

Wroclaw University of Technology  
Institute of Mining Engineering

A methodology for developing  
decision support system  
for management  
of municipal waste and mining voids

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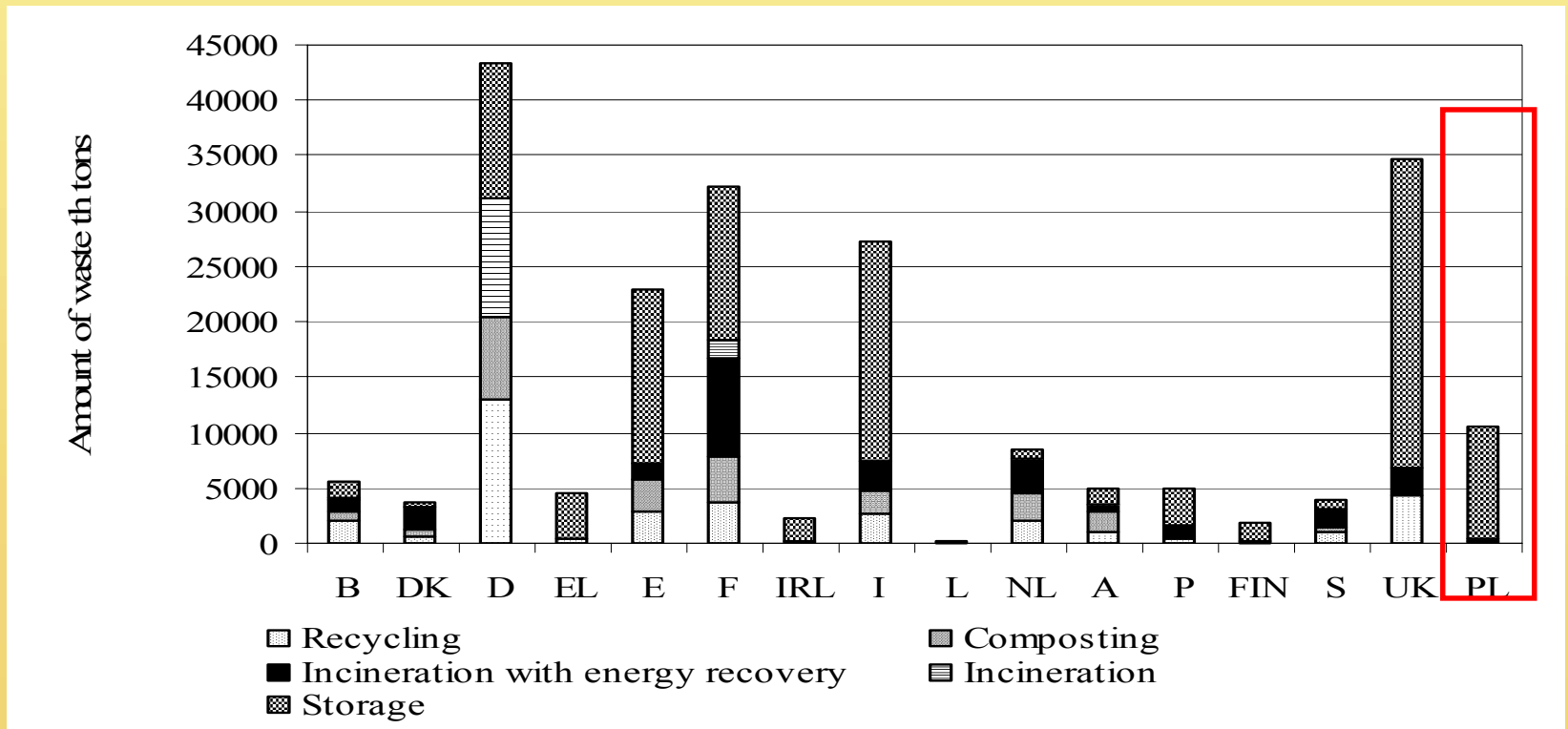
# Introduction - motivation, problem definitions

**Waste levels are increased** due to growth of population as well as the level of production and consumption in the particular countries

**Theoretical requirements for:**

- new technologies that minimise or even eliminate the production of waste
- programmes promoting recovery of waste materials

**Common practice: waste management by storage**



The waste management in selected European countries in 2002. Data from EUROSTAT (2003)

# Introduction - motivation, problem definitions

- **higher** demand for new locations of waste management sites is a **result** of the increase of waste levels

## Possible solution for this problem

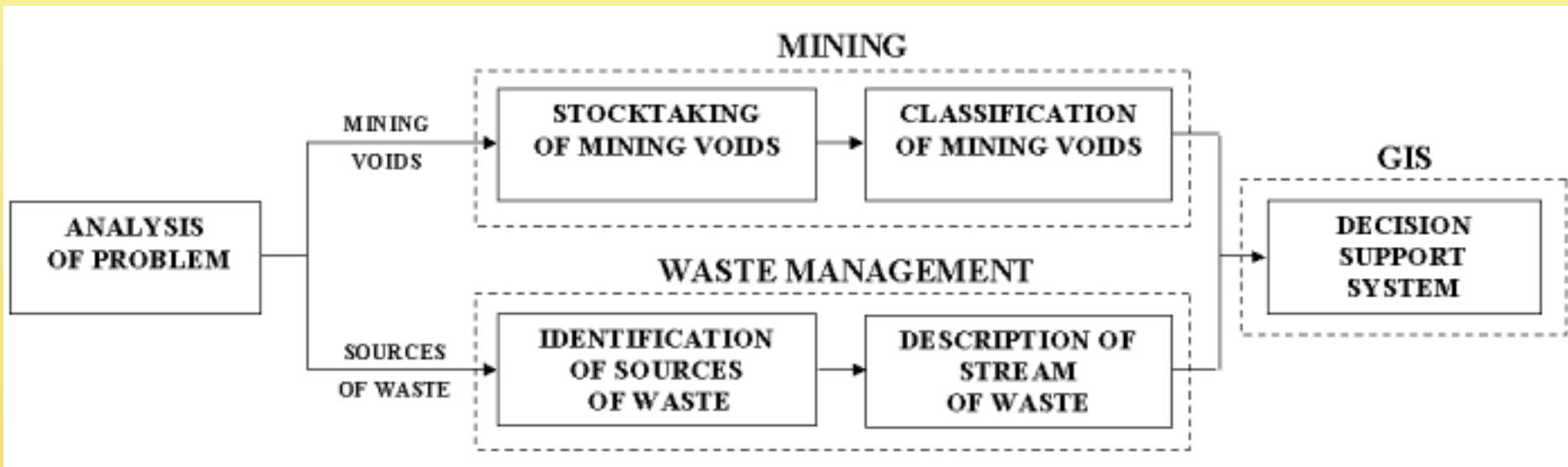
combine the goals of the mining industry and the municipal administration

use **mining voids** for **temporary** or **final storage** of industrial and **municipal waste**  
(or other objects like waste sorting plants, waste processing sites,  
neutralisation or composting plants)

### Main goal of research:

develop **methods and tools for optimising the decision making process** while selecting mining voids as a location for waste management facilities within the broadly understood environmental resource management

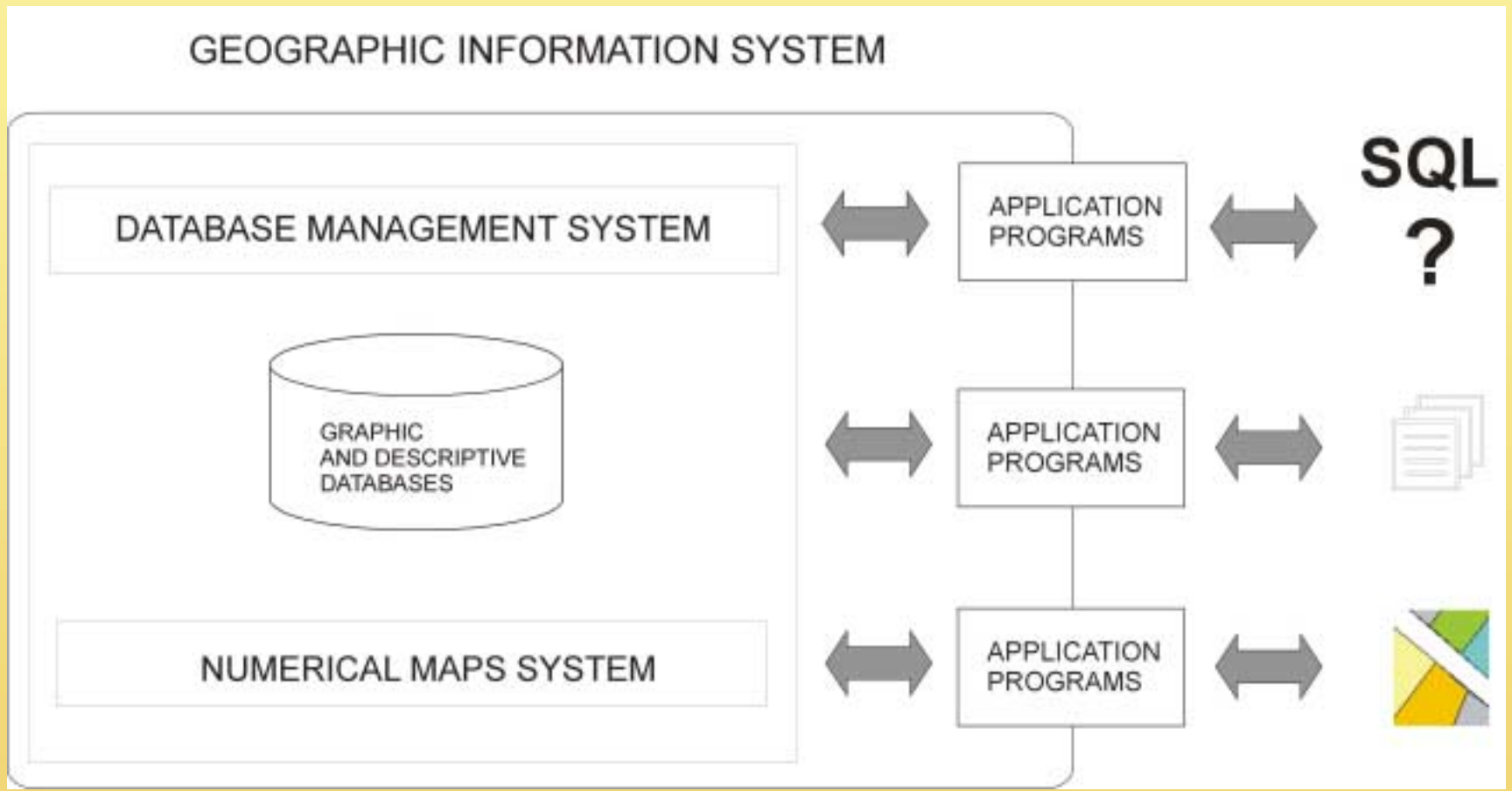
## Subject area of research and specifications



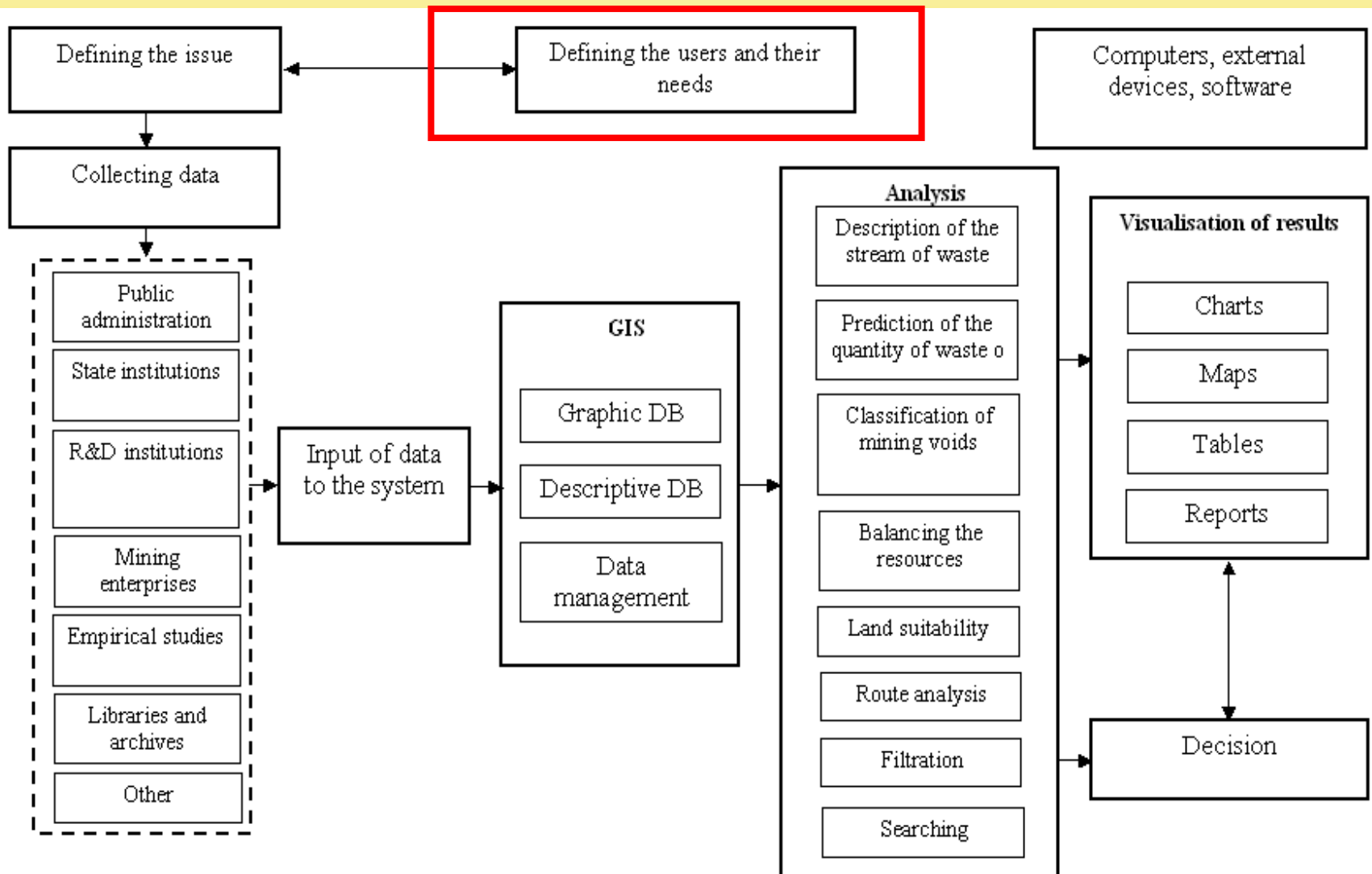
# Why Geographic Information System?

- to include expert's experience and knowledge from analyses efforts
- to collect, store, update, verify, integrate, manage, process, analyse, and visualize the spatially-related data
- for application in the fields where particularly complex issues are analysed to solve spatial and non-spatial data needs
- to organize data in graphic and descriptive databases
  - graphic database contains digital thematic maps, digital orthophotographs, digital terrain models or individual elements
  - individual elements in graphic database are connected with attributes stored in a descriptive database
- to provide the user with current, comprehensive, descriptive and spatial information that facilitate decision making with respect to system operation area
- to produce charts, maps, tables and information that can help to make optimal decisions
- to provide the best answer to user's questions

# Structure of Geographic Information Systems



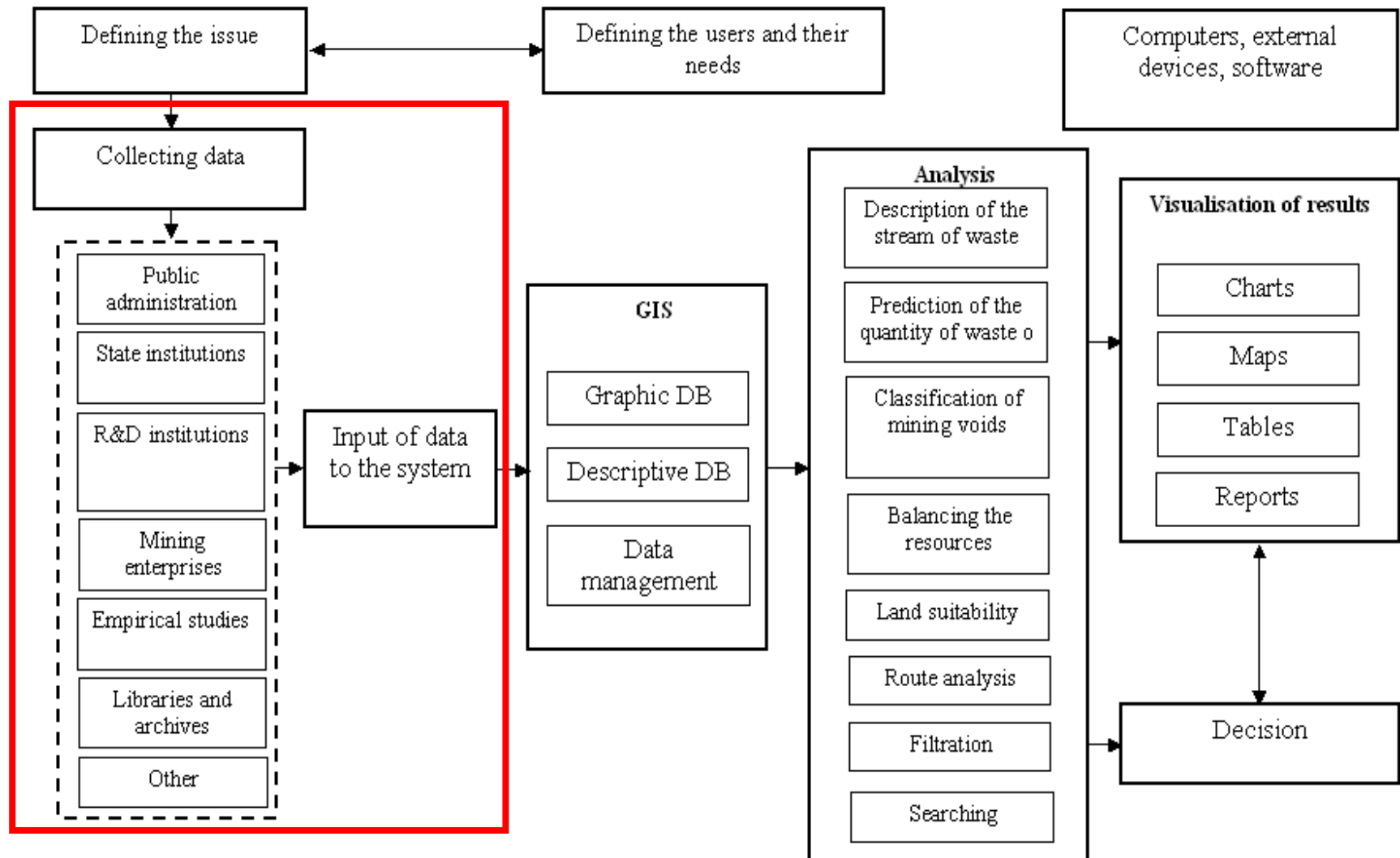
# General structure of the decision support system for decisions related to administration of mining voids in view of municipal waste management



# Defining the users and their needs

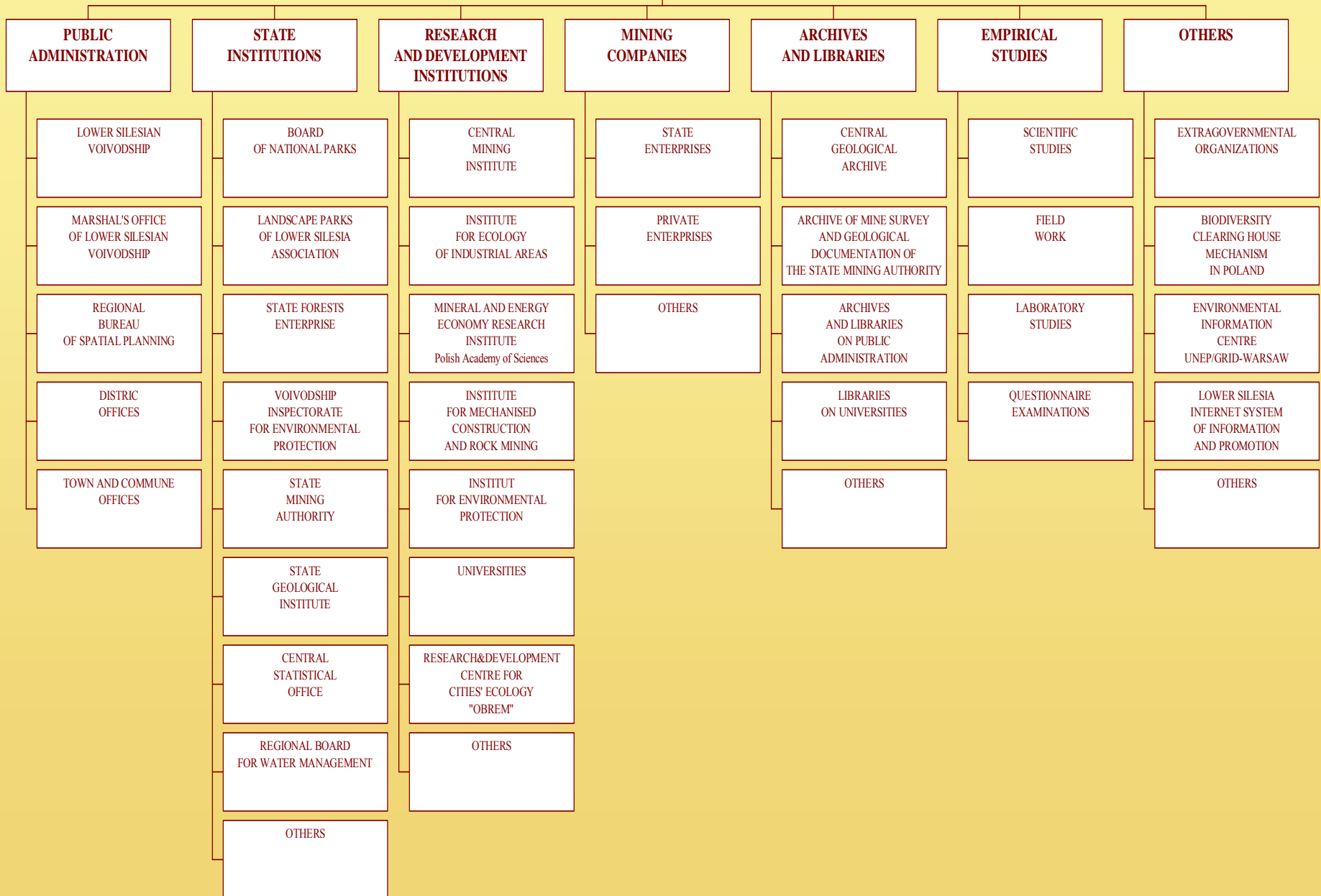
- public administrations responsible for planning and applying waste management in region, province and commune
- public administrations and institutions responsible for space management in region, province and commune
- mining companies responsible for management of mining voids

# General structure of the decision support system for decisions related to administration of mining voids in view of municipal waste management

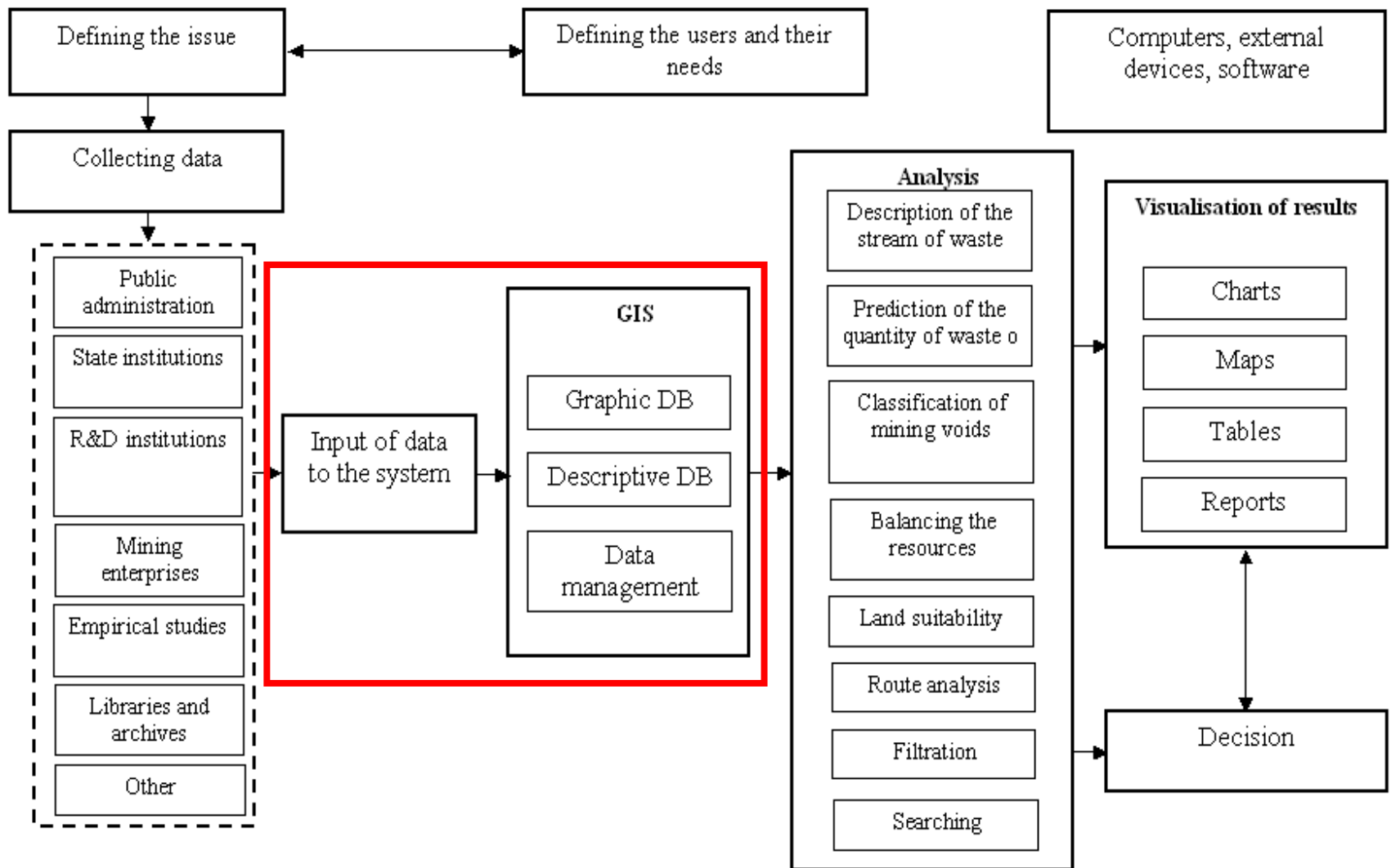


# Sources of data in system

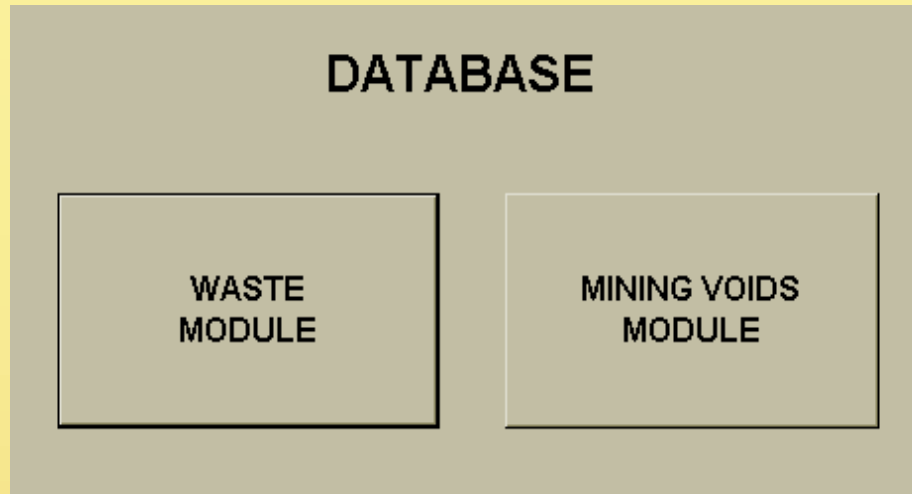
## SOURCES OF DATA



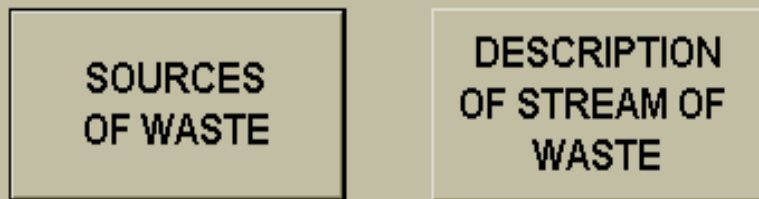
# General structure of the decision support system for decisions related to administration of mining voids in view of municipal waste management



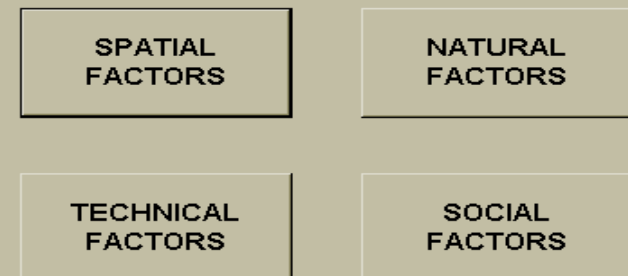
# General structure of the descriptive database developed for the project



## WASTE MODULE



## MINING VOIDS MODULE



# WASTE MODULE

## The spatial description of waste stream used in the decision support system

$$q = f(\delta, r, m, v, \rho, f)$$

where

$\delta$  – density of population [M]

$r$  – type of generated waste, e.g. municipal waste

$m$  – mass index of waste accumulation [kg/M/year]

$v$  – volumetric index of waste accumulation [m<sup>3</sup>/M/year]

$\rho$  – bulk density of waste [kg/m<sup>3</sup>]

$f$  – structure of waste:

$$f(s) = f_w(s) + f_m(s)$$

where

$f_w(s)$  – share of rural waste in the total waste

$f_m(s)$  – share of urban waste in the total waste

# MINING VOIDS MODULE

The description of condition of the mining void used in the decision support system

$$qv = f(v, p, t, s)$$

$$qv = f(x_1, x_2, \dots, x_{98})$$

$$q_v = \sum_{i=1}^{98} w_i \cdot x_i$$

where

$qv$  – mining void quality

$v$  – spatial factors

$p$  – natural factors

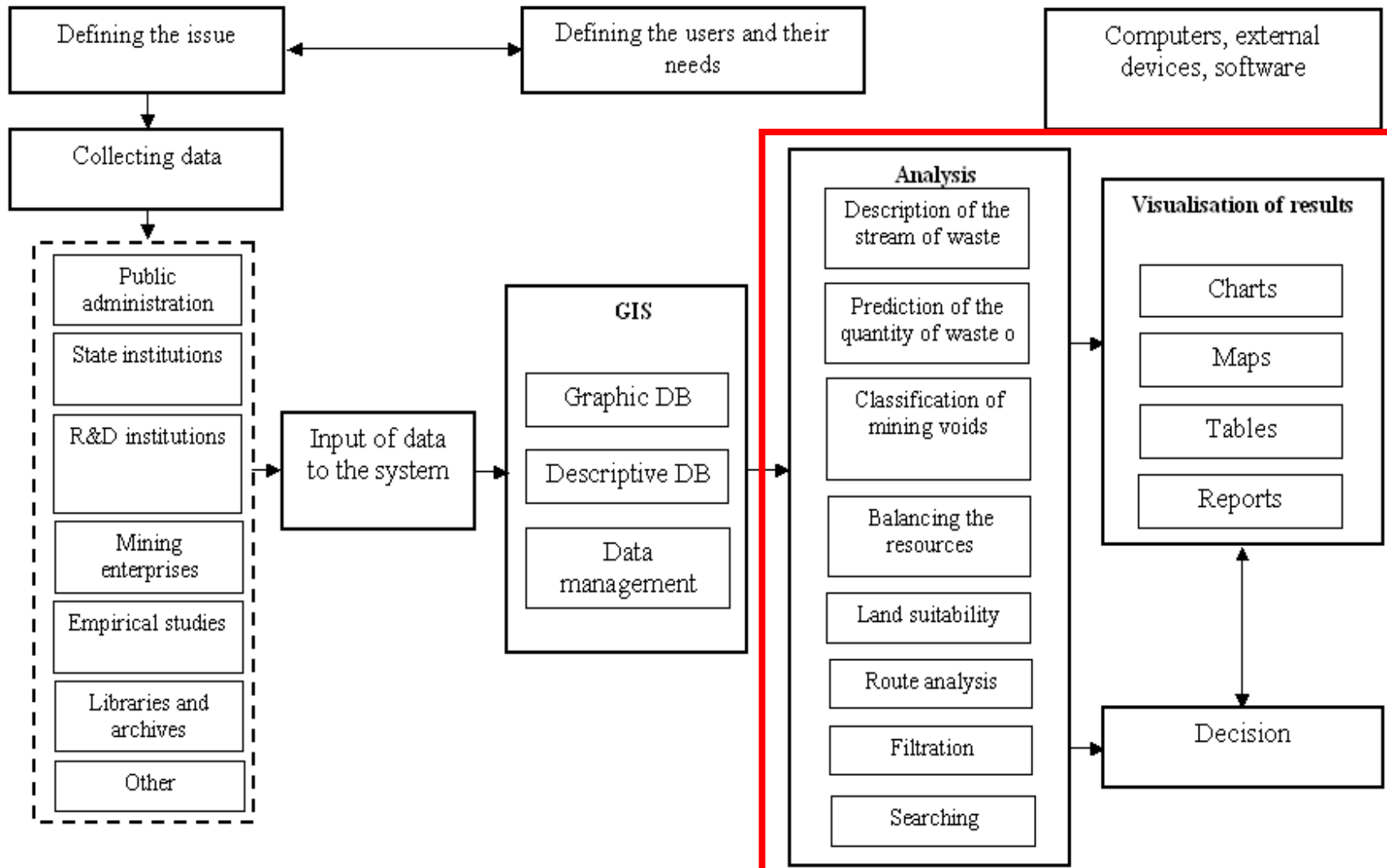
$t$  – technical factors

$s$  – social factors

$w_i$  – weight describing the value of the  $i^{\text{th}}$   $x$  factor

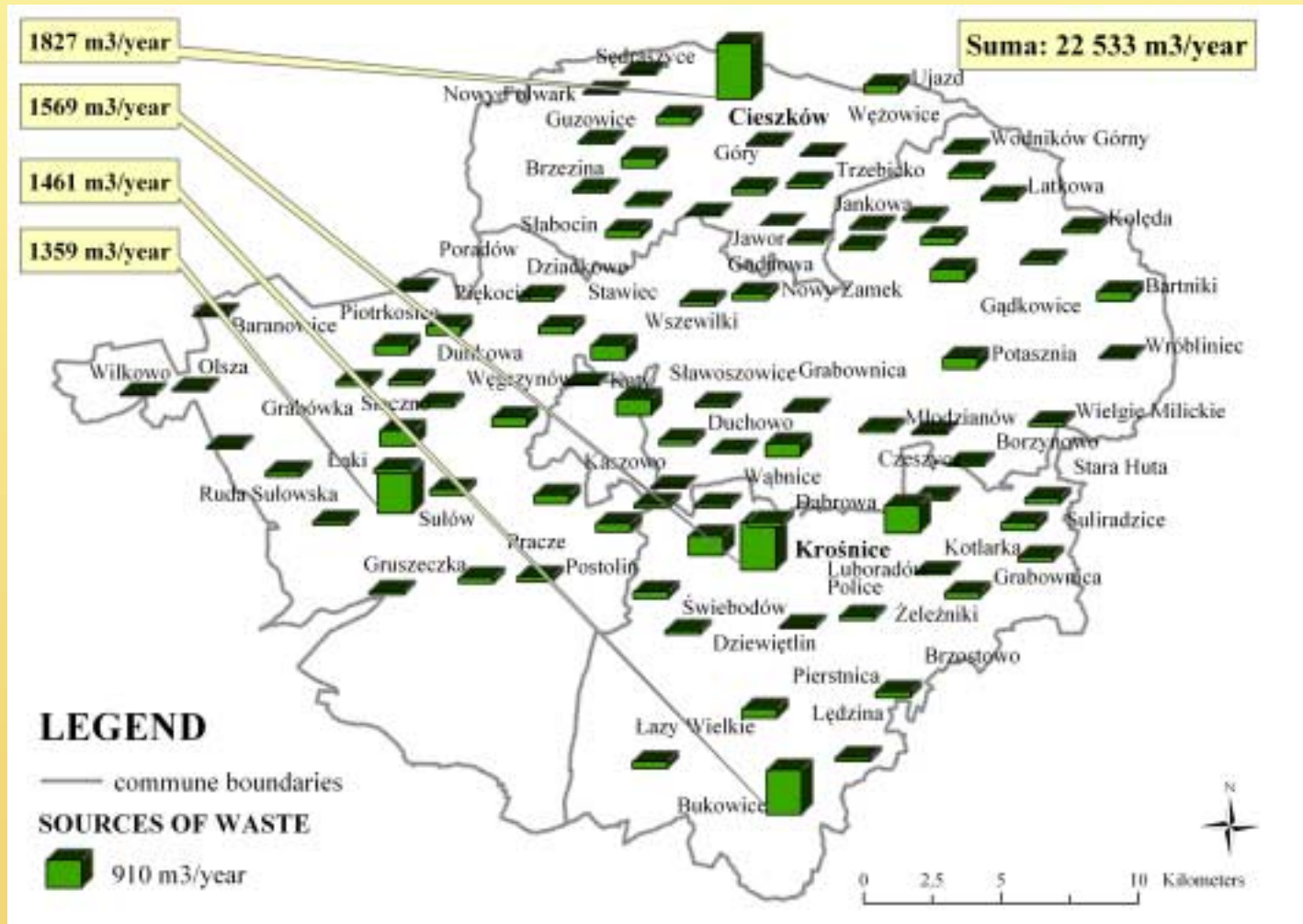
$x_i$  –  $i^{\text{th}}$  factor describing the condition of the mining void

# General structure of the decision support system for decisions related to administration of mining voids in view of municipal waste management



# ANALYSIS MODULE

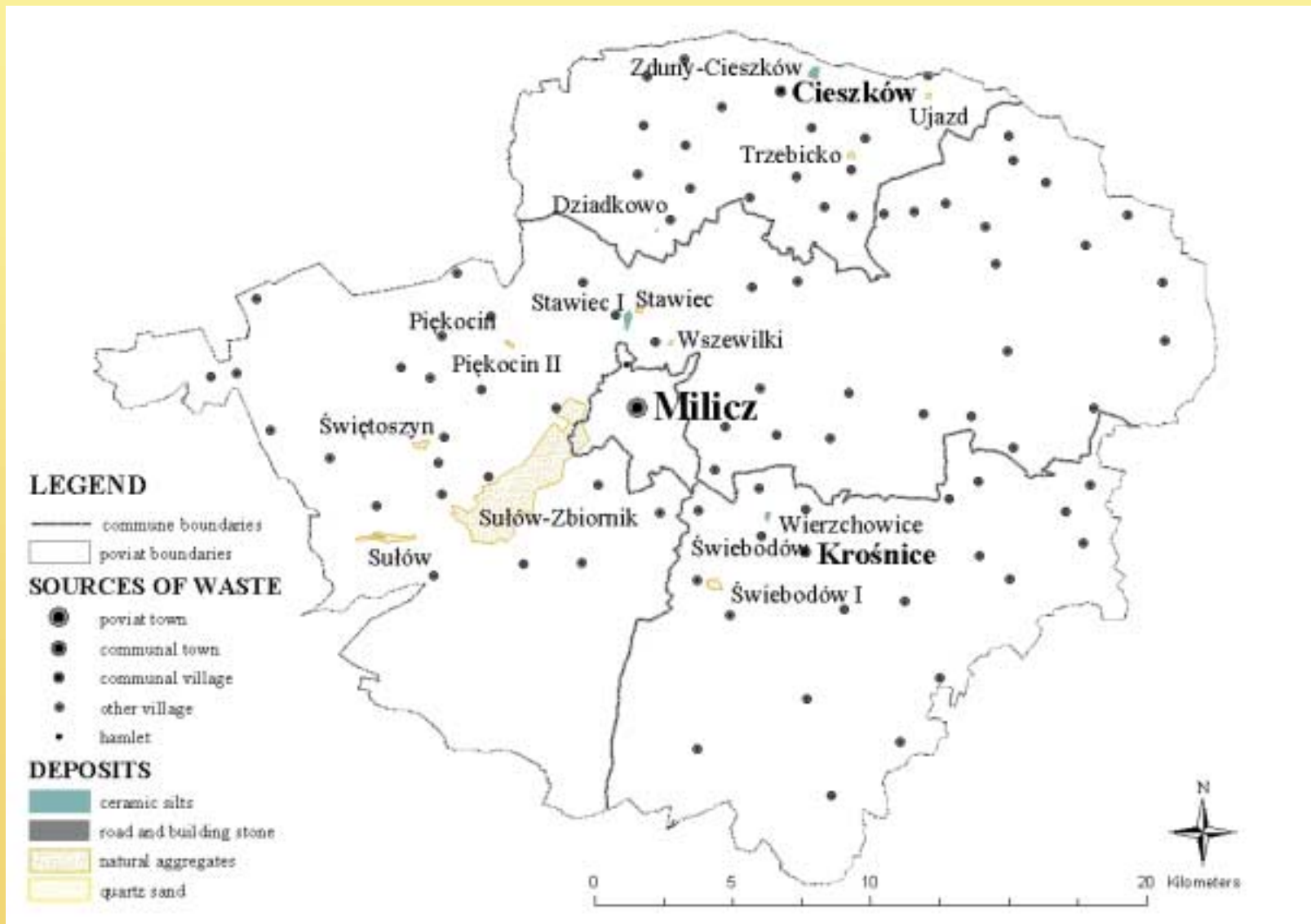
## The spatial description of the waste stream used in the decision support system



The visualisation of the municipal waste quantity produced in the Milicz County in 2004 [m³/year]

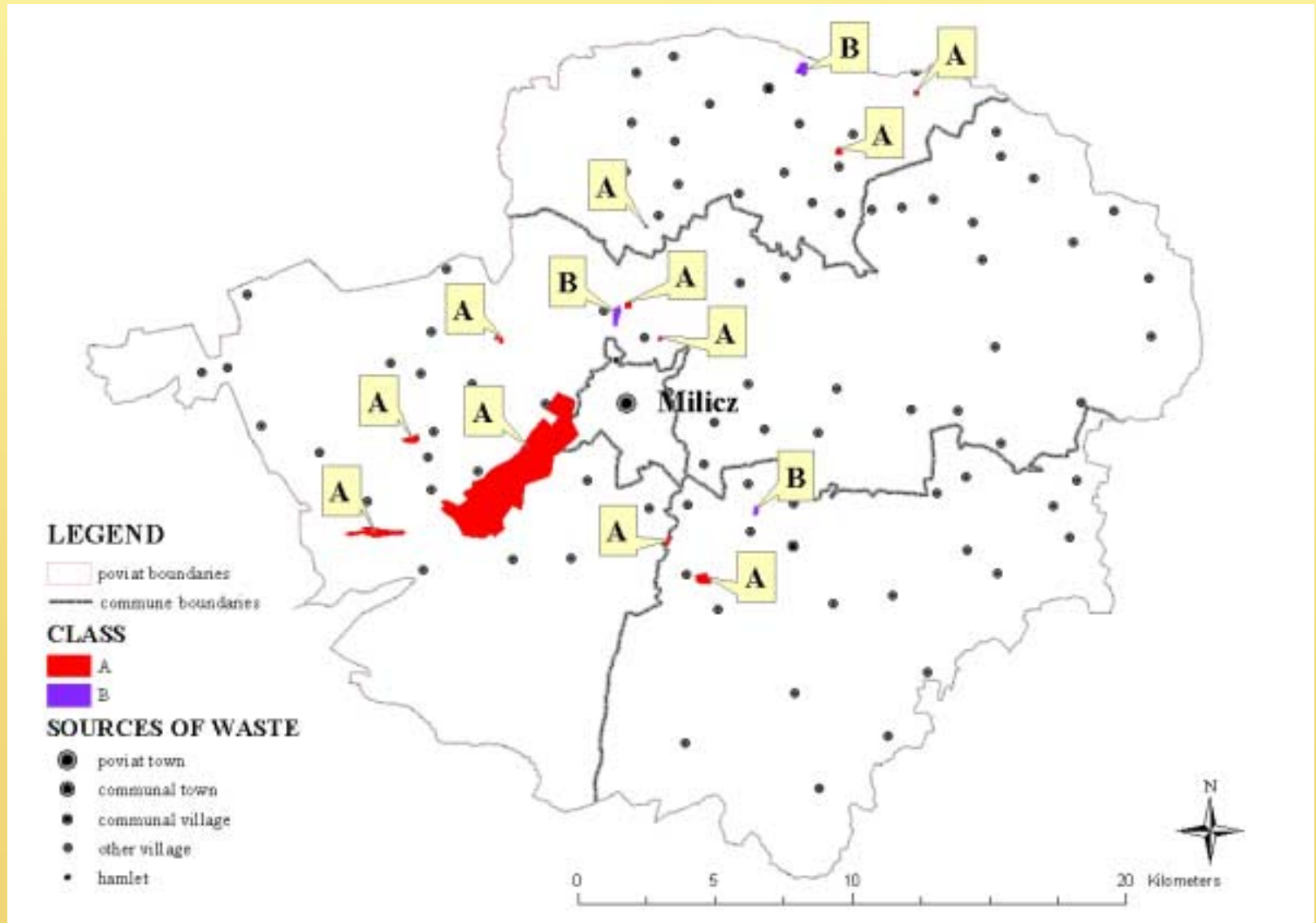
# ANALYSIS MODULE

## Spatial visualisation of potential mining voids in the Milicz County

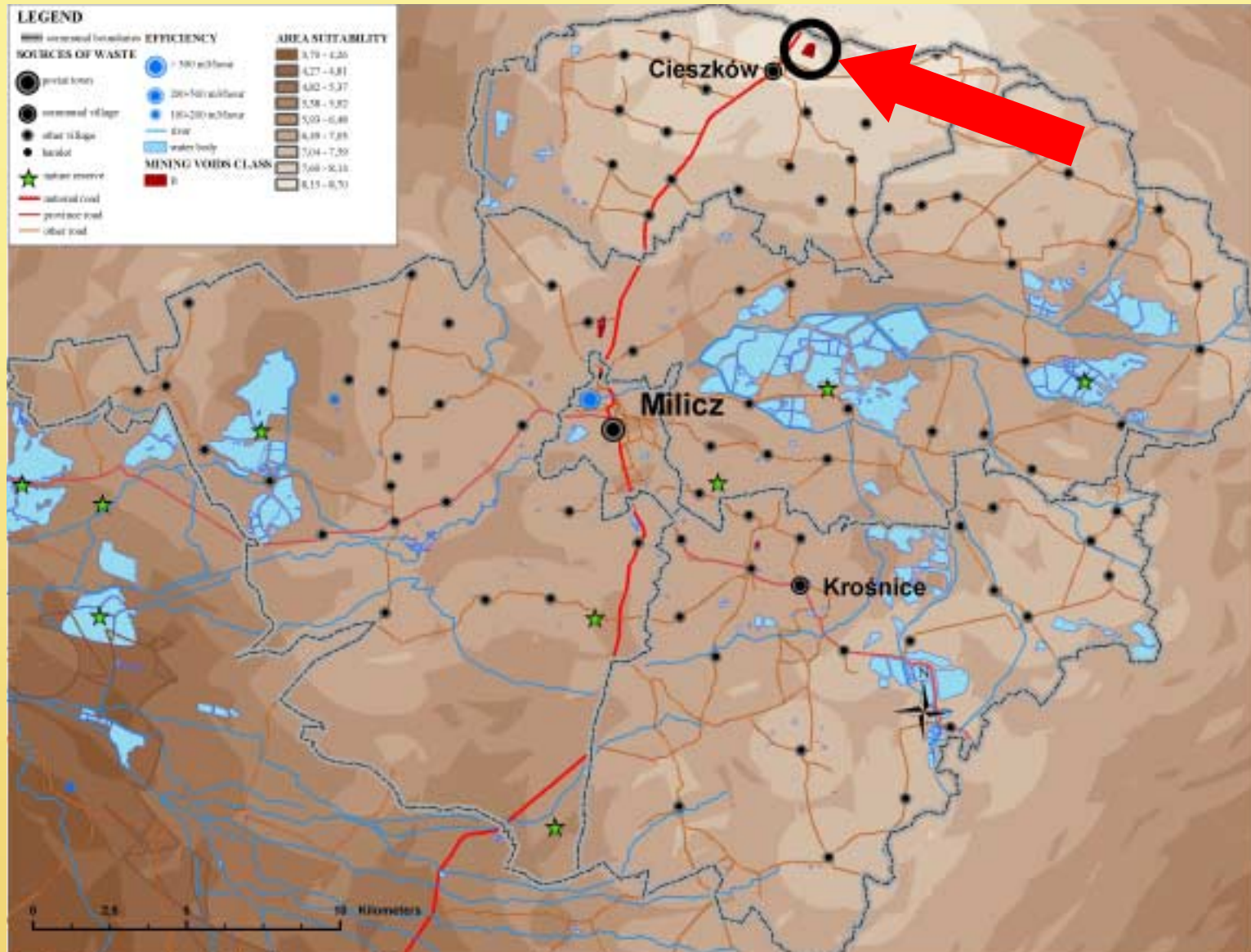


# ANALYSIS MODULE

## Spatial visualisation of mining voids classified by neural networks in the Milicz County



# ANALYSIS MODULE



Spatial visualisation of the area suitability for location of municipal waste storage site

# A methodology for developing decision support system for management of municipal waste and mining voids

## Conclusions

Proposed **decision support system** provides the user with **useful information and helps to make decisions** and plan processes related to location of new municipal waste management sites in the analysed area

**This information** includes: demographic characteristics of the analysed area, spatial location of sources of waste, the quantity and quality of waste produced by those sources, information on other elements located in the analysed area, such as mining voids, natural structures, transportation etc.

The **decision support system** was built with the use of the GIS technology

For comprehensive environmental resources management of areas with many potential voids that could be used as storage sites (e.g. for Lower Silesia Region) advanced computer techniques seems to be natural direction