

# UQUADO - ENVIRONMENTAL CHART OF DORTMUND

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## **ABSTRACT:**

This paper describes the development of a tool to make quality estimations for the environment of regions or a whole town area. UQUADO is a tool to standardise an interpretation to an equal cartographic output. It is completely developed in AML (Arc Macro Language) with Arc/Info (ESRI). The aim of UQUADO is to combine different special field data to give the possibility to make declarations about the quality of areas for planning purposes.

## **RÉSUMÉ:**

Cet article décrit le développement d'un instrument pour faire des estimations de qualité de la nature d'une région ou une ville. UQUADO est un outil pour standardiser une interprétation à une unité cartographique unique. Le programme est complètement développé à AML (Arc Macro Language) avec Arc/Info (ESRI). Le but de UQUADO est de combiner différentes informations spatiales pour donner la possibilité de faire des déclarations de la qualité des régions pour des planifications.

## **KURZFASSUNG:**

Dieser Beitrag beschreibt die Entwicklung eines Werkzeuges für Umweltbewertungen einer Region oder einer ganzen Stadt. UQUADO ist ein Werkzeug, um die Interpretation in einer einheitlichen kartographischen Ausgabe darzustellen. Es ist vollständig in AML (Arc Macro Language) unter Arc/Info (ESRI) entwickelt worden. Das Ziel von UQUADO ist, verschiedene Raumdaten zu kombinieren und die Möglichkeit zu geben, Aussagen über die Umweltqualität von Flächen für planerische Zwecke zu machen.

## **1 INTRODUCTION**

For planning purposes detailed knowledge of the environment is necessary. In the past precaution of environmental resources played only a secondary part. Nowadays a more sensibility against environmental questions has grown up several systems in this sector.

Since nearly ten years the town of Dortmund deals with environmental questions. Besides the introduction of the environmental information system Dortmund (UDO) different reports have been elaborated, which is for example the handbook for environmental estimation.

One aim of the administration of Dortmund is to set up an environmental plan of precaution for the whole town area. The base forms the map of environmental quality which can directly be derived from the handbook for environmental estimations.

A long term aim is to cover the whole town area. To do this in an operational form it is only possible with computer support. Therefore the methodical concept is transformed to a Geographic Information System (GIS) and a user friendly graphical interface (GUI) was developed.

## **2 METHODOLOGICAL CONCEPT**

The map of environmental quality chart is based on the 'Handbook for environmental estimations' [Schemel/Langer/Baumann, 1990], a concept and aid for environmental planning and the examination of the ecological harmless. In this concept the description level is distinguished from the estimation level. With this method it is now possible to

- order and simplify the features for description and rating, that a classification is practical and accurate,
- to put the criterion for the description and rating in a concrete spatial form,
- to fence off units of volume as reference base,
- to form the process of the estimation of the environmental situation and quality transparent and comprehensive for the user.

The main basis for the development of the 'Map of environmental quality of Dortmund' are the following methodical concepts:

- list of units of volume
- catalogue of environmental criterion
- forms

## 2.1 Units of volume

The units of volume are the spatial base for capture and estimation of the environmental situation. They exist for the whole town area in digital form and are environmental assessed. They have a homogeneous structure which means that important features of use mark the type of different units of volume (e.g. agricultural fields, forest, park).

Units of volume	Remarks	KVR
Buildings		
W1	single house	010, 150, 271, 291
W2	apartment blocks	020, 150, 271, 291
Industry		
I	industries	060, 150
Transportation		
V1	main street	110, 140
V2	parking	170

Table 1: Part of the list of units of volume

The units of volume are derived from the land use map of „Kommunalverbandes Ruhrgebiet“ (KVR). From 47 categories of use of the KVR with 138 sub categories a list with 34 units of volume has been developed (Table 1).

## 2.2 Catalogue of criterion

The second important feature is the catalogue of criterion. Each unit of volume has to be examined with regard to this catalogue.

The criterion are assigned to the following 8 components:

- soil
- water
- air
- noise
- climate
- animals and plants
- recreation
- cultural possessions

The base of information for each criterion is listed in the following table. For some criterion more than one base is possible.

Criterion	Main parameter	Supplementary parameter	Base of information
Soils			
Soils feature (Bodeneigenschaften)	condition of soils		soils map 1:25000
Soils contamination (Bodenkontamination)	concentration of inorganic and organic substances	dangerous waste from the past	map of dangerous waste from the past 1:20000

Table 2: Part of the catalogue of criterion

For each of this up to now 19 criterion main and supplementary parameters are defined, which operate as rules to qualify/quantify the criterion.

## 2.3 Forms

The criterion and rules are defined in forms which are the background for the transformation to the GIS. Besides the list of units of volume and the catalogue of criterion these forms define the main items for the creation of the map of environmental quality of Dortmund.

The forms are subdivided into two levels:

- description
- rating

The example shows the description and rating forms for the criterion 'Formation of new ground water'. In the description level the measurements are divided into nine classes.

Form II A	Description
Component	II Water
Criterion	A. Formation of new ground water
Main parameter	new ground water/year
Supplementary parameter	
New ground water	Class
0 - 50 mm/year	9
51 - 100 mm/year	8
101 - 150 mm/year	7
151 - 200 mm/year	6
201 - 250 mm/year	5
251 - 300 mm/year	4
301 - 350 mm/year	3
351 - 400 mm/year	2
401 - 450 mm/year	1

Table 3: Form; description level

In this example in the rating level the nine classes are now building five different grades.

Form II A	Rating
Component	II Water
Criterion	A Formation of new ground water
Main parameter	New ground water/year
Supplementary parameter	
New ground water	Grade
Class 8 + 9	V
Class 6 + 7	IV
Class 4 + 5	III
Class 2 + 3	II
Class 1	I

Table 4: Form; rating level

These forms exist for each of the 19 criterion. To describe the environmental situation for each criterion a description and rating will be carried out with these rules.

### 3 TECHNICAL TRANSFORMATION INTO A GIS

#### 3.1 The program UQUADO

That under chapter 2 methodically developed concept for the environmental estimation should be implemented on a workstation computer under the Geographic Information System Arc/Info. The program to be developed should offer thereby possibilities, to update and complete the valid program version any time in case of new knowledge from the technical part as well as possible changes of existing legal basic conditions. In addition it should consist of an user-friendly graphical interface and give also users without Arc/Info knowledge the possibility, to work with the program.

From these requirements the program UQUADO emerged, which has been programmed in the Macro Language AML (Arc Macro Language) under Arc/Info. The task of UQUADO is, to associate the units of volume to environmental qualities with the help of the algorithms from the forms and to visualise these so-called profiles of environmental quality, which can be given out subsequently on a printer or plotter.

Arc/Info is a vector GIS and has to be chosen because it has powerful tools in the area of environmental questions. It has good opportunities of overlays and it is independent of the hardware. Different data bases can be used to store the thematic information (e.g. INFORMIX, ORACLE). There are tools for TIN (Triangulated irregular network), for network analysis and for grid operations, to revise raster images, which can be used as background information.

Arc/Info has a powerful programming language (AML) so that it is possible to create automated processes, menus and forms masks.

#### 3.2 System requirements

UQUADO has been developed on a SUN Sparcstation 2 with 32 MB RAM under OpenWindows 3.0. Because of the large data a hard disk capacity not fewer than 1 Gigabyte is to be recommended. Because of the tremendous drop-off in prices the standards change herewith however constantly. Computers with larger RAM are likewise now already on the market.

Beside the usual hardware a digitizer of the size DIN A1 should be available for the data entry, furthermore a Laser printer (postscript) for the output of the profiles of environmental quality. A CD ROM drive belongs nowadays already to the standard of a computer. A Streamer, Exabyte or DAT-drive for the data backup should not be missing.

Since no system commands have been used, but all program parts consist only of AML-commands, an installation on other platforms is possible without further shift, which was already utilised in the practice, since the city of Dortmund uses IBM computers.

#### 3.3 Data preparation

The land use map of the „Kommunalverbandes Ruhrgebiet“ (KVR) serves as data base, from which the map of units of volume has been derived. All the other information (e.g. map of dangerous waste from the past, soils map etc.) have been stored first of all in separate layers (Fig. 5). The important thing is here, whether it concerns of points, lines or area information, since points and areas can not be managed under Arc/Info in common layers.

Subsequently the individual layers have been overlaid with the units of volume map. This has the advantage, that the information are directly available to the units of volume. In contrast it has the disadvantage, that at a change of the map of units of volume or of one layer the overlays have to be calculated again. Although for this operation AML-routines are available, the time element is not to be underestimated, meanwhile the system is not available to the user.

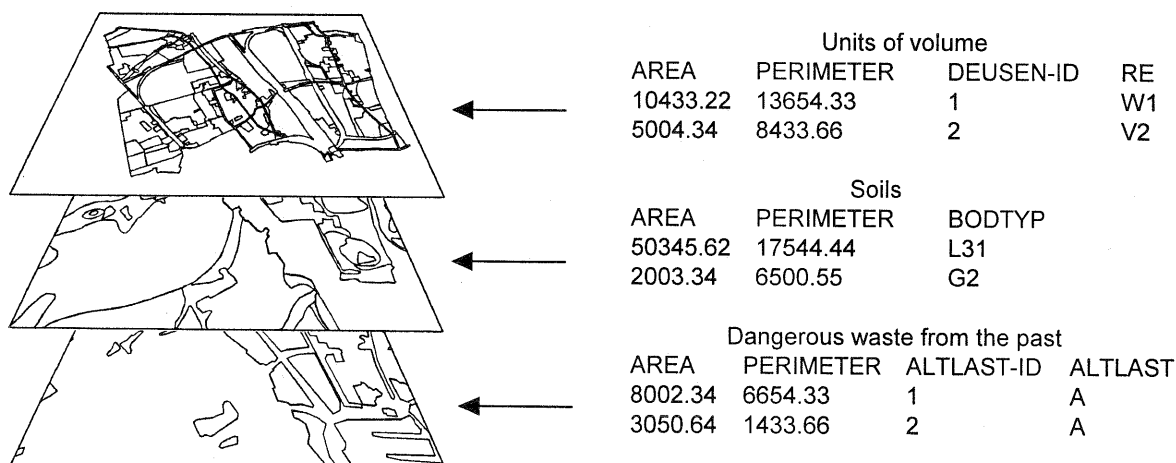


Figure 5: Layers in UQUADO

Through the overlays so-called „One to one“ or „One to many“ relationships between the map of units of volume and the results of the overlays are created. At the analysis in UQUADO an unit of volume is selected in the map of units of volume and corresponding information (e.g. the existence of a dangerous waste from the past) can be won through the relationship to the overlays (Figure 6). For this the cursor technique is used which is well known in data base operations.

Units of volume Coverage KOERNE (TG3)					
SRECNO	AREA	PERIMETER	KOERNE#	KOERNE-ID	RE
..					
7	9,895.750	431.865	7	21	W5
8	5,254.750	395.907	8	22	G
9	26,453.560	2,286.080	9	146	V1
10	289,874.100	5,496.519	10	147	W2
11	2,565.938	206.521	11	23	W5
..					

Overlay of TG3 with layer ALTLAST					
SRECNO	ID_TG3ALTLAST#	ID_TG3ALTLAST	ALTLAST	KOERNE-ID	
..					
80	80	79	A	0	
81	81	80	A	145	
82	82	81	A	147	
83	83	82	A	0	
..					

Overlay of TG3 with layer BODEN					
SRECNO	ID_TG3BODEN#	ID_TG3BODEN	BODTYP	KOERNE-ID	
..					
1560	1,560	1,559	L31	146	
1561	1,561	1,560	L31	147	
1562	1,562	1,561	L32	23	
..					
1575	1,575	1,574	L32	24	
1576	1,576	1,575	L32	147	
..					
1628	1,628	1,627	sL31	147	
1629	1,629	1,628	sL31	0	
..					

Figure 6: Relation between the map of units of volume and overlays

Beside the vector data the possibility exists likewise, to integrate raster data (aerial views) into the system. To display images they must first of all geocoded by using rectification or generating orthoimages [Schiewe/Siebe, 1994]. Then they can be presented as background information to the map of units of volume on the monitor. In addition the layers can be displayed as well as the original land use map .

### 3.4 Program organisation

To guarantee the clarity of the program and better adjustment at changes, a modular construction has been chosen. The program is composed of approx. 60 different modules and 16 menus. A flow chart makes it possible for the programmer to win a fast overview and to understand the co-operation of the individual modules.

The program UQUADO divides into two main parts (Figure 7):

- Data capture and editing
- Presentation and analysis

The main emphasis of UQUADO has been put on the area of analysis and presentation.

In the current version of UQUADO data for three test areas are implemented. After the selection of a test area a menu appears, over which analysis -, presentation - and output possibilities are offered.

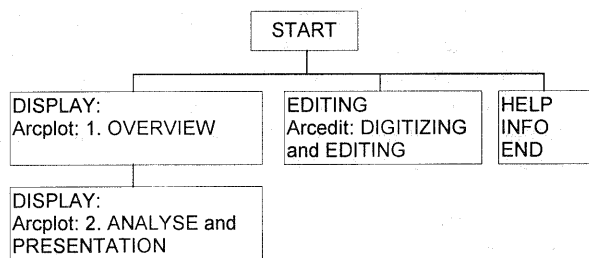


Figure 7: Program organisation of UQUADO

The most important function of UQUADO is the generation of profiles of the environmental quality

Optionen für die Profildarstellung

Bodenkontamination:

Grundwasserbeschaffenheit:

Grundwasserempfindlichkeit:

Gewässerstruktur:

Gewässergüte:

Gewässerchemie:

Luftschadstoffe:

Schallmissionen:

Strahlungstemperatur:

Figure 8: Options menu for the profile display



for the units of volume, their display at the monitor or the creation of a plot file, which can be given out onto a printer (Fig. 9). During the generation of the profiles the operator can select with an option menu which parameter of the criteria should be presented (Figure 8).

The average time from the selection of the unit of volume in the test areas up to the construction of the profiles on the monitor totals 45 sec. At a computer of the newer generation there can still be an essential time saving. A test was carried out also with the data, which exist for the entire urban area of Dortmund. The construction time for the profiles was not essentially higher. A prognosis over the term the display will take at the existence of all data for the entire urban area of Dortmund can not yet be given at this point indeed. With sufficient computer speed this might be however still in a justifiable time.

#### 4 EXAMPLE

The practical application serves as the fundamental demonstration of the translation of the methodical concept with the help of the computer aided prototype of UQUADO.

With the help of the methodical modules described in chapters 2 for each zone unit the environmental situation both on the subject level (describing classification) as well as on the value level (rating classification) can be presented. To fashion the statements to the environmental quality transparently and comprehensible and to present the environmental situation of the respective unit of volume in their entirety clearly, a so-called profile of environmental quality has been developed as display type.

The example (Figure 9) shows exemplary among others the main structure of the profile of environmental quality, i.e. the maximum shaping of the classes (10) and levels (VIII) for the describing classification and/or the rating classification. For the clear display of the environmental quality of the units of volume an uniform output in the DIN A4 format has been developed.

In the upper half a part of the respective area to be examined is copied. The units of volume, for which the profile should be calculated, are emphasised graphically. References of the chosen scale as well as the date of processing are displayed. The lower half shows the structure of the describing classification (left) and the rating classification (right).

In this example two areas of the same land use (Kleingarten/garden plot) have been selected and the differences are shown in the profiles and in additional text attributes. At the soils contamination for example the element (Cd) with the worst measurement values is displayed. At the noise pollution the T indicates that the day values were chosen from the options menu (Figure 8). At the criterion 'Bes. gesch. Natur und Landschaftsteile/special protected areas' on the description is it only marked that there is an area to

protect in unit one. On the right side this is stated more precisely (LSG/Landschaftsschutzgebiet/nature reserve).

#### 5 CONCLUSION

A program for the estimation of the environmental situation has been developed under a Geographic Information System. The program UQUADO allows a user without having detailed knowledge of a GIS software to produce so called profiles of the environmental quality in a very short time. These profiles can be used for planning purposes and help making decisions.

The map of the environment serves to objectivize preparations of decisions by clarifying

- under which point of view a certain unit of volume is defined
- which information are the base
- how the described situation will be rated from the point of view of the environment
- which rules are used for estimation.

For the future the main effort has to be to set up the data for the whole town area. Only if this is to be done UQUADO is a powerful tool for decisions, analysing and information.

Nevertheless UQUADO is a passive tool to help making decisions. To become an active instrument objectoriented technologies and artificial intelligence has to be implemented.

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