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VISION Environment (VE) - The Integrating Information System for Border-crossing and Trans-departmental Cooperation

1 Introduction

In 1991, the ministry of environment of Lower Saxony commissioned Sema Group GmbH to draft a concept for an executive information system (EIS) which was to constitute the integrating shell for the compound system "Niedersächsisches Umweltinformationssystem" (environmental information system for Lower Saxony).

Three of the most important premises for this conceptual work were:

1. This system was not to keep any data of its own. The request was rather that the system was to start from data which were established, administered and authorized by department officials. This implied that this new system needed an access to be determined to a very heterogeneous variety of departmental systems.
2. All data would have to be displayed and evaluated in trans-departmental contexts.
3. The system was to be able to adjust to the constantly changing interests and new insights about the interdependencies of factors important to the environment. So, the resulting demand was: the system has to be able to deal at any time with completely new data - possibly even unknown at the time of the system's realization.

One question which arose during the drafting phase was particularly discussed: the "direct access to data from departmental systems versus (seemingly) redundant storage of data in the EIS. After intensive discussions it was agreed to implement data storage within the system which would periodically import all relevant (aggregated) data from the departmental systems. This implied that an autonomous system and not only an access shell for the department systems', was to be implemented.

Based on this decision the conceptual work was continued and a first prototype was established. At that time the name of VE as in use today was created.

In 1993 the ministry of environment of Saxony-Anhalt decided to have Sema Group to develop from the above mentioned basis the nucleus for a state-wide environmental information system in Saxony-Anhalt. Following this the *Länder* (states) of Lower Saxony and Saxony-Anhalt formed cooperation. And from 1994 the Land of Hesse has been participating in the project, too.

The further development of VE has since continued in coordination and agreement within the framework of this cooperation, financed jointly by the participating *Länder*.

2 Objectives

VE is an information system for the sector of environmental protection designed for the higher levels of administration. Data from departmental information systems which are relevant for these levels are

imported and kept in an independent relational data base, making them accessible for various queries and evaluations. Exemplary applications are:

- support of environmental decisions in politics by appropriate propositions,
- support of the departments at evaluations and at ad-hoc inquires,
- support of general reports,
- detection of increased problem frequency via interdisciplinary evaluation of data,
- detection of regional problem foci,
- supervising of recognized problematic developments,
- monitoring of passed legislation or measures taken,
- crisis management support.

The queries are supported by textual and graphical dialogue elements. The results of evaluations can be displayed in various alpha-numerical as well as graphical ways and can also be transferred to other applications (such as the office communication system "ALIS").

3 Geographical Reference and Visualization

It is imperative for an environmental information system that specific data and processes are shown in their geographical context. Accordingly VE has a geographical interface which can be used for interactive dialogue with the data base.

The system allows views in two directions: one starts from the objects (e.g. biotopes) and analyses their data whether related to geographical location or not; the second - only possible with an interactive graphical user interface - starts from an arbitrarily chosen regional detail and enquires about objects and processes connected to it. The example on this page shows the second direction - the selections of objects via geographical reference. The co-ordinates (Gauß-Krüger) displayed in the upper part of the dialogue window show which region (rectangle) objects have been selected from. These objects are listed below. The question: "which air monitoring stations are located in the xyz region?" was answered by the system by showing a list of all stations. The enquirer can now continue to ask, e.g. "Show all mean values for May of the station of Burg".

Fig. 1 Object selection in the interactive graphical interface

This makes VE an instrument which allows finding answers to all kinds of different questions:

- Where can be found certain plants? Or, where can be found excessive values of a particular series of measurements?
- Is there a contiguous biotope network in a certain region or where can relevant gaps be made out? Or: how did the frequency of dangerous incidents with regard to old polluted sites develop over a number of years in a given area?
- What picture results from the all area covering, grid like representation of ozone model calculations?
- How many biotopes can be found within or inside a radius from 100 m of old polluted sites? or: How many settlement areas of a given type will be affected by the construction of a road considering a given minimum distance?
- In which districts does the number of pigs exceed a specific level? Which stretches of water can be found in theses districts? What readings do the water protection monitoring stations give for these stretches of water? Are there indications that the water quality is significantly impaired by liquid manure?

Judging formally at the visualization used, VE can be classified as a descriptive, analytical and multi-media tool.

4 "The Map"- an Interactive Geographical User Interface

VE disposes an interactive geographical interface which as a working term is called "*the map*". It is used for visualizing the evaluation results and offers the user an interactive access to the displayed objects.

The objects shown in the map comprise:

- area-, line-, and point-like objects,
- background maps (surveyors', aerial views, city plans, etc.) stored in raster or pixel format,
- located diagram representation,
- thematic maps using color or symbol signatures.

4.1 Interactive Objects

All geo-objects stored in the system as well as the diagrams generated by queries are available for graphical interaction. In other words: they are not only displayed but can also be clicked on bythe mouse and thus offer additional communication and manipulation possibilities, for example:

- getting further information on this object,
- inclusion of the object into other queries (selection, non-selection),
- modification of the object (diagrams only) with regard to position, size, proportion, orientation (graphical manipulation).

4.2 Background maps

Ideally all geo-information would exist in vector form. In reality however this is not yet possible. Vector data are only available for certain objects and often only for selected geographical areas. Here raster maps, usually offered by the state surveying office, present a necessary and useful addition.

VE is not bound to a specific map base. Depending on implementation different raster maps can be added or omitted. System standard is a general map, scale 1: 500,000 and a surveyors map, scale 1:100,000 or higher. Within these raster images however, interaction in the above mentioned sense is not possible.

4.3 Map Functionality

VE includes all the necessary functions for the working with maps as known from standard geographical information systems for the display editing and the navigation on the map.

The most important ones - not mentioned in other sections - will be presented hereafter

4.3.1 Navigation in the Map

On startup of VE the scaling factor of the map is preset in such a way that the area of interest, such as a Land, will be displayed entirely in the map window. Often however, only a section of it is of particular interest. For this the system offers a **zoom function**. With the help of a "rubber band" the user determines a rectangle which will be zoomed to fill the whole window. The picture scale can also be reduced or enlarged by a factor 2 or 4.

All vector objects are presented to scale. Point objects do not alter their sizes, but their geo-positioning is certainly maintained according to scale. If necessary, an automatic conversion takes care for

switching from area to point presentation if an object does in fact have an area definition but would otherwise become invisible in a presentation accurate to scale, due to its size.

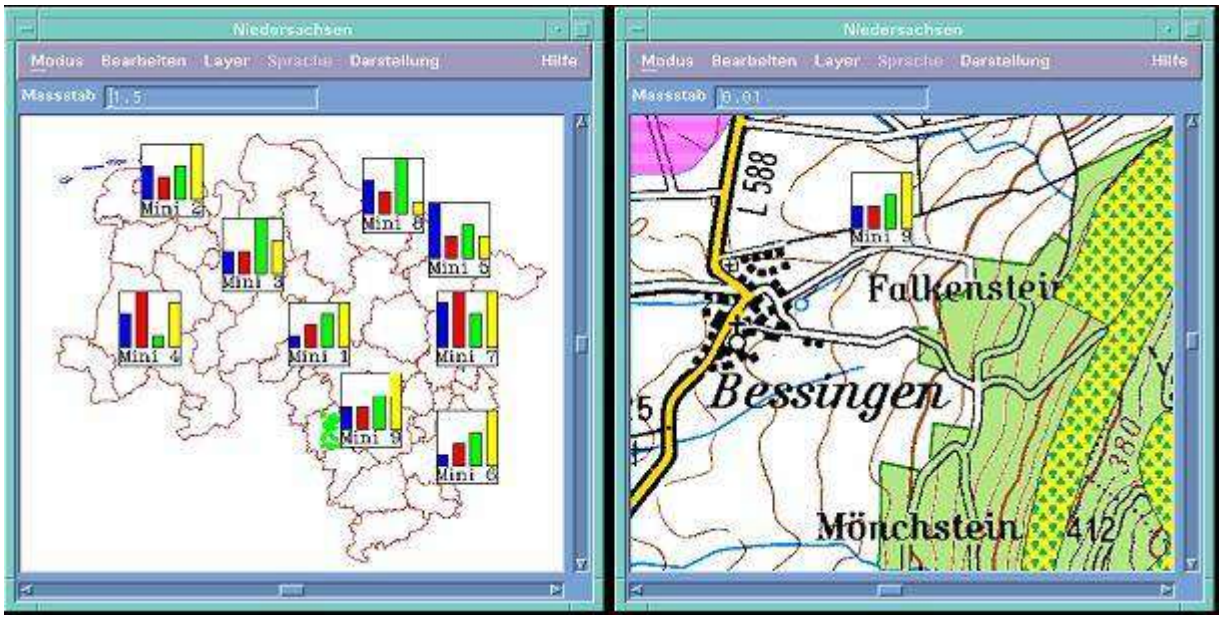

Fig. 2 Polluted sites on background map, regional survey, and regional detail

As long as a topographic background map is displayed it will automatically change according to the new scale. This "new" map can be the same as before only displayed in an other resolution (e.g. general map 1:500,000 in varying resolution) or just a different one, if this one is more suitable for the new scale (e.g. switch from general map 1:500,000 to topographical map 1:100,000).

To move from one detail sector to another without change of scale, a "scrolling" function is offered. By moving the knobs of the scroll bars at the right side and at the bottom of the map window with the mouse, the whole (defined) geographical area can be viewed (cf. pictures above). The needed segments of the background map are automatically loaded.

4.3.2 Map Functions for Presentation Editing

All objects are initially displayed in the map in a signature (color, pattern, and border) which is defined individually for each object type in the object type catalogue. The various layers will be stacked, one above the other, in the order of their creation. In order to achieve optimal recognition respectively distinction between them, or to adapt the presentation to the customer's preferences, a number of visual editing options are offered.

The layer dialogue has the following features:

- a complete layer (all its objects) can be made invisible, in other words, it can temporarily be removed from presentation.
- it can also be set to non-selectable; i.e. the interactive feature can temporarily be suppressed.
- the stacking order of layers can be changed.
- a layer can be selected for transfer into main dialogue, e.g. in order to delete it.

All geo-objects and diagrams in a layer can be changed in their presentation.

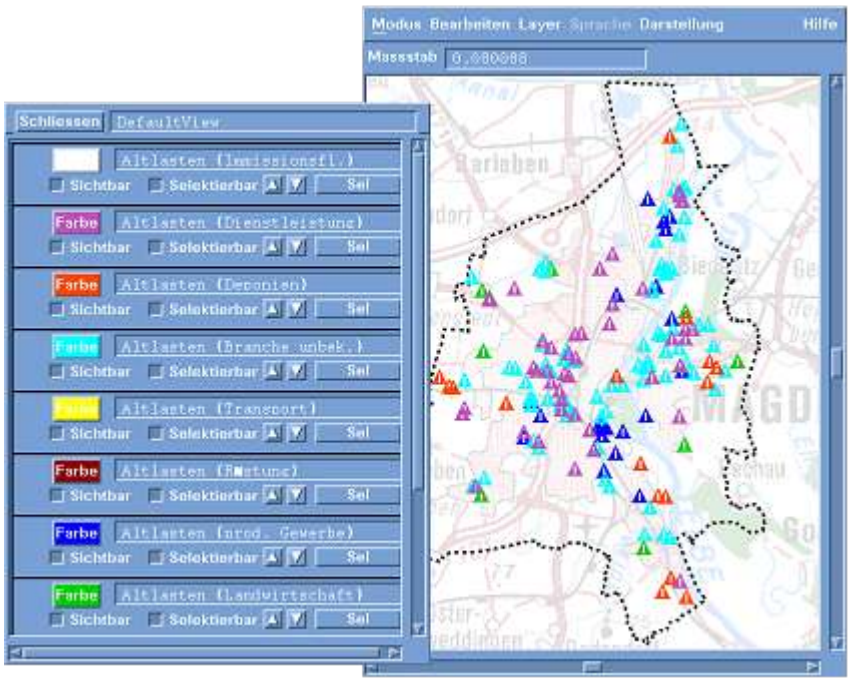

Fig. 3 Signature dialogue

This is achieved via the signature dialogue which is activated by clicking on the command bar in the layer dialogue. The following features can be changed independently:

- the color of the objects,
- color and line type of borders, as well as
- fill pattern for the flat objects (in the object's color).

Background maps can not be altered with the signature dialogue. They have their own dialogue which allows them

- to appear and disappear from the screen,
- to be displayed in color, grey shades or black and white, or
- to be altered in contrast.

4.4 Monitoring Series of Measurements

Working with VE frequently means handling measurement values. The most prominent characteristics of a measuring station are their positions and the series of measurements they establish. A series of measurements is defined by the factor (including unit) it is measuring, the interval in which the measurements are taken, and the statistical function according to which the results are aggregated (E.g. mean value). Finally, each value can unambiguously be identified via his measuring series, a station ID, and a time stamp.

Other statistical series, such as regional statistics, are formally handled by VE in the same way as data sets.

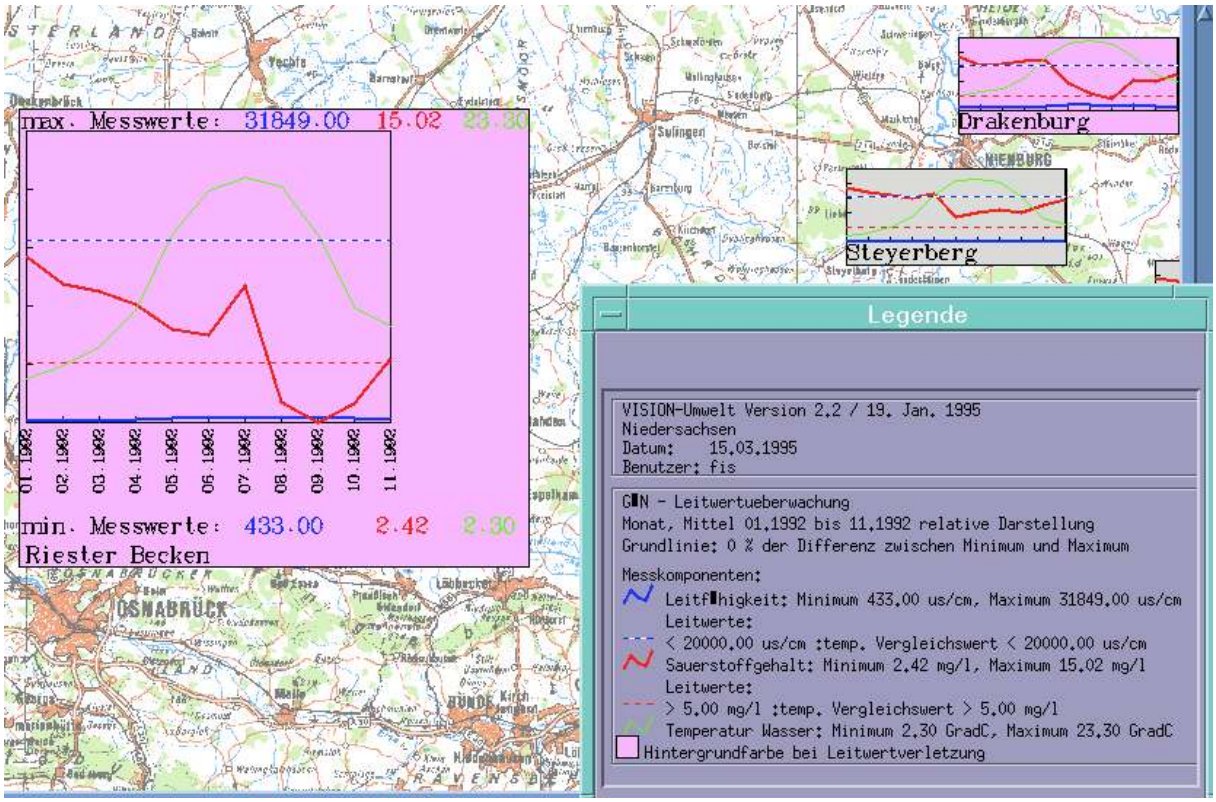

Fig. 4 Visualizing series of measurements

For the presentation of the results various means are used, such as color grading (cf. picture above of a district statistics) as well as bar and line charts.

Each of the diagrams can be presented in two forms:

1. small simplified mini-charts for more general qualitative statements (particularly exceeding or low, direction of trends),

2. larger "business charts" for more exact quantitative analysis of the results.

5 Data Integration

5.1 How Does the System Obtain its Data?

VE has no direct access to the underlying departmental systems but starts from the selected and aggregated data released by the specialists and entered into the system via an import interface. This import can take place on demand or - as is specific of measuring values - periodically. For obvious reasons these cycles are determined by the intervals the values are gathered: hourly taken values are transferred hourly, aggregated daily values once in 24 hours etc.. The import of less dynamic data is activated and supervised by the system administrator of VE.

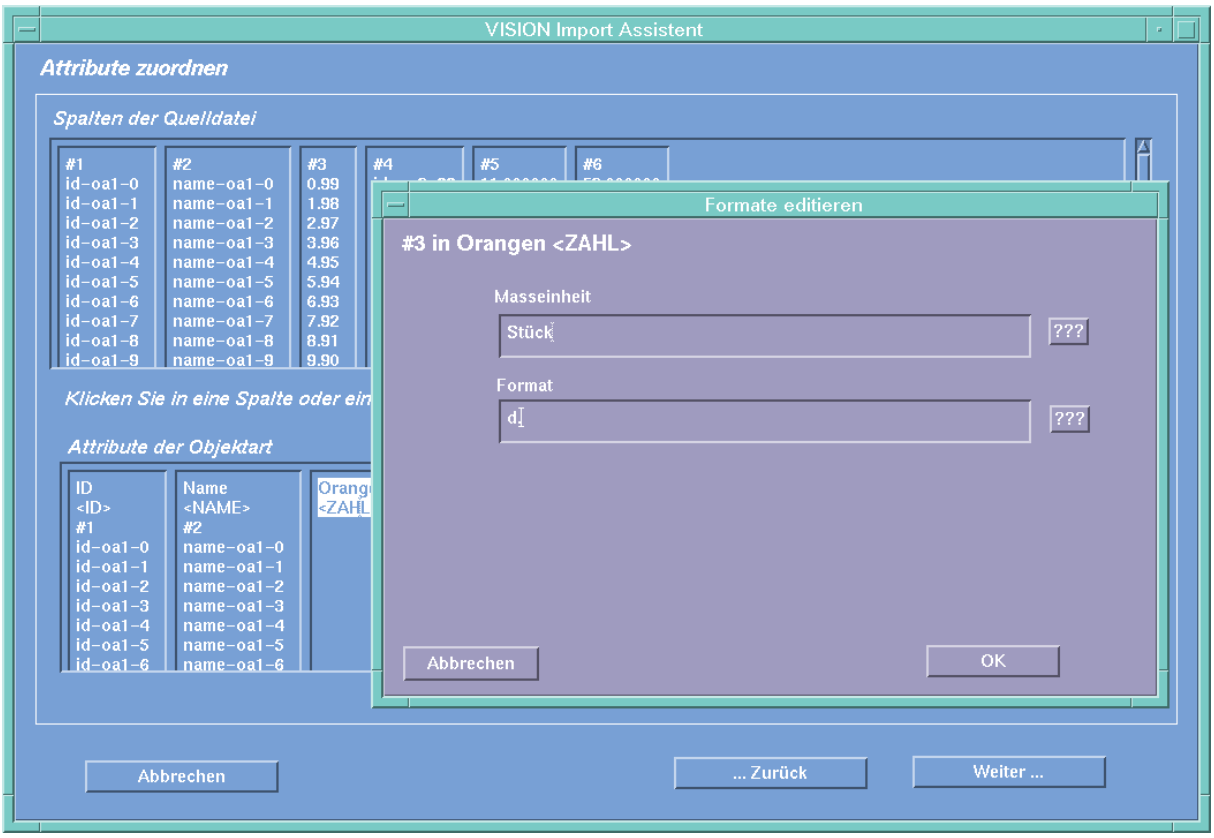

Fig. 5 Data Mapping with the Import Assistant

An on-line interface has been implemented for the periodical data import for the monitoring networks. Sema Group has developed an EDIFACT standard conforming to data format for the transfer of data from any data sets.

VE is an integrating information system. It therefore does not interfere with the professional authority of the connected special departments. It relies on all data being checked and approved by the transmitting department. This concept is necessary for professional reasons and the only way to a co-operation transgressing vertical and horizontal administration barriers.

5.2 Automated Import and Alarm Server

Linked to the above mentioned function "auto-import" is another feature: the so-called "alarm server". The system then reacts to pre-defined events, like the exceeding of a certain reference value or threshold in the measured values. Possible system reactions are:

- sending a message via electronic mail to a user who is not logged on,
- automated actualization of a data set display,
- color change or blinking of objects/data sets in question exceeding a threshold, on the screen of the person responsible,

This way VE can for example also be used as a support for crisis management in a control or crisis centre.

5.3 How Long are Data to be Kept in the System?

It is obvious that new data cannot be imported into the system indefinitely. So, from time to time the system has to part with old data. This is done in previously agreed intervals and is dealt with on the system administration level. This, too, of course depends on the nature of the data: values which arise in short intervals are replaced quicker due to their sheer number than long-ranging values. In case of on-line automated import the deletion of old data is done automatically too.

6 Working with VE

6.1 The VE Dialogue Interface

To arrange for direct access to the numerous specialized data bases from which the information for VE originate, many different query languages would be needed. Inside the executive information system these data are integrated and accessible via a uniform SQL interface. But this language too demands good knowledge in data base technology which can not expected from the average user.

Thus in VE a consistent graphical user interface has been implemented on top of the SQL interface to provide a comfortable access to the information with the help of an standardized dialogue structure. This concept is fundamental to a wider employment of VE. The dialogue surface was implemented according to the OSF/Motif Style Guide.

Every working session in VE consists of a sequence of more or less complex dialogues. One aim while drafting the user interface was to use consistent dialogue features. The user can expect similar working structures in similar situations - essential for intuitive working.

6.2 The Concept of Layers

The notion of a layer in this context describes a thematic layer of a complex map. It is used in this sense in VE and enlarges its meaning a little. VE takes it to signify a whole query sequence including the visualization of its results.

It thereby comprises a thematic layer in the map, plus its complete semantics as defined by the user's query and also its assigned signature.

From a purely formal point of view, a session in VE consists only in producing a finite number of layers. These can be created, loaded from former sessions, deleted, reactivated, and modified.

Layer can be linked to each other in geographical or thematic view, depending primarily on the user's decision. VE supports such groupings by allowing several layers of one session to be filed (and called up again) together.

This filing feature allows storing fully formulated evaluation requests as layer groups. Complex queries for frequently asked questions can thus be defined once, and called up again in a single dialogue step.

In addition to the evaluation requests, the result from a previous evaluation session can be included in the filing operation. That way data can be "frozen" or filed.

6.3 Application Control

The system's inner logic always leads from object to action and not vice versa. The basic idea was that the user would rather be interested in a certain subject (e.g. water quality, or a specific harmful substance - e.g. nitrate) and would then think about procedural aspects. More specifically: the user wants information about the water monitoring network; diagram colors are chosen last; he or she would rarely say "let's follow the yellow line" and then select the water monitoring network.

Working with the VE system is usually done in four steps:

6.3.1 First Step: Selection of an Object Type

In a first step the intended subject is decided on. The standard procedure for this is the user choosing an object type from a list.

Another possible procedure would be to pick an object type from the map. That way not only an object type is chosen but at the same time a set of objects as well. An example will show how: The user marks a rectangle in the map; since this is a water monitoring layer he or she declares to want all information in this sector about water monitoring stations.

(See also: Fig. 1.)

6.3.2 Second Step: Selection by Attributes

In a second step it is determined which specific objects the user wants to see from the selected object type. The selection of an object type implies the selection of all objects of this kind filed in the system. Normally only the user's interest concentrates on a subset of these objects only. In order to narrow down this set, selection criteria can be named for all attributes of the particular object type. These criteria will be presented in a list under their names and can be selected in any order and combination.

When several attributes are included in one selection process, a logical "and" operation is implied on the query command level; in other words, the selected objects have to fulfill all of the criteria specified.

Each individual condition can in turn be constructed from several sub-conditions using "and" as well as "or" conditions.

6.3.3 Third Step: Determination of Attributes to be Displayed

In a third step it is determined which attributes of the chosen object set are to be displayed. They can be the same ones named as criteria in the step before, or completely new ones.

For this the system offers the same list of attributes for the object type again, but this time from the aspect which attributes should be chosen for display.

For example the criteria may be: "Find all biotopes with a mean altitude of more than 300 m above sea level". "Net surface" and "cataloguing units" could be requested as possible attributes to display.

At the same time, different presentation modes are offered for the expected results.

6.3.4 Fourth Step: Choice of Presentation Mode

The presentation options which can be chosen at any given time depend on the decisions taken so far. Basically the following presentation options are available:

- Alphanumerical ("ASCII")
  The selected features are displayed in a separate window in simple tabular form.
- ALIS
  "Alis" is a variant of ASCII where the results are stored in a file formatted in such a way that it can be imported into the office information package "Alis".
- Objects, geographically ("Geo")
  "Geo" creates a simple geographic display of objects in the map.
- Diagrams in map ("DIA")
  "DIA" works logically for all scalable attributes (such as number, time, and data set). It is however best suited for data sets. "DIA" is a geo-coded presentation which can display simultaneously the time series of several quantities of influence at different places.
- Classification ("KLASS")
  This is a geo-coded presentation where the categories of the objects are displayed by specific signatures. "KLASS" is offered for features that can be classified, such as various numerical attributes ("number") and certain limited views on the attribute type "series of measurements".

Exemplary pictures for the geographical presentation modes have already be presented in previous chapters.

7 Technical Platform

VE runs under UNIX with OSF/Motif 1.2 and a relational data base (ANSI-SQL). Currently it supports:

Operating systems:

HP-UX 9.xx, DEC-Ultrix 4.3, SUN Solaris 2.3

Data base systems:

Oracle 7.xx, Informix online 5.0

Single user installations on RISC workstations (f. ex. HP9000-715) require 32 MB of main memory, approx. 1 GB of disk space and a 19" color graphics display.

Further ports within the Unix universe are possible at short notice.

VE includes components from **DIADEM**, a standard product of Sema Group for the display of thematic maps as well as their interactive editing.

Using VE on PCs is at present only possible in a client-server configuration under the precondition that an X-server emulation is available on the PCs in question (condition: at least one Unix server in the network). Sema Group is currently examining whether a MS-Windows compatible version of VE is feasible in 1995.