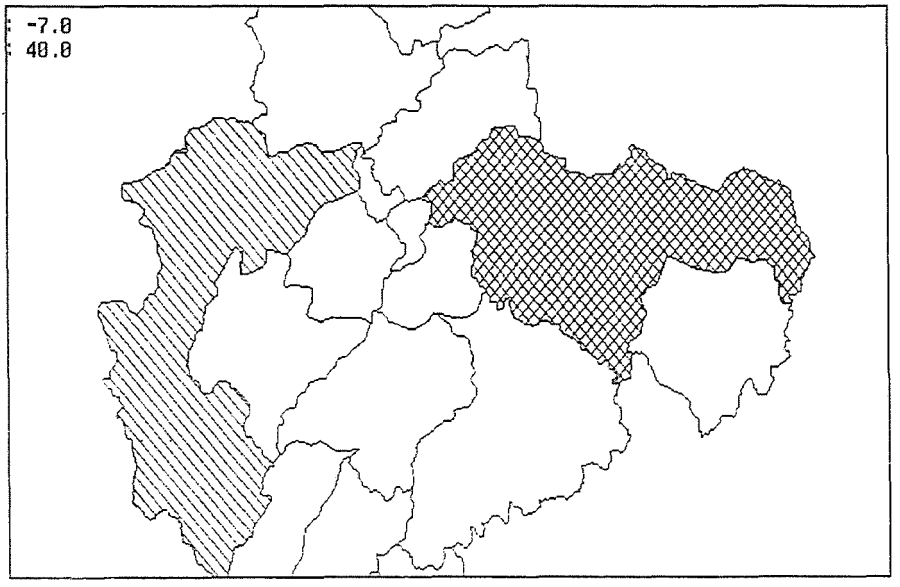

Fig. 5. Main and Mosel watersheds

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