ЕВРОПЕЙСКИ СЪЮЗ
ЕВРОПЕЙСКИ СТРУКТУРНИ И ИНВЕСТИЦИОННИ ФОНДОВЕ

“Кариерно развитие на младия учен“

ОПЕРАТИВНА ПРОГРАМА
НАУКА И ОБРАЗОВАНИЕ ЗА ИНТЕЛИГЕНТЕН РАСТЕЖ

HISTORICAL, SOCIAL AND METRICAL ASPECTS OF SUSTAINABILITY

Prof. Dr. Vasil Simeonov

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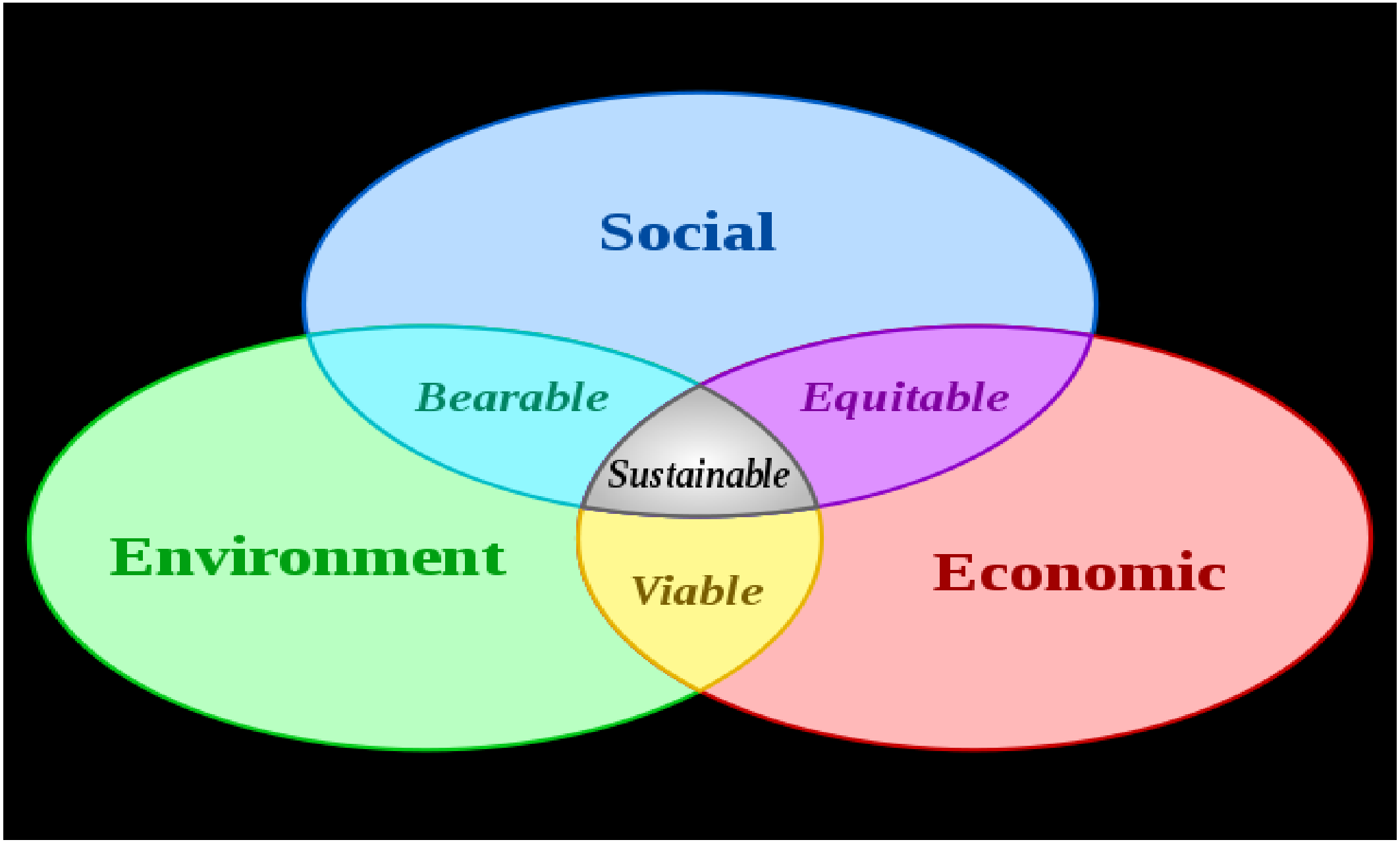
Проект BG05M2OP001-2.009-0028 "Постигане на оптимална среда за обучение, научни изследвания, иновации и устойчиво развитие на човешкия капитал в сферата на химическите науки: Адаптиране на образованието днес за утрешния ден", финансиран от Оперативна програма „Наука и образование за интелигентен растеж“, съфинансирана от Европейския съюз чрез Европейските структурни и инвестиционни фондове.


The Road To Sustainability
Impact Assessment
Risk Assessment
Risk Management
Benign by Design
WASTE MINIMIZATION
INTERSTATE
P2
Computer Modeling
Green Chemistry
CLEAN CATALYSTS
SEPARATION CHNOLOGIES
Clean Products
CLEAN ENERGY
Renewable Sources
Electrochemistry
Solar, Wind, Biomass
SLOW
Roadwork Ahead
Systems Analysis
Life Cycle Assessment (LCA)


Social
Bearable
Equitable
Sustainable
Environment
Viable
Economic

ENVIRONMENT AND SOCIETY

- Historical lessons in the environmental changes and the role of the anthropogenic impacts.
- Overpopulation, technological progress, richness and poverty in the society.
- The relation between nature and human beings.
- Global changes and risk scenarios for the future.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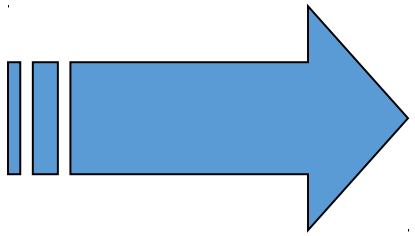
- Wastes and treatment of wastes from historical perspective.
- Industrial development without wastes.
- Problem of toxicity of wastes.

The long history of Garbage: dealing with the remains from Ancient Rome to modern times.

The quality and amount of the OUTPUT of a society - wastes and emissions - as well as the potential hazard they present depend on the INPUT into this society

INPUT

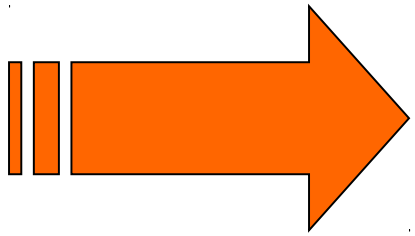


RAW MATERIALS

wood, food, metals, crude oil, ...

A STORAGE CALLED SOCIETY

OUTPUT



WASTES

solid
liquid
gaseous

Supply and Disposal in Antiquity

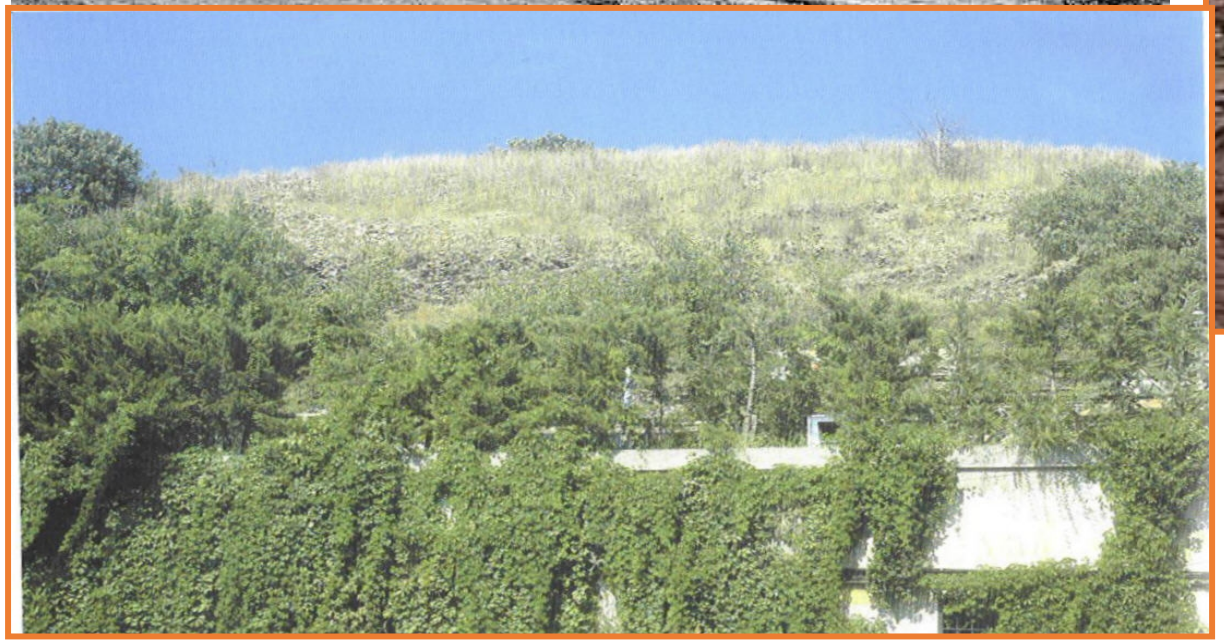
Garbage in Antiquity

http://ceipac.gh.ub.es/MOSTRA/u_expo.htm

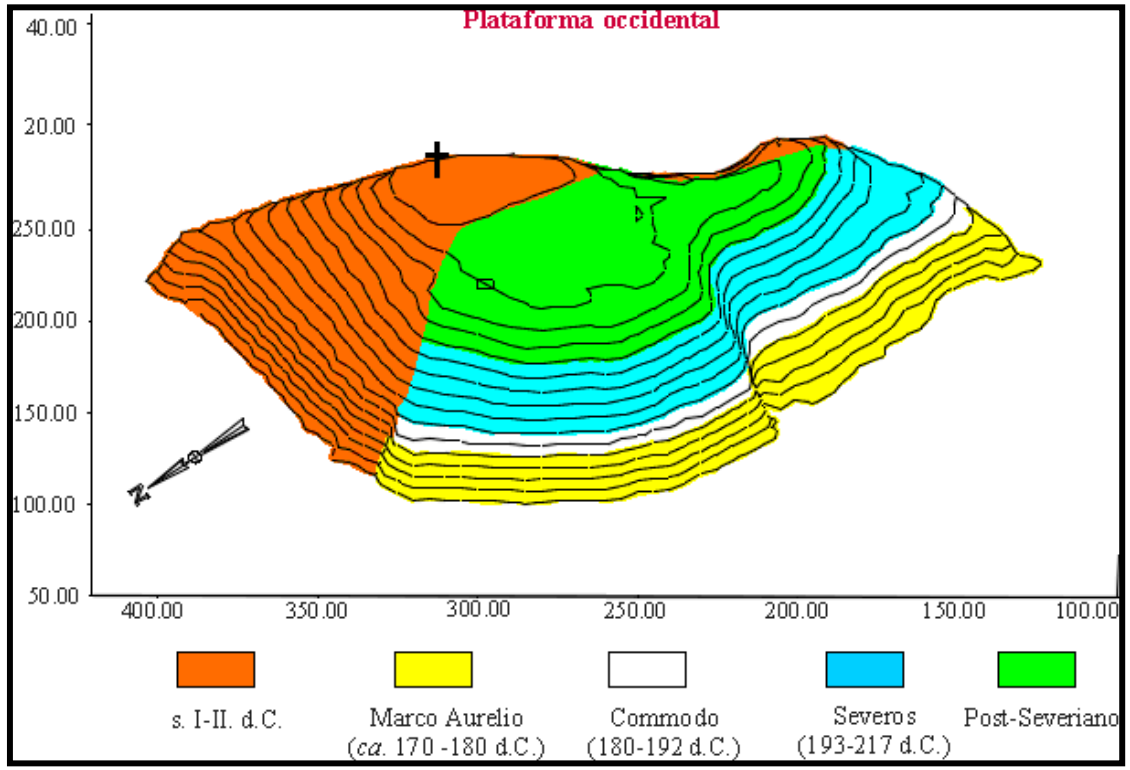
Mount Testaccio is an artificial hill of more or less triangular base, settled on the banks of the river Tiber, in the south-east of Rome. Mount Testaccio is nearly 50m high and has a perimeter of 1490m, which makes a total area of 22.000m^2.

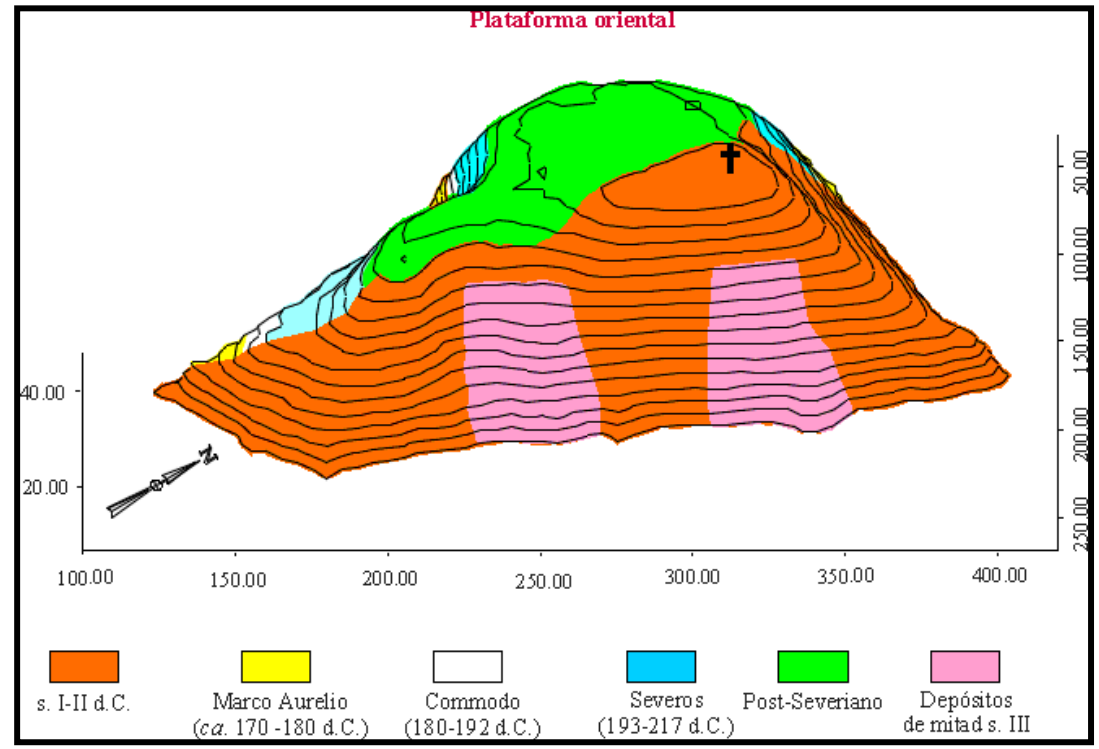
Garbage in Antiquity

Garbage in Antiquity



Garbage in Antiquity

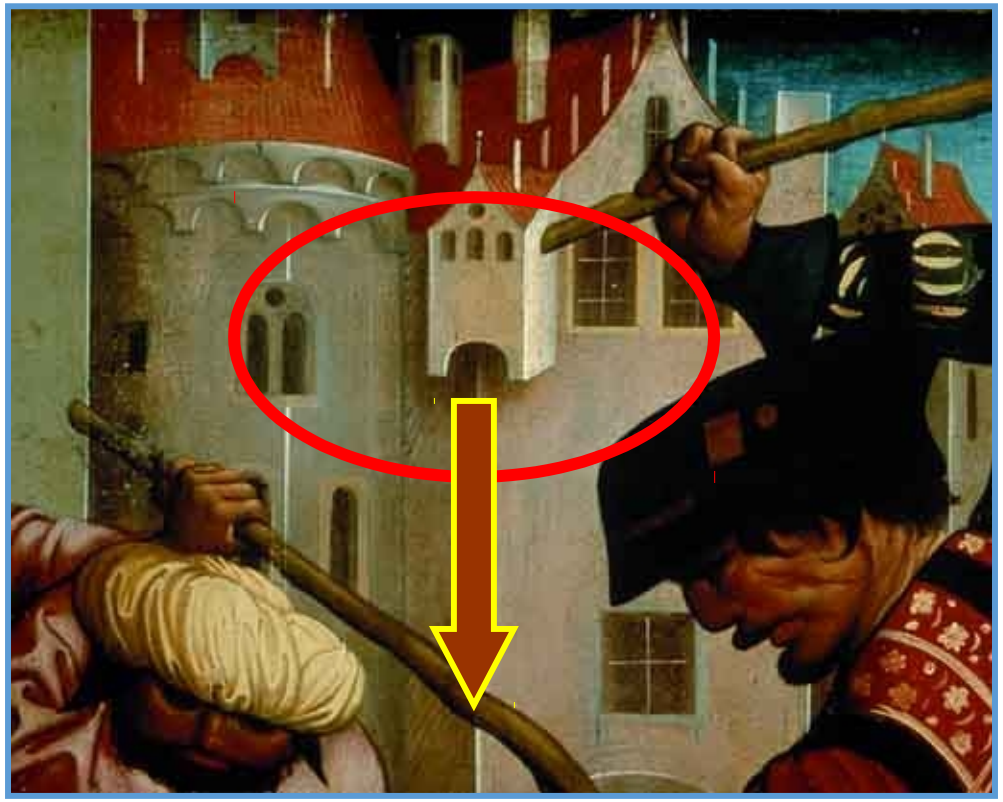




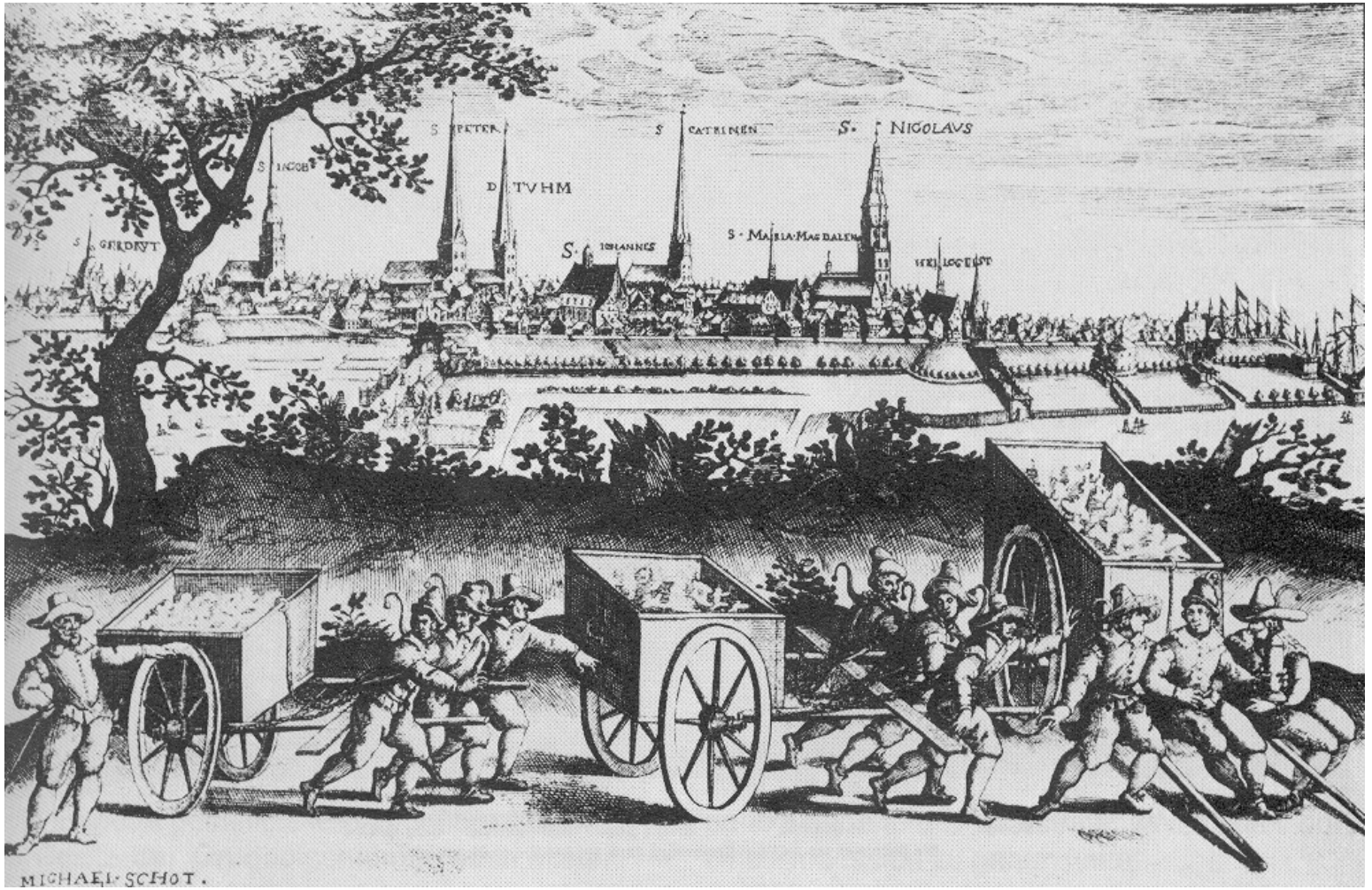
Supply and disposal in medieval times

The Middle Ages were an age of recycling...

Garbage in the city: Middle Ages



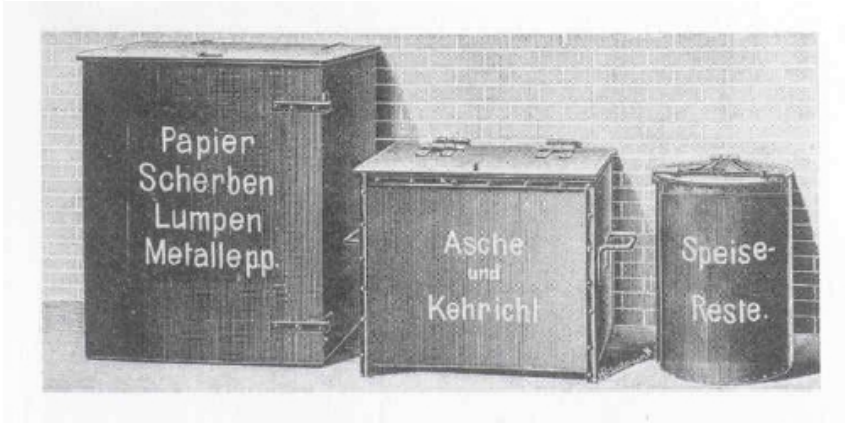
Pieter Brueghel, 1559 (Berlin)

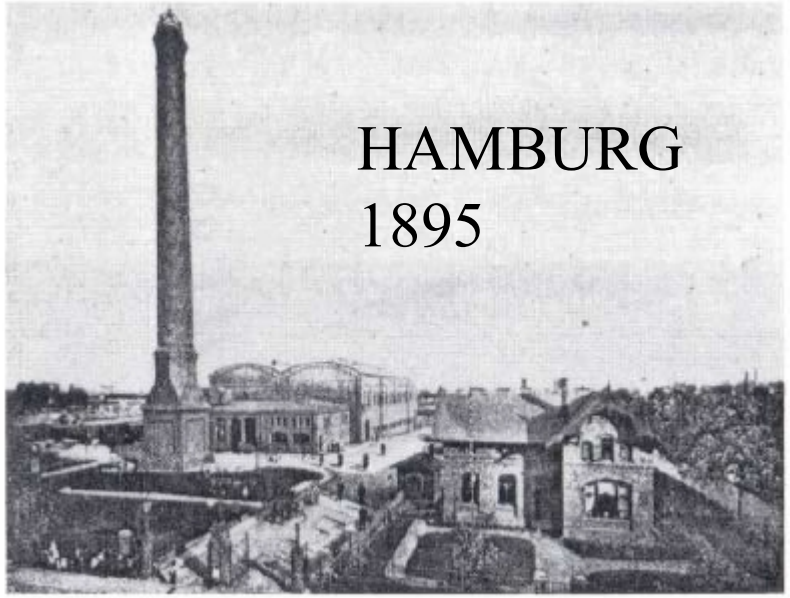


Hamburg, 1609: Prisoners with so-called ‚Schot‘schen Karren‘

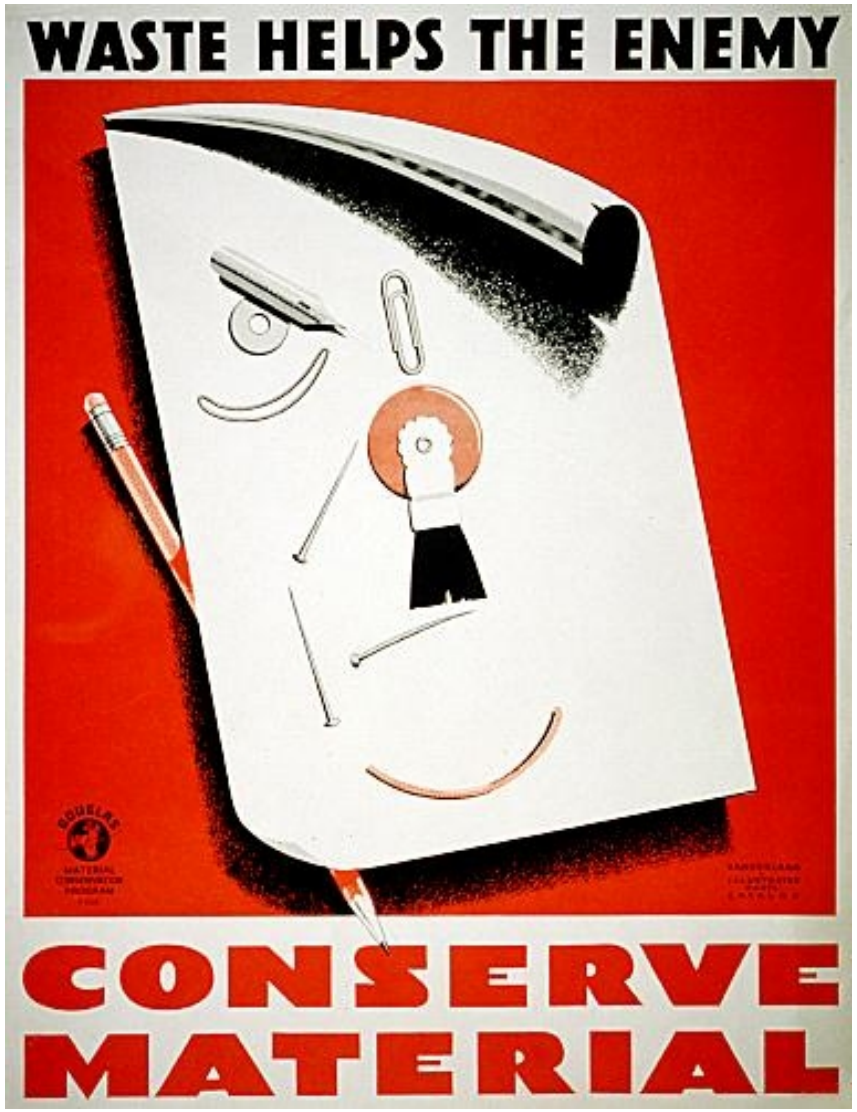
Garbage in the city: INDUSTRIAL SOCIETY

Garbage in the city: INDUSTRIAL SOCIETY

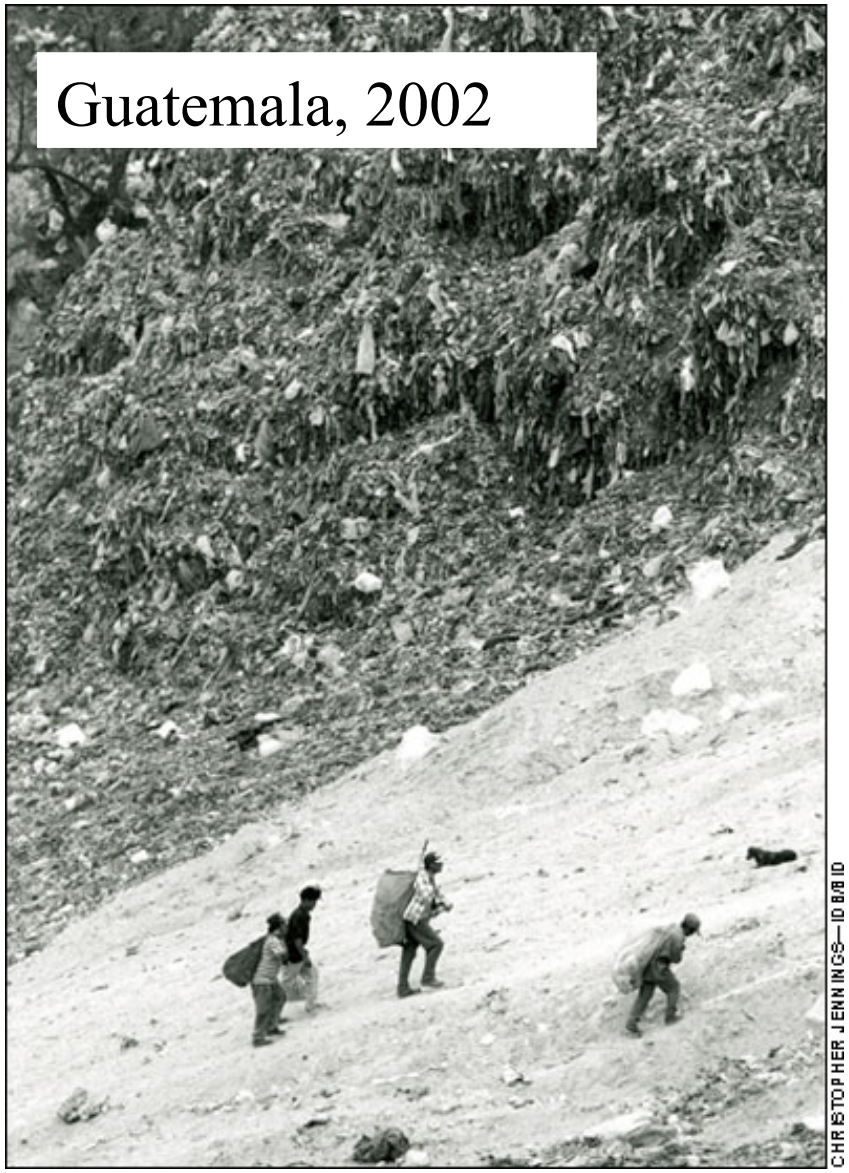




Mid-20th century Recycling-Histories



Conclusion



Model of Sustainability

- PSR model, which takes into account the ***Pressure – State – Response*** situation in the society requires indicators being able to signal about the anthropogenic ***pressure*** on the environment leading to a certain ***state*** of pollution which needs in turn a respective social ***response*** in order to diminish the environmental hazards.

Sustainability indicators

The sustainable development is characterized by three major coordinates:

- Technological (industrial)
- Ecological
- Social

What is ecoefficiency

Ecoefficiency = product value related to a certain environmental effect

Ecoefficiency indicator

- ***Ecoefficiency indicator = economic indicator related to environmental indicator***

Social indicators

- Specific number of workers
- Relative payment
- Fraction of “happy” workers”
- Level of advance of career
- Time -off due to medical reasons
- Charity actions
- Regional projects
- Local consumption of the production
- Birth rate of the region

Ecological indicators

- Input eco-indicators: energy-related, materials and resources related
- Output eco-indicators: price, wastes – both solid and liquid, emissions in the atmosphere

Economic indicators

- Financial indicators – added value, investments for sustainability and environmental protection, environmental responsibility, complaints of clients, ethical activities, number of distributors ready to work for environmental protection, number of broken contacts due to discrepencies in environmental issues

Economic indicators 2

- Labor power indicators – expenses for labor power, period of employment of a worker, expenses for medical insurance, noise level, investment in qualification of the employees, period of qualification activities, number of suggestions for improvement of the labor conditions and product sustainability from the employees.

Industrial ecology and industrial metabolism

Feature	Natural ecosystems	Industrial ecosystems
Major unit	Organism	Enterprise
Material flows	Closed cycle	One-way in most cases
Recycling	Complete	Very low level
Realization	Tendency towards concentration	Tendency towards de-concentration
Reproduction	Major function	Not reproduction but goods

Modern attitude to the environmental problems – metrics for industrial, economic and social issues. Modeling of risk of pollution. Role of environmetrics in quality of life assessment. Environmental modeling of different environmental compartments

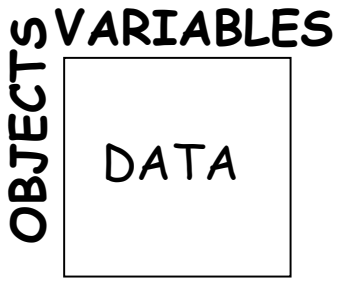
MAJOR ENVIRONMETRIC METHODS FOR CLASSIFICATION AND MODELING

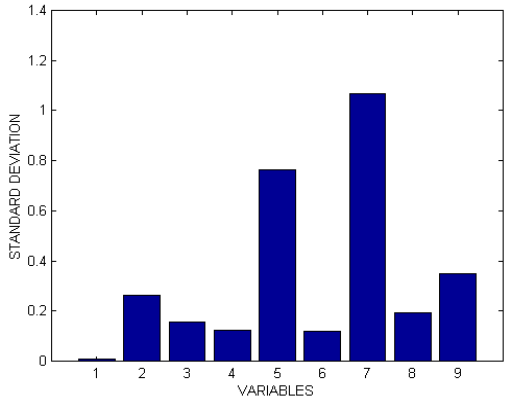
- Cluster analysis
- Principal components or Factor analysis
- Principal Components regression (PCR)
- N-way PCA and PARAFAC
- Time-series analysis (TSA)
- Partial Least Squares regression (PLS)
- Self-Organizing Maps (SOM)
- Receptor Modeling

Cluster Analysis

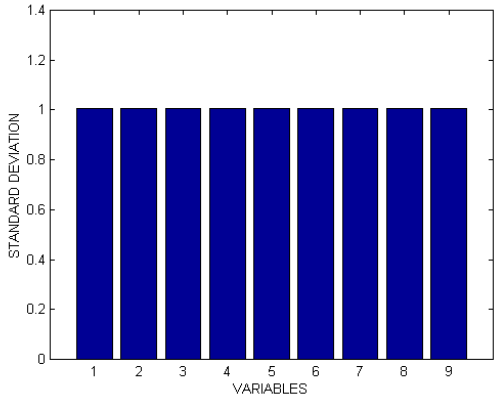
- Similarity or dissimilarity between different objects described by many variables
- The same for the variables
- Data standardization
- Similarity measure
- Method of linkage
- Dendrogram
- Cluster significance test

$$X = \begin{pmatrix} x_{11} & x_{12} & \dots & x_{1m} \\ x_{21} & x_{22} & \dots & x_{2m} \\ \dots & \dots & x_{ij} & \dots \\ x_{n1} & x_{n2} & \dots & x_{nm} \end{pmatrix}$$

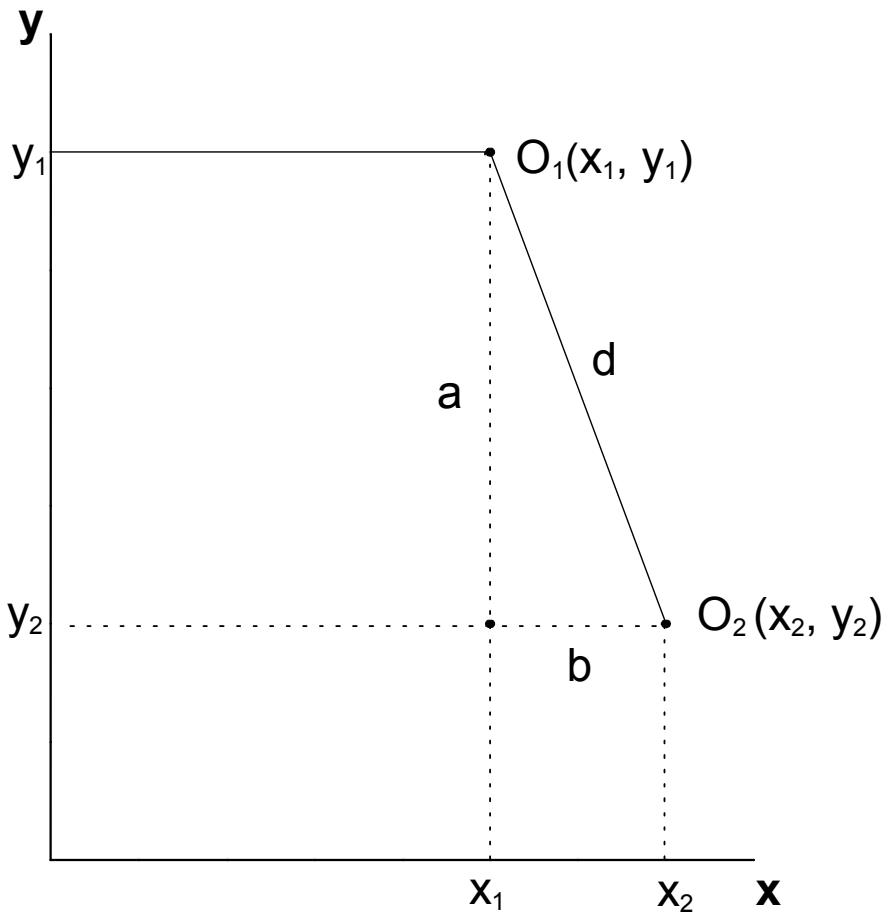




$$z_{ij} = \frac{x_{ij} - \bar{x}_j}{s_j}$$



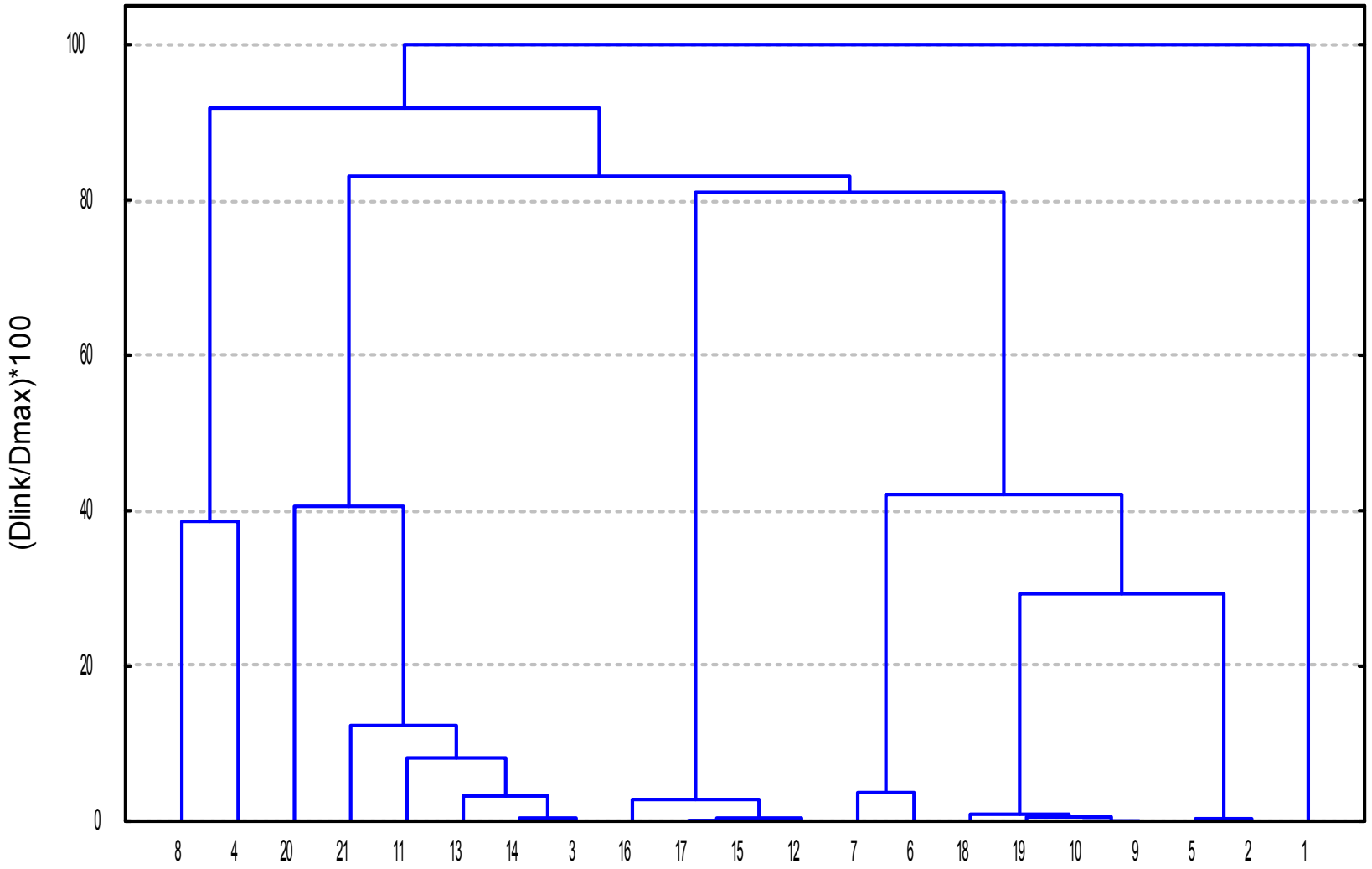
където $\bar{x}_j = \frac{1}{n}\sum_{i=1}^{n} x_{ij}$ и $s_j = \frac{1}{n-1}\sum_{i=1}^{n}(x_{ij} - \bar{x}_j)^2$.



$$d(O_1, O_2) = \sqrt{(y_1 - y_2)^2 + (x_1 - x_2)^2}$$

$$d(i,k) = \sqrt{\sum_{j=1}^{m} (x_{ij} - x_{kj})^2}$$

$$D = \begin{pmatrix} 0 & d_{12} & d_{13} & \dots & d_{1n} \\ d_{21} & 0 & d_{23} & \dots & d_{2n} \\ \dots & \dots & \dots & \dots & \dots \\ d_{n1} & d_{n2} & d_{n3} & \dots & 0 \end{pmatrix}$$


(Dlink/Dmax)*100
100
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0
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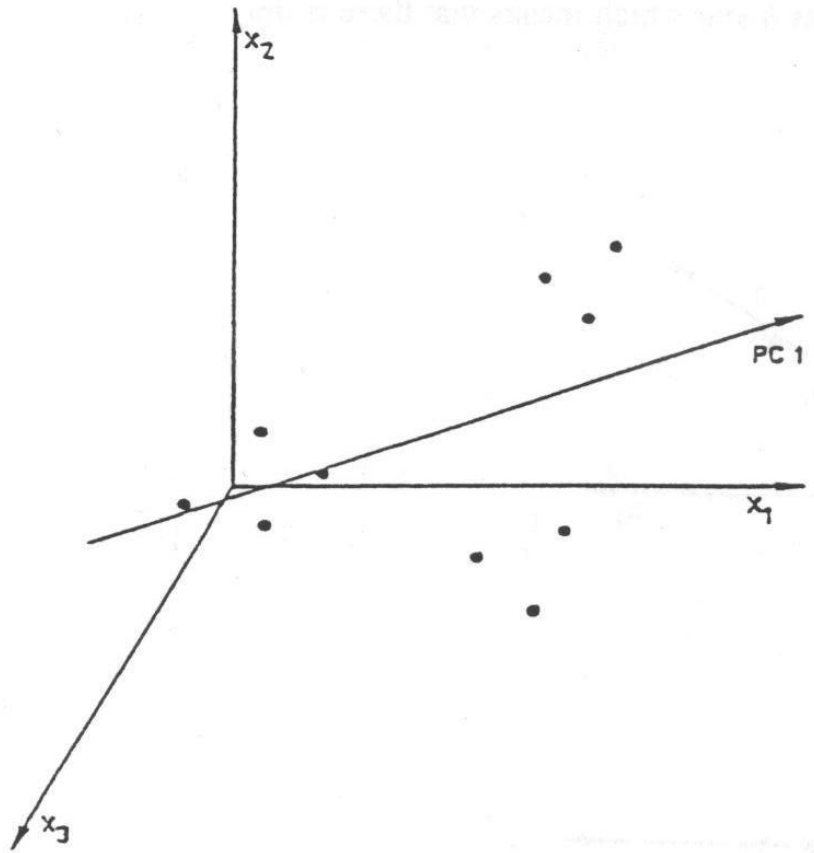
2
1

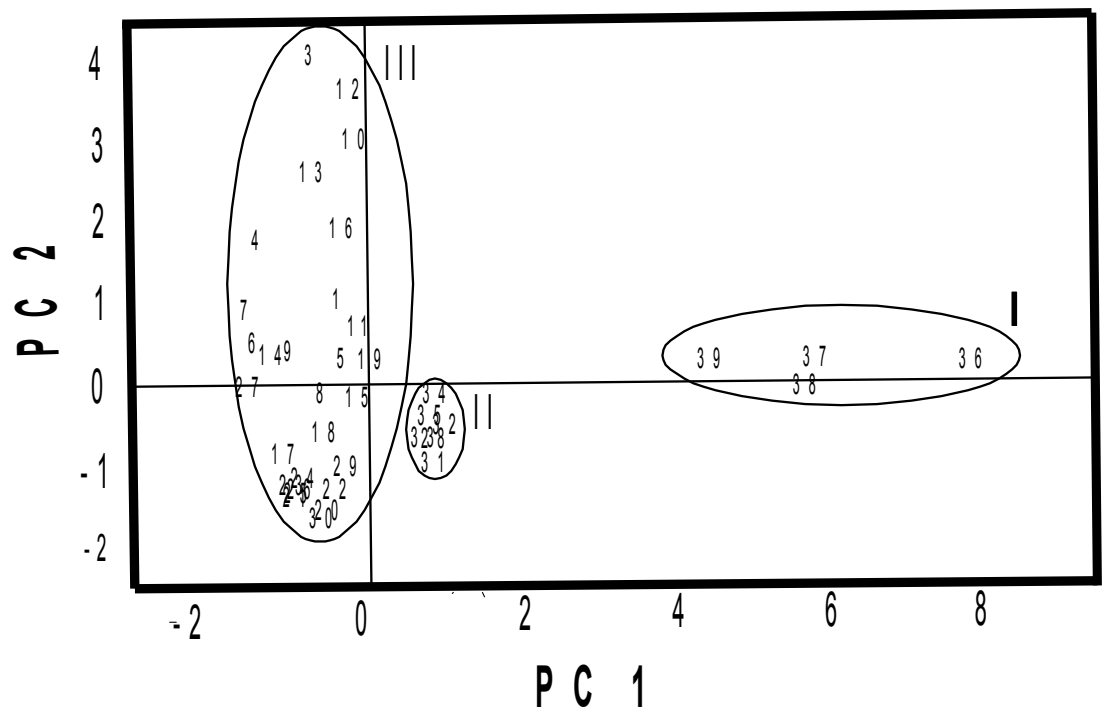


PC1 = a1X1 + a2X2 + a3X3

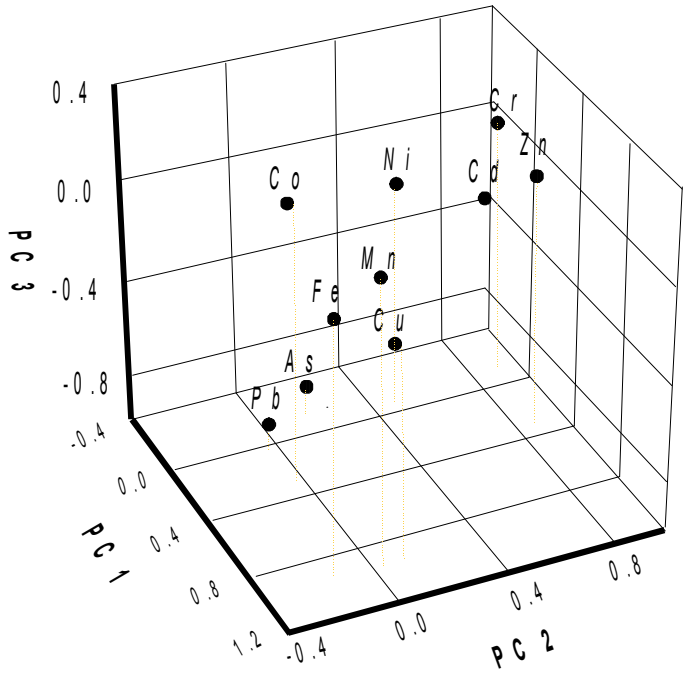
DATA

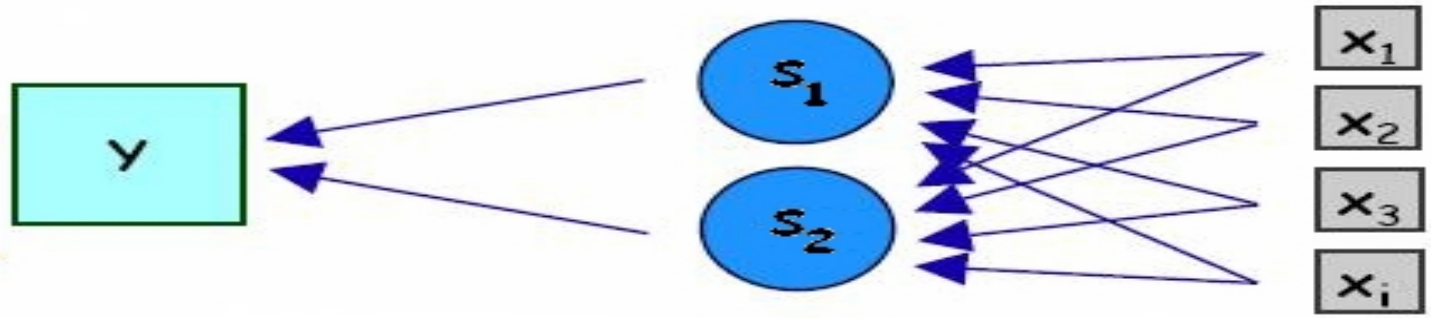
$$\begin{pmatrix} x_{11} & x_{12} & \dots & x_{1n} \\ x_{21} & x_{22} & \dots & x_{2n} \\ \dots & \dots & \dots & \dots \\ x_{m1} & x_{m2} & \dots & x_{mn} \end{pmatrix} = \begin{pmatrix} a_{11} & \dots & a_{1s} \\ a_{21} & \dots & a_{2s} \\ \dots & \dots & \dots \\ a_{m1} & \dots & a_{ms} \end{pmatrix} \times \begin{pmatrix} f_{11} & f_{12} & \dots & f_{1n} \\ f_{21} & f_{22} & \dots & f_{2n} \\ \dots & \dots & \dots & \dots \\ f_{s1} & f_{s2} & \dots & f_{sn} \end{pmatrix} + \begin{pmatrix} e_{11} & e_{12} & \dots & e_{1n} \\ e_{21} & e_{22} & \dots & e_{2n} \\ \dots & \dots & \dots & \dots \\ e_{m1} & e_{m2} & \dots & e_{mn} \end{pmatrix}$$

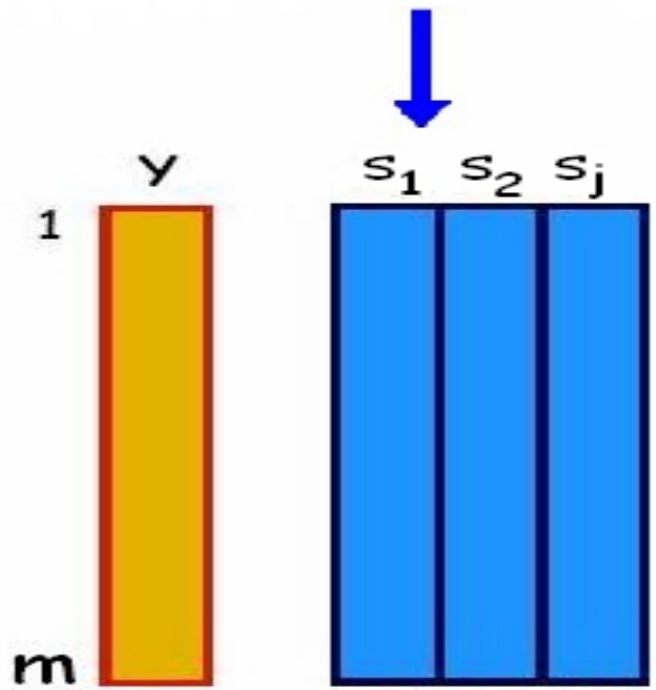
$$\boldsymbol{X} = \boldsymbol{A} \cdot \boldsymbol{F} + \boldsymbol{E}$$


PC 2
PC 1
4
3
2
1
0
-1
-2
-2
0
2
4
6
8
III
II
I

Variable	PC 1	PC 2	PC 3	PC 4
T_s	-0.21	0.03	**0.96**	0.13
P	0.25	**-0.80**	0.33	0.30
T_c	-0.12	-0.05	0.34	**0.87**
J_c	-0.44	0.01	0.21	**-0.77**
Sr	**0.87**	0.16	-0.38	0.07
Ca	**0.93**	0.09	-0.30	0.15
Cu	**0.86**	-0.21	0.38	0.01
LP	-0.02	**-0.99**	0.02	0.07
TE	0.23	**0.87**	0.24	0.23
Explained total variance 93 %				



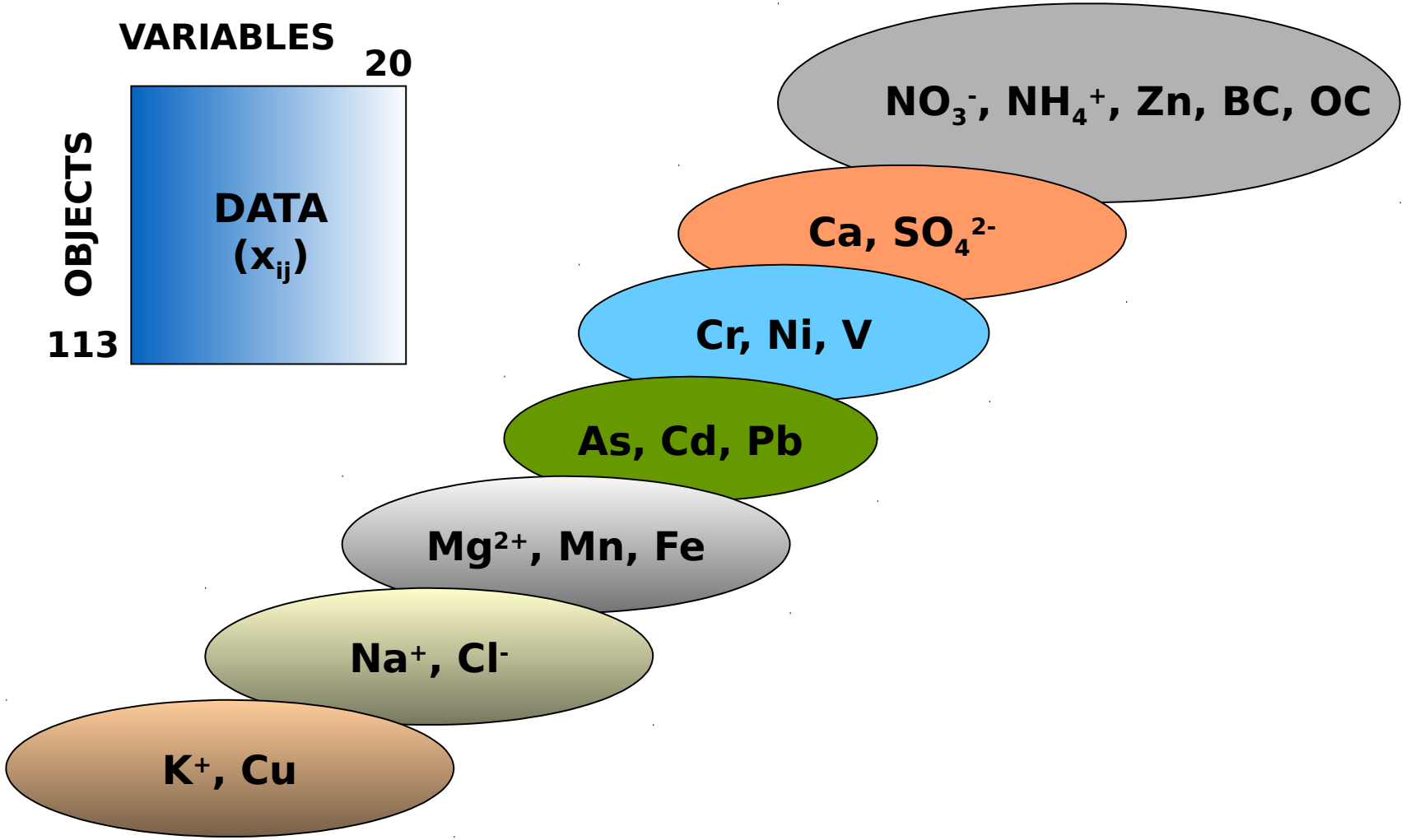




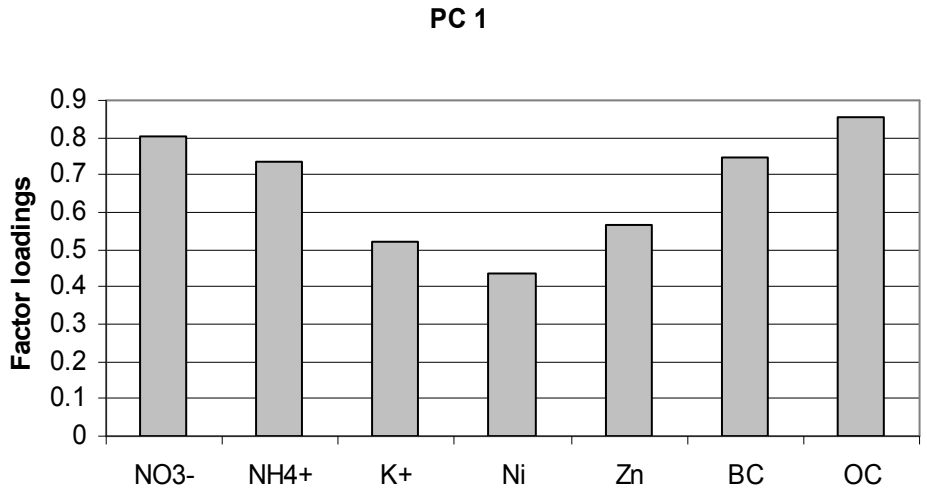
$$Y = b_o + \sum_{j=1}^{P} b_j s_j + e$$

P < N

UNTERLOIBACH -CLUSTERING

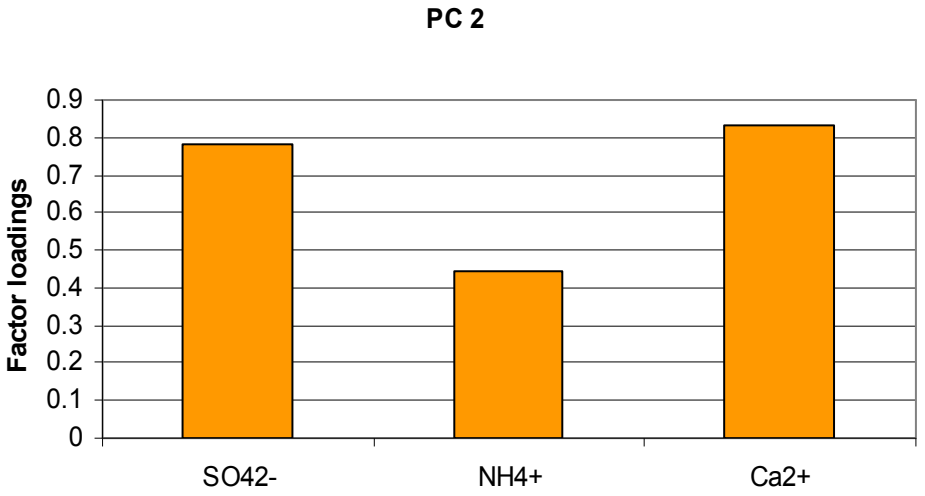


UNTERLOIBACH - PCA

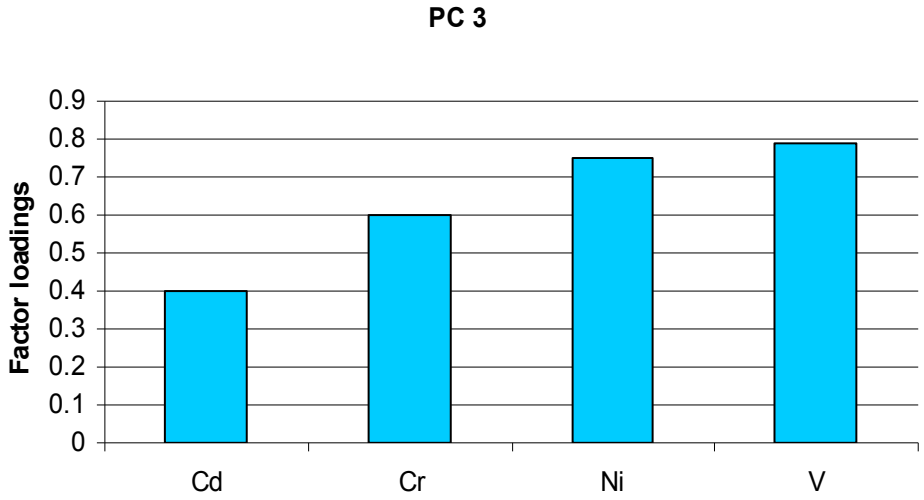


Secondary emission(19%)

Mineral dust (12%)

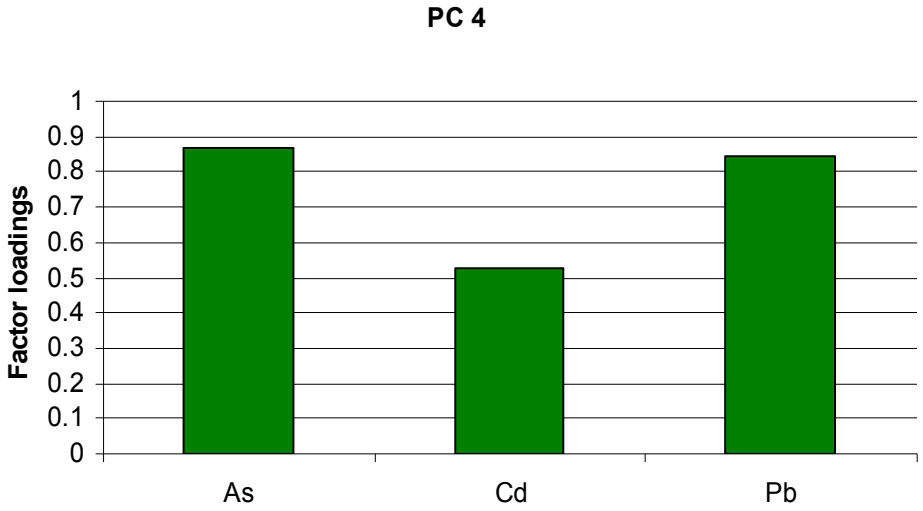


UNTERLOIBACH - PCA

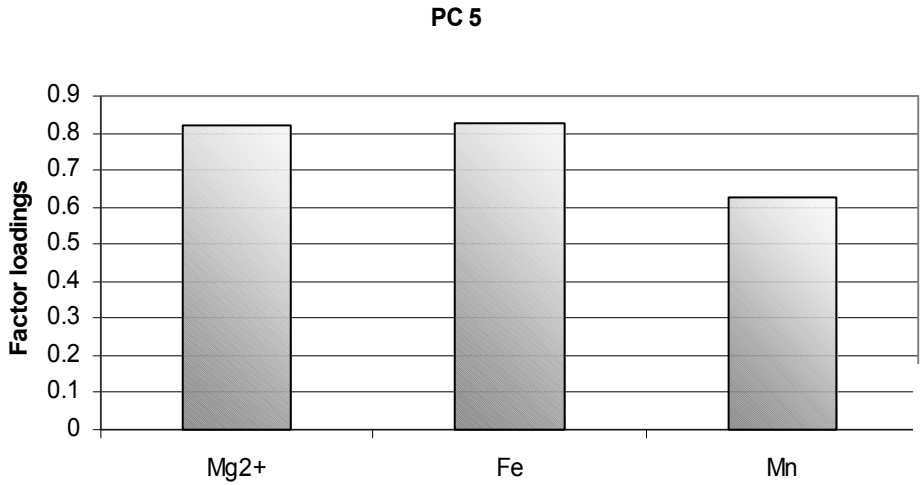


Oil combustion (12%)

Lead smelter (11%)

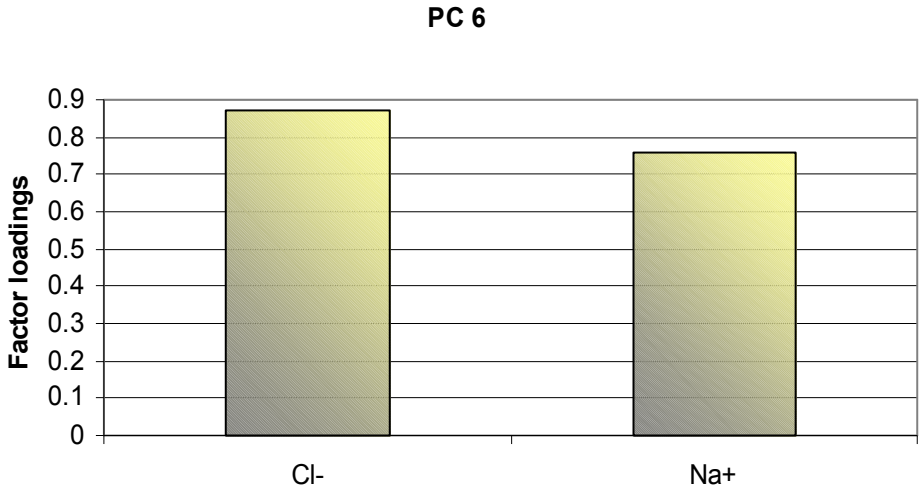


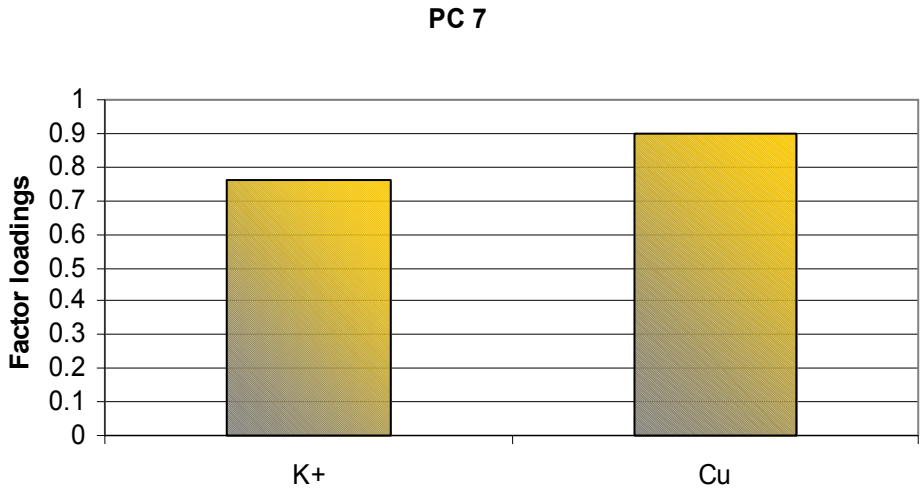
UNTERLOIBACH - PCA



Steel production(12%)

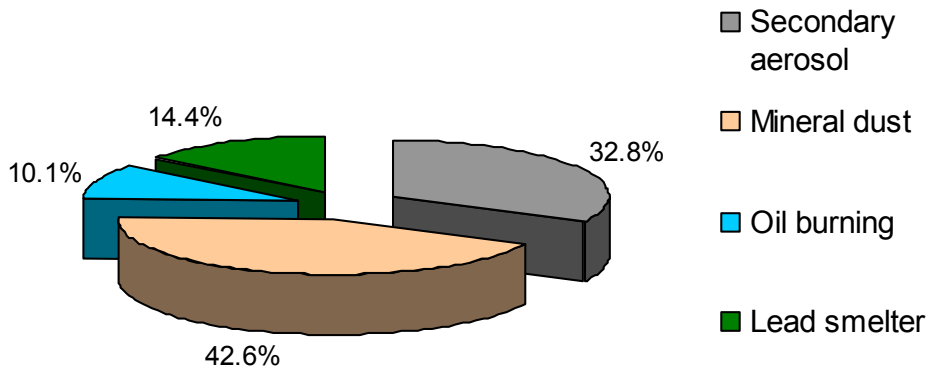
Fertilizer (8.7 %)

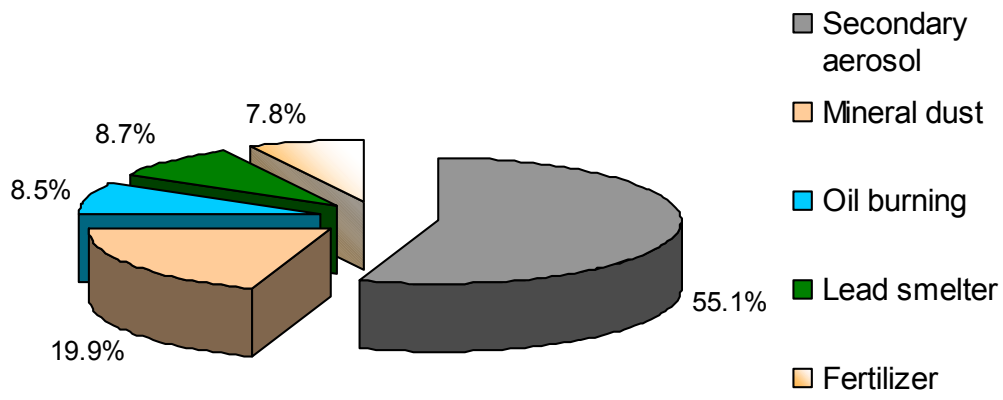




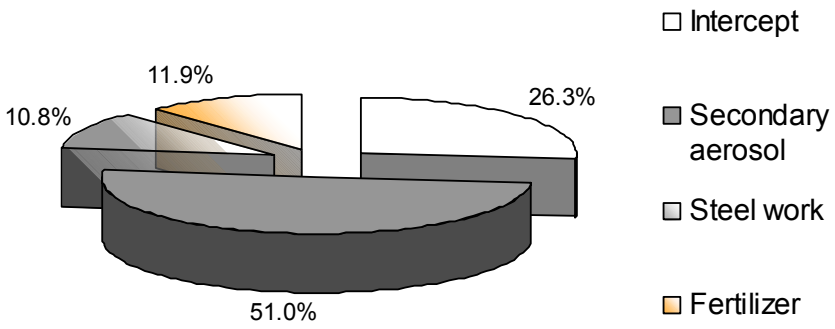
Salt(8.7 %)

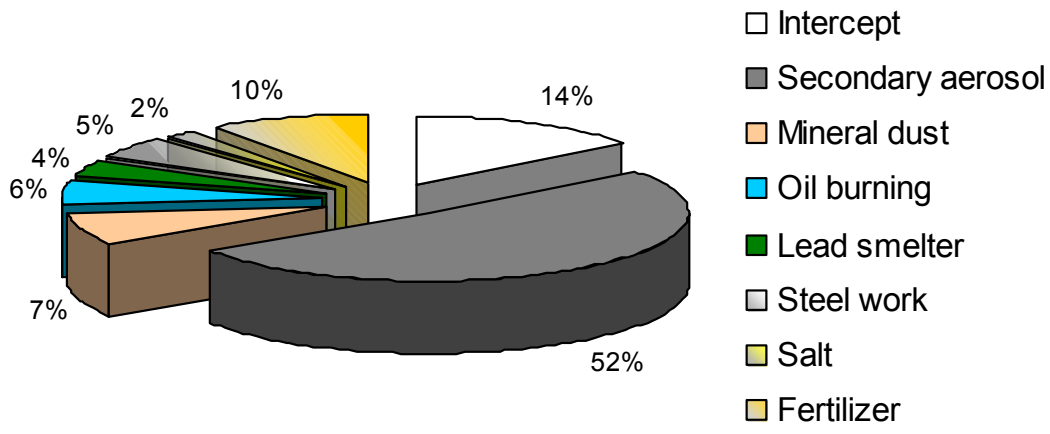
UNTERLOIBACH - apportioning



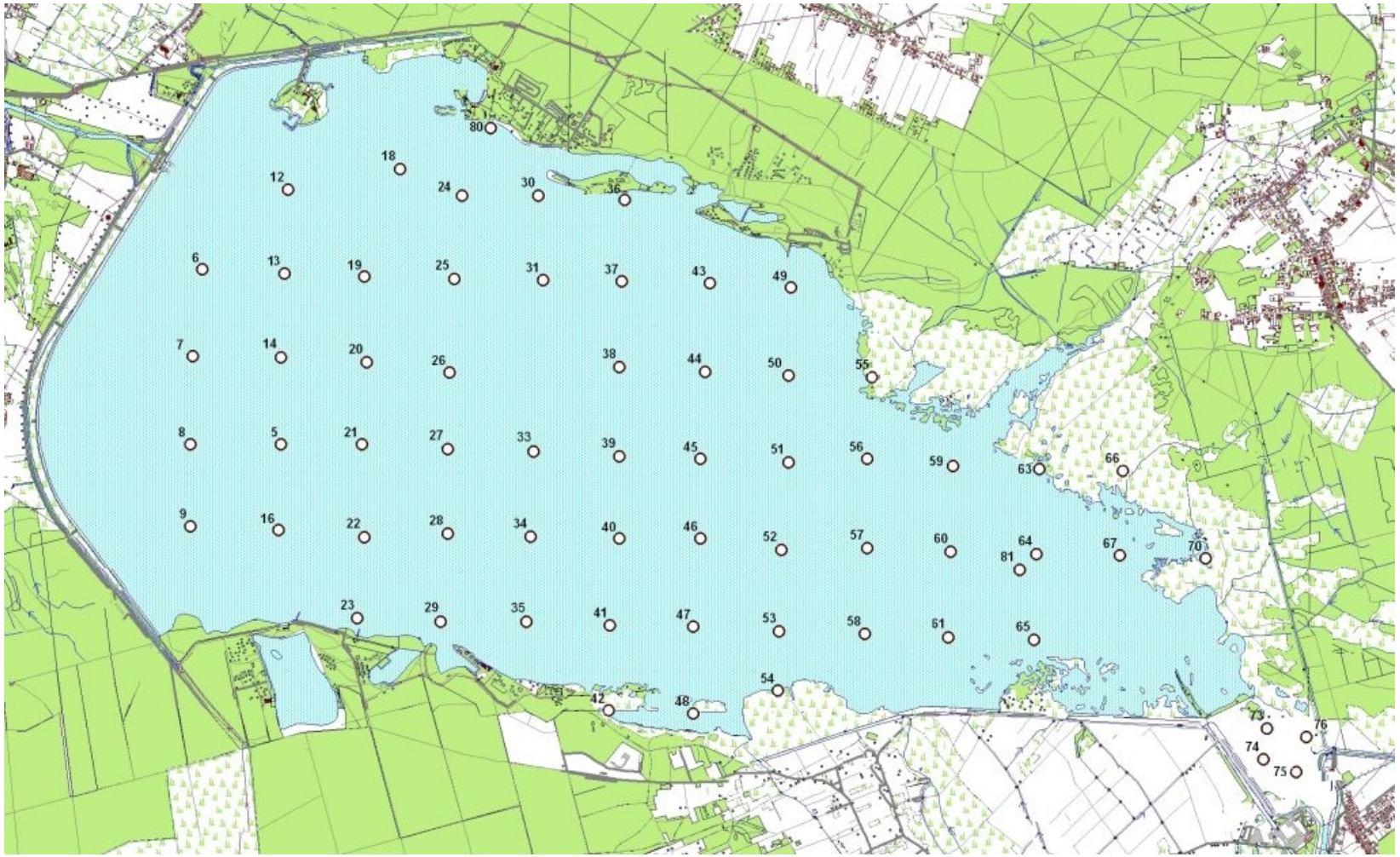


UNTERLOIBACH - apportioning

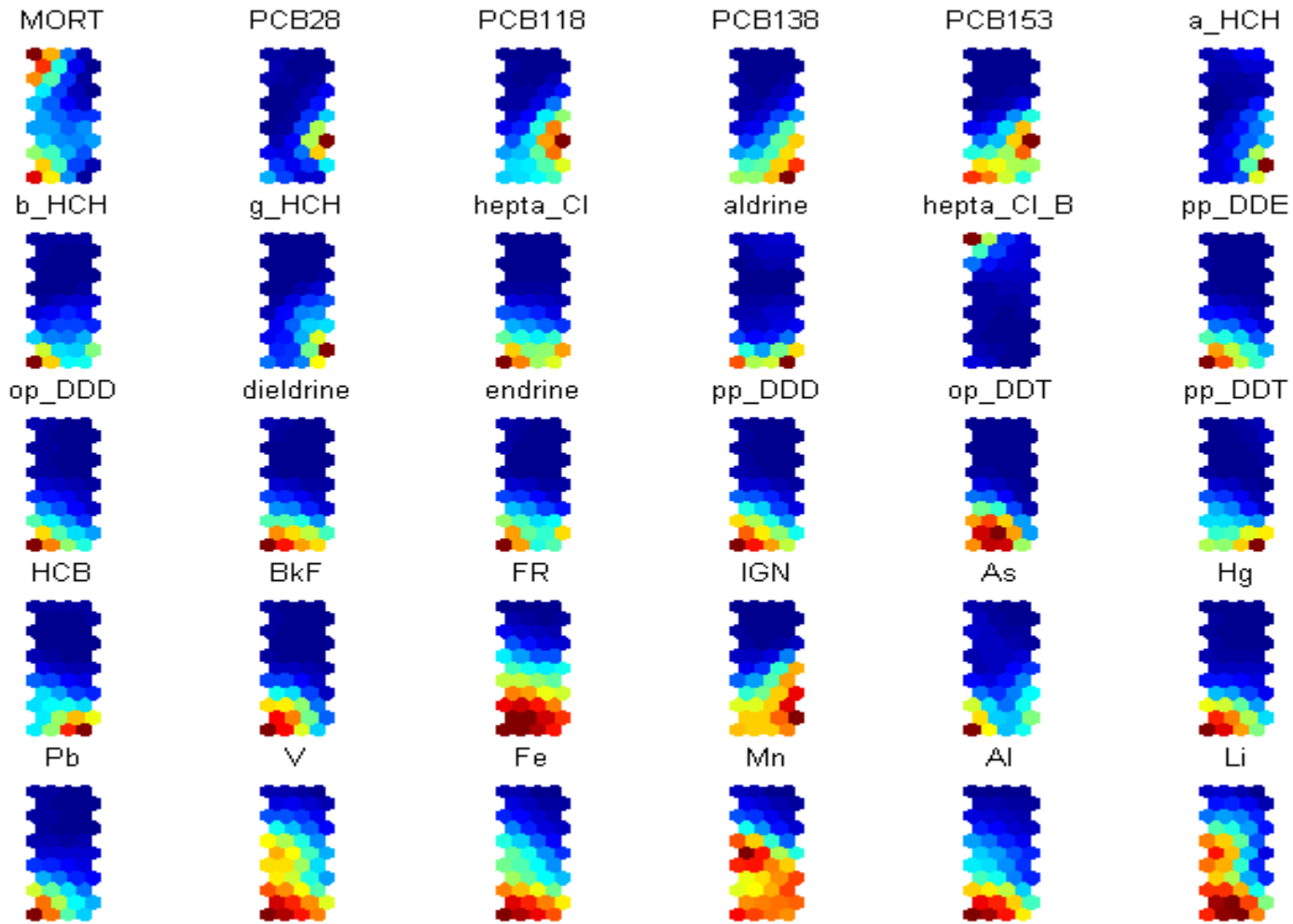




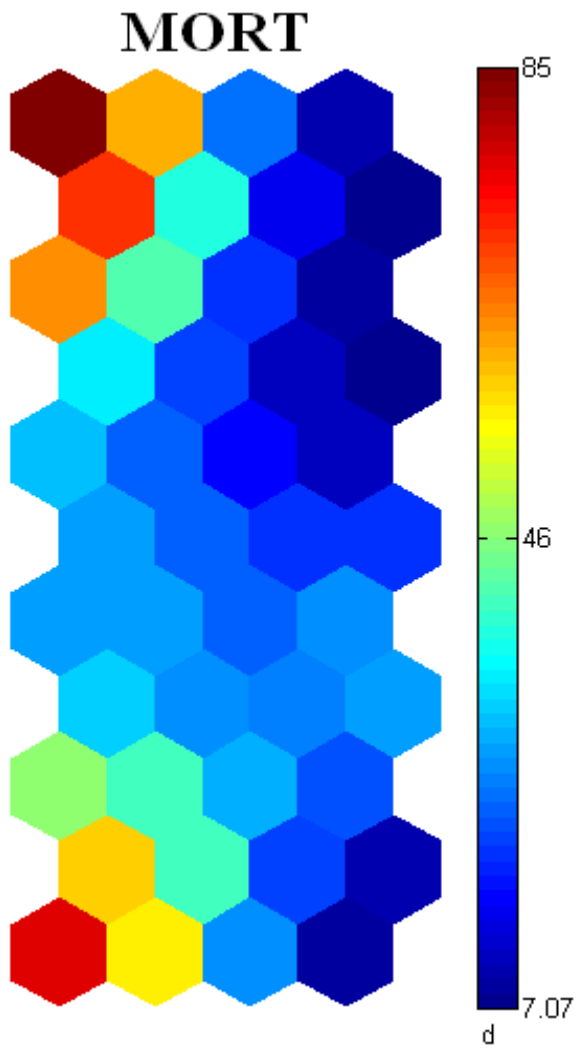
Sampling grid for the bottom sediments from Turawa Lake

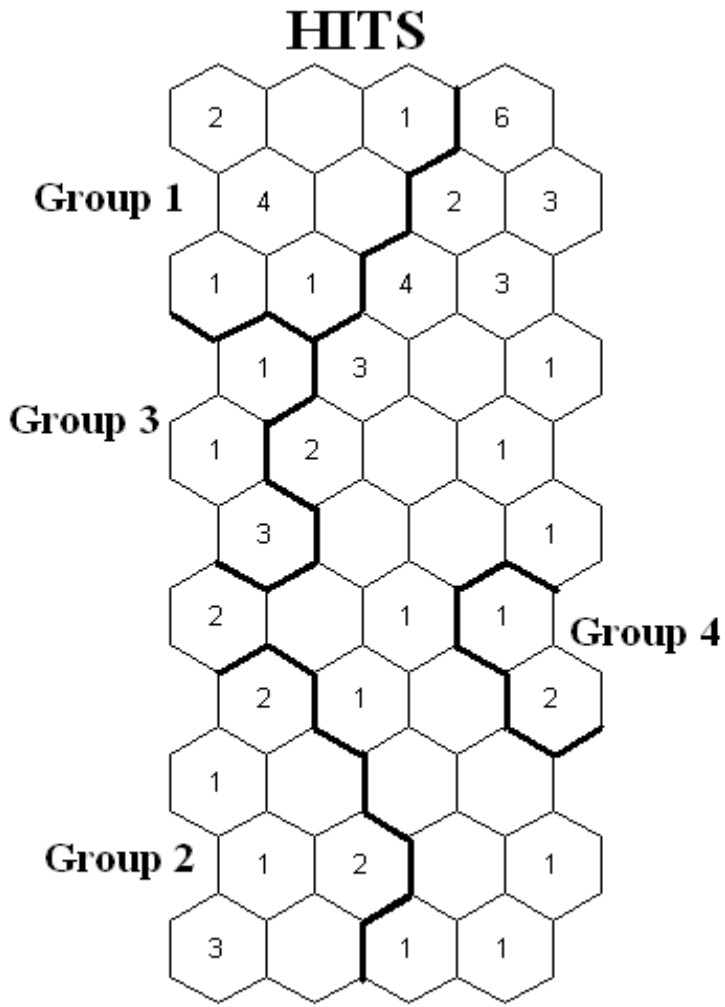


SOM for all sites and 30 parameters in chronic toxicity mode

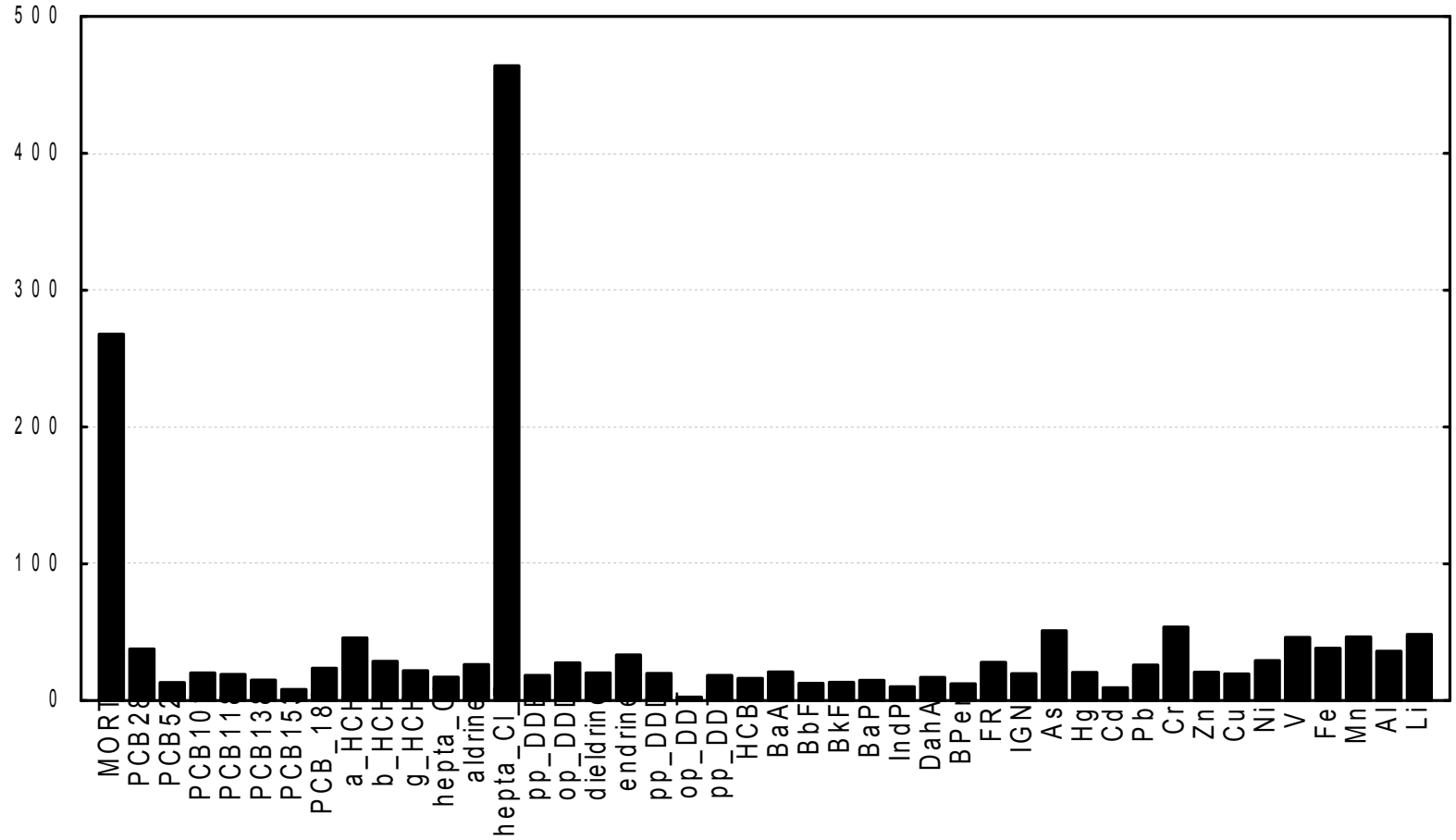


Mortality SOM and hits diagram for the identified 4 chronic toxicity groups

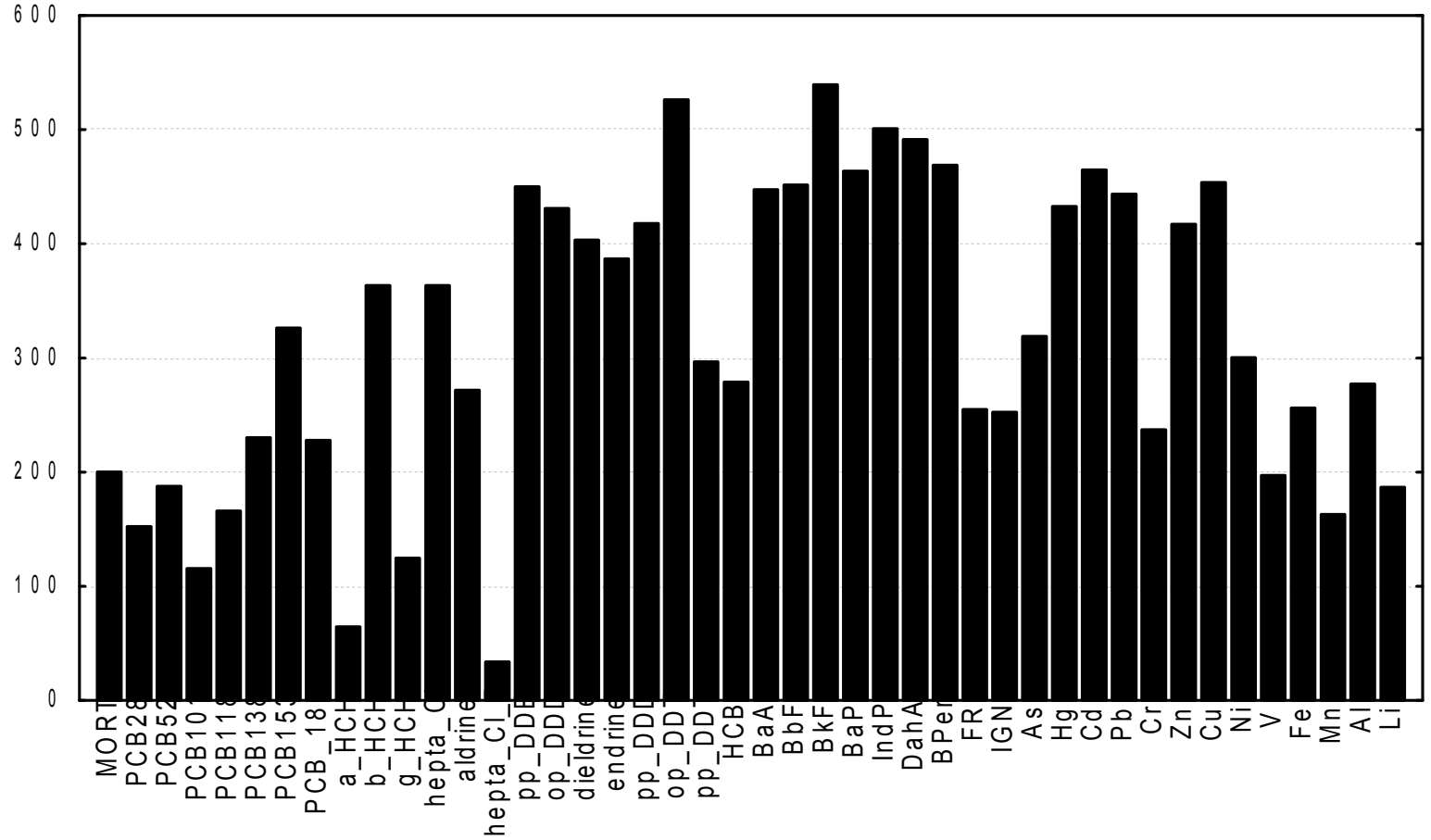




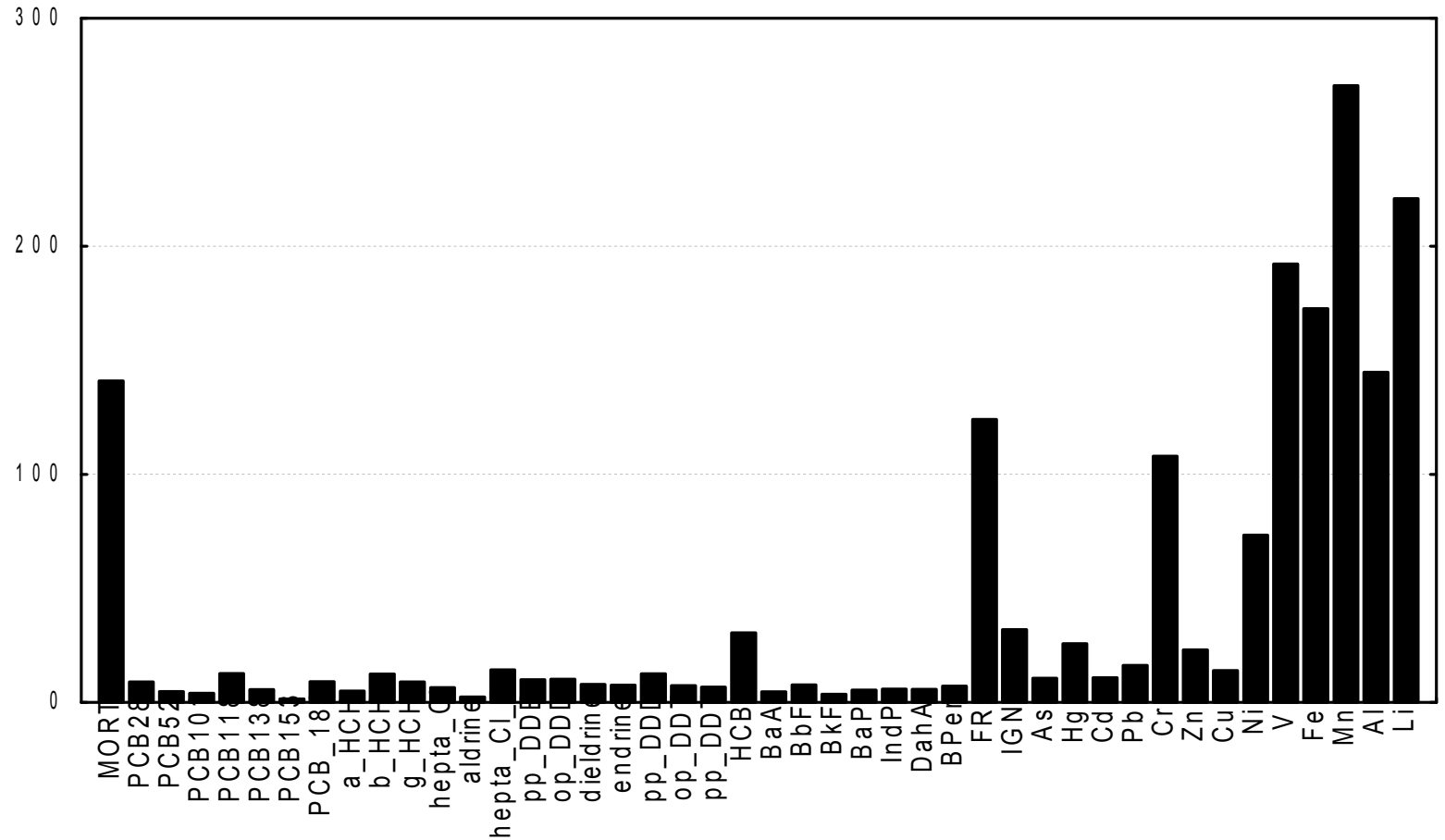
Indices distribution for all parameters with respect to mortality (group 1)



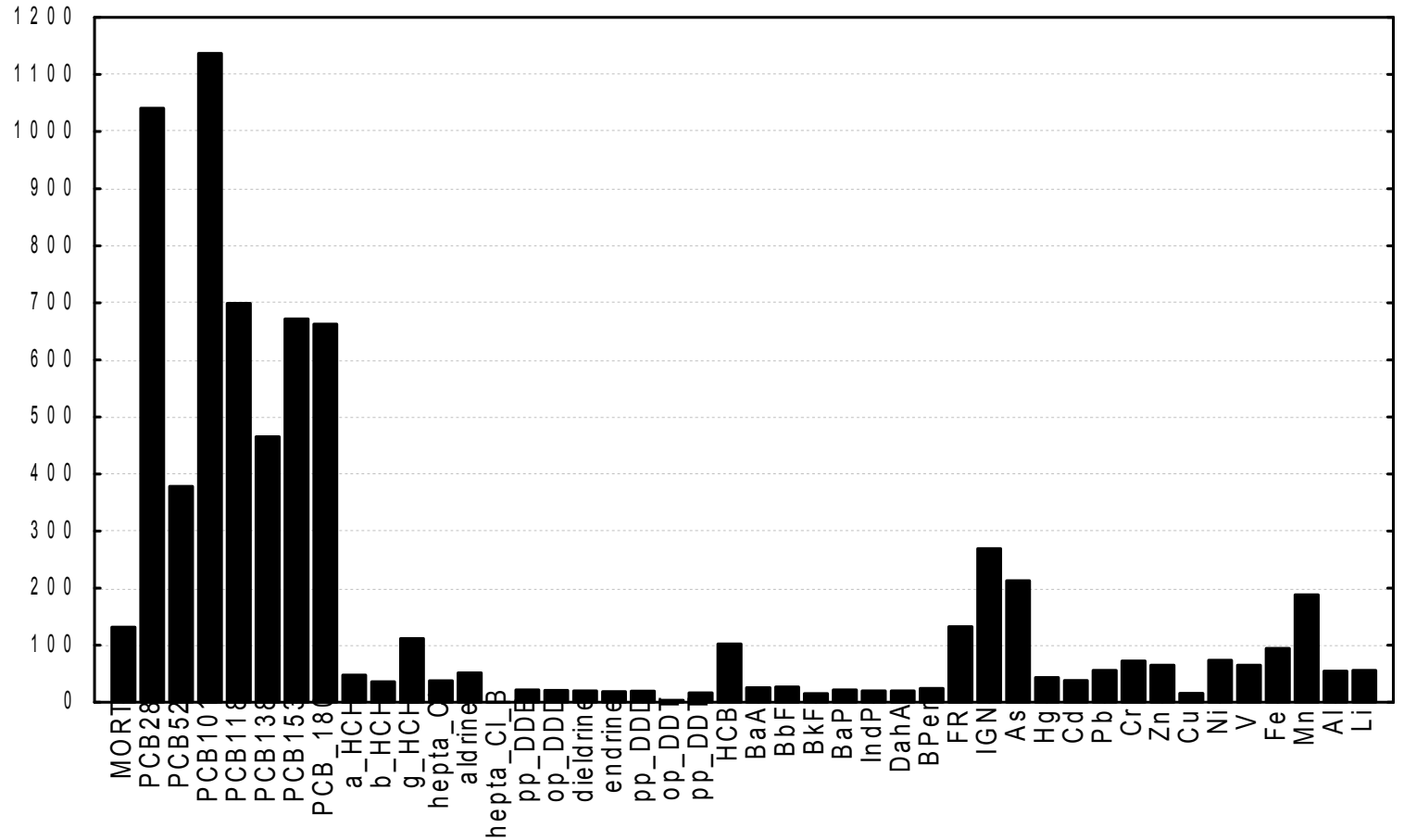
Indices distribution for all parameters with respect to mortality (group 2)



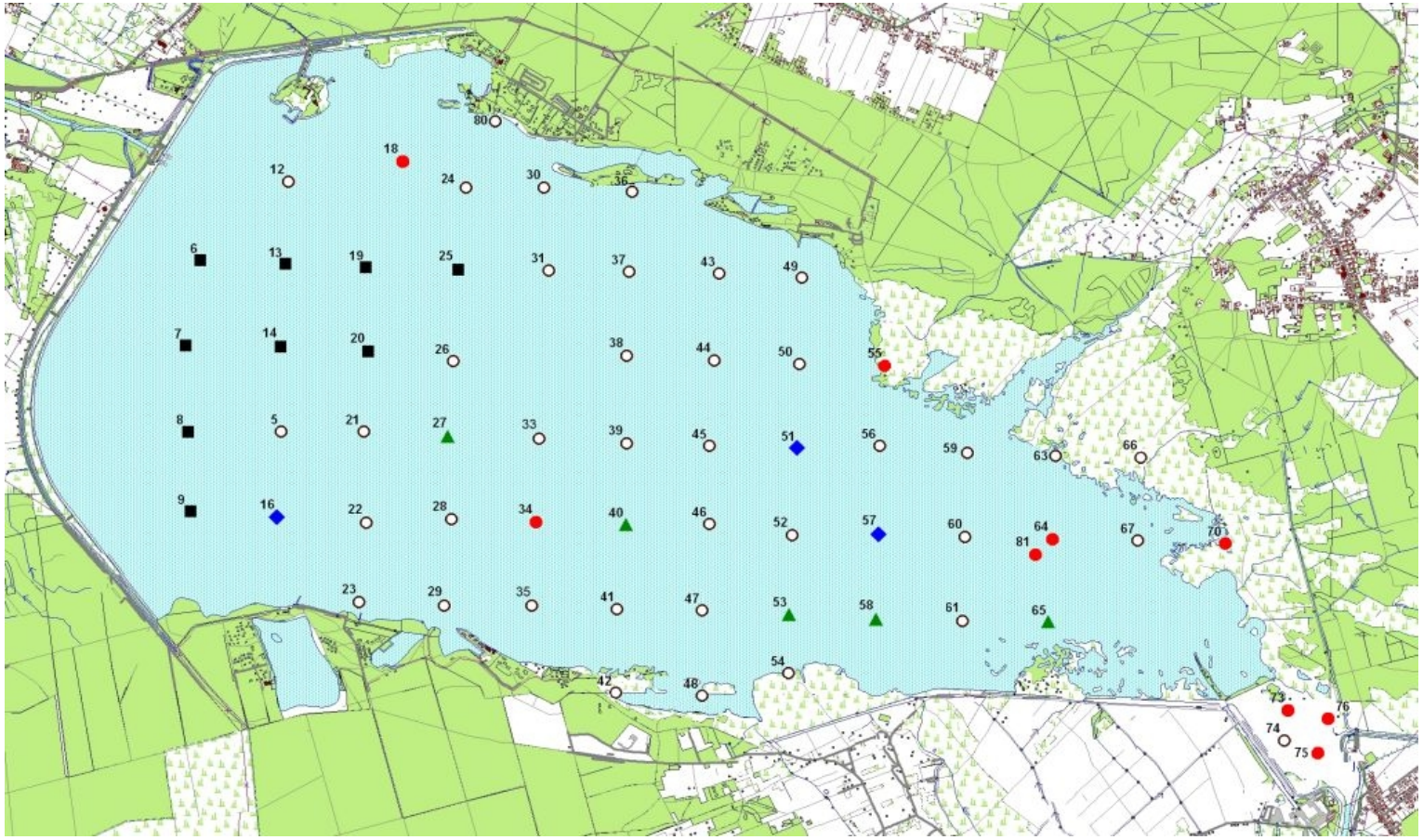
Indices distribution for all parameters with respect to mortality (group 3)



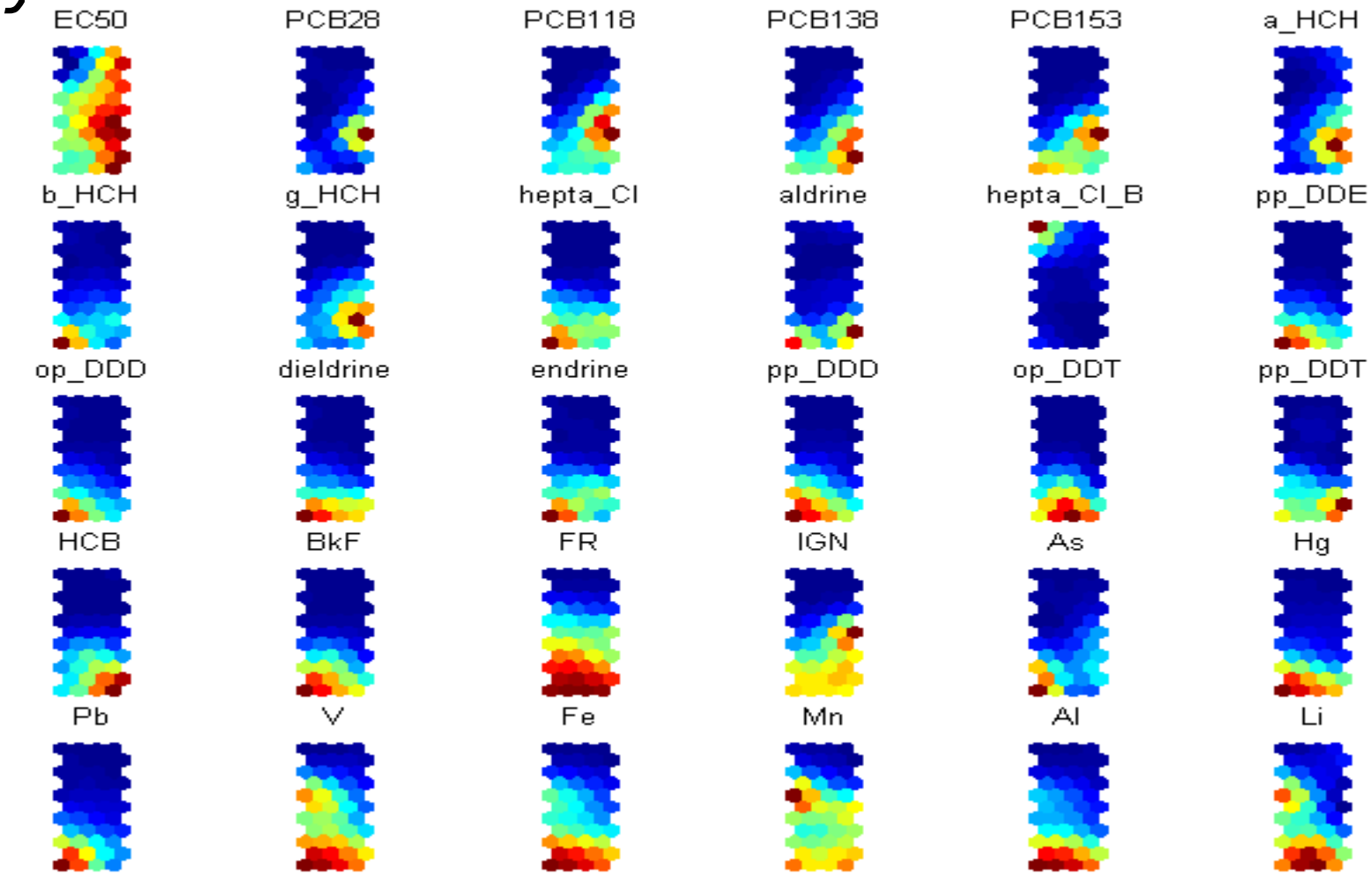
Indices distribution for all parameters with respect to mortality (group 4)



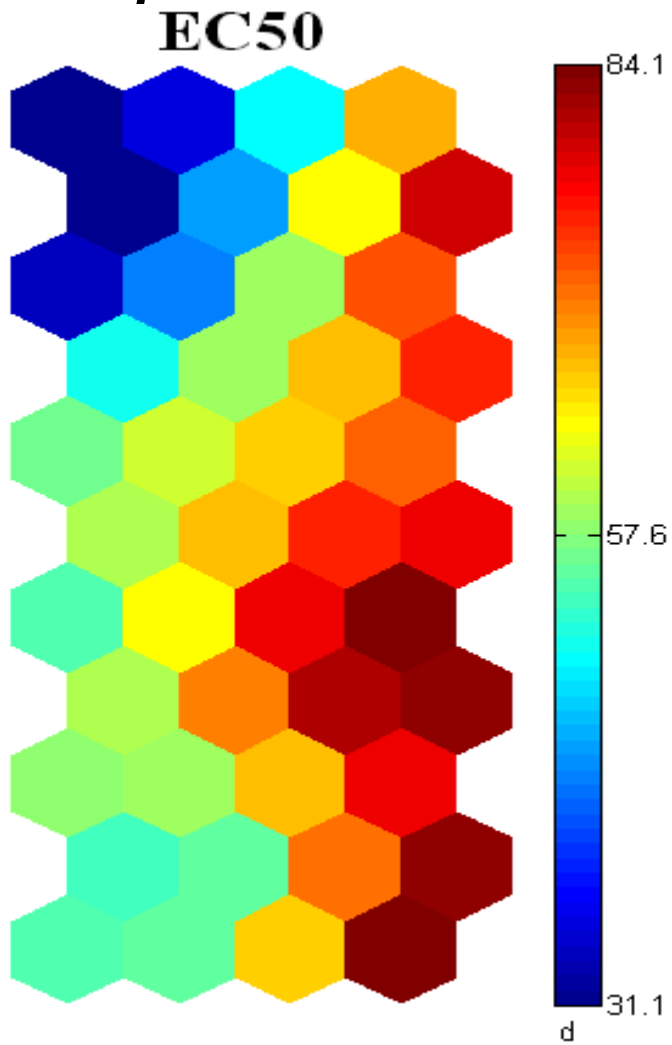
Location of the sites according to the chronic toxicity mode

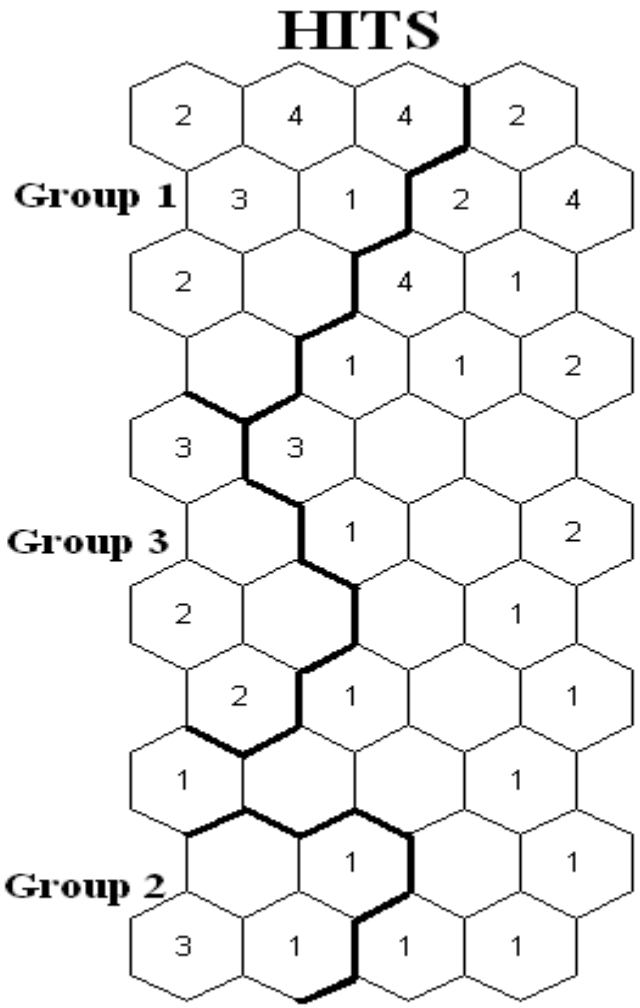


SOM for all sites and 30 parameters in acute toxicity mode

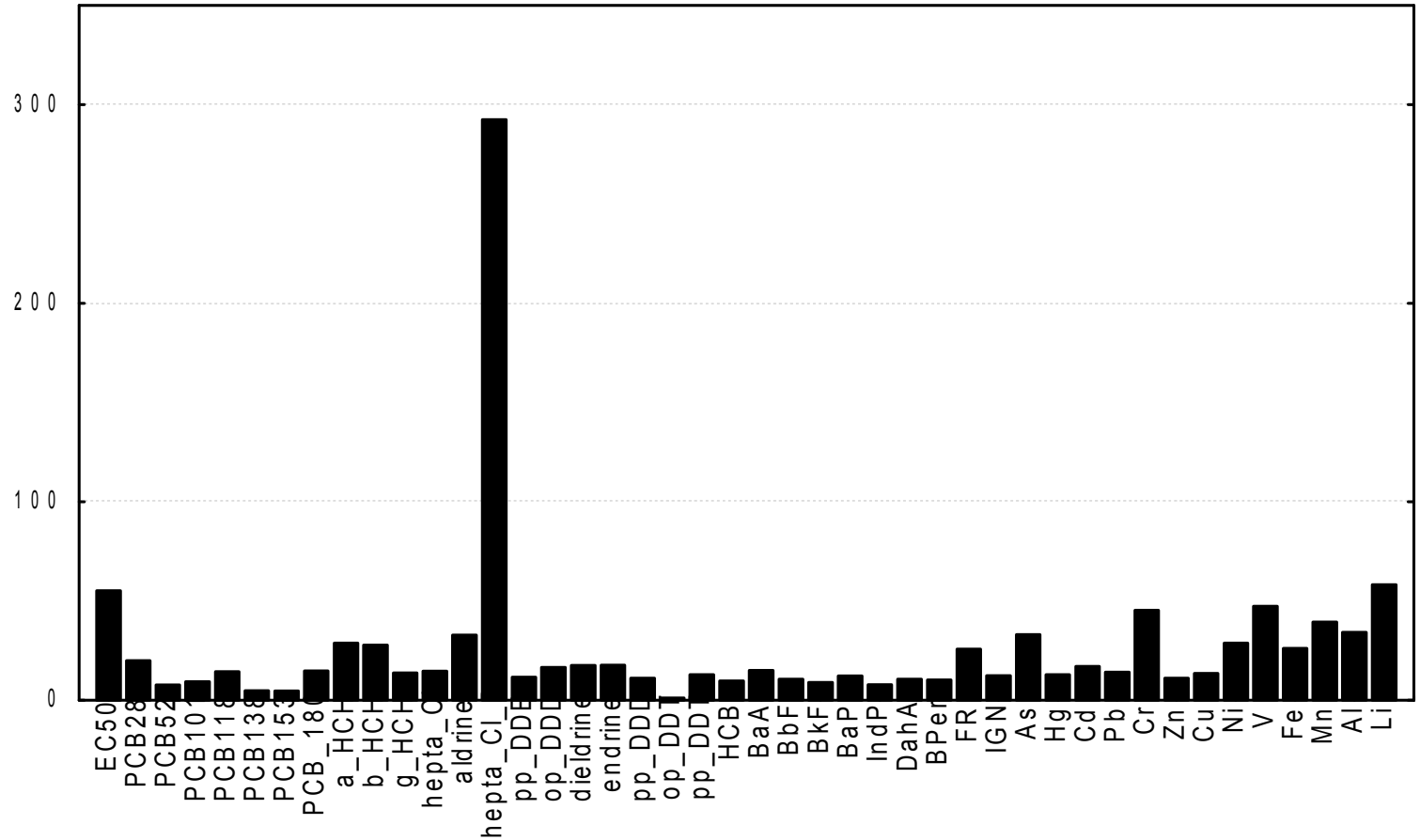


EC50 SOM and hits diagram for the 3 acute toxicity groups identified

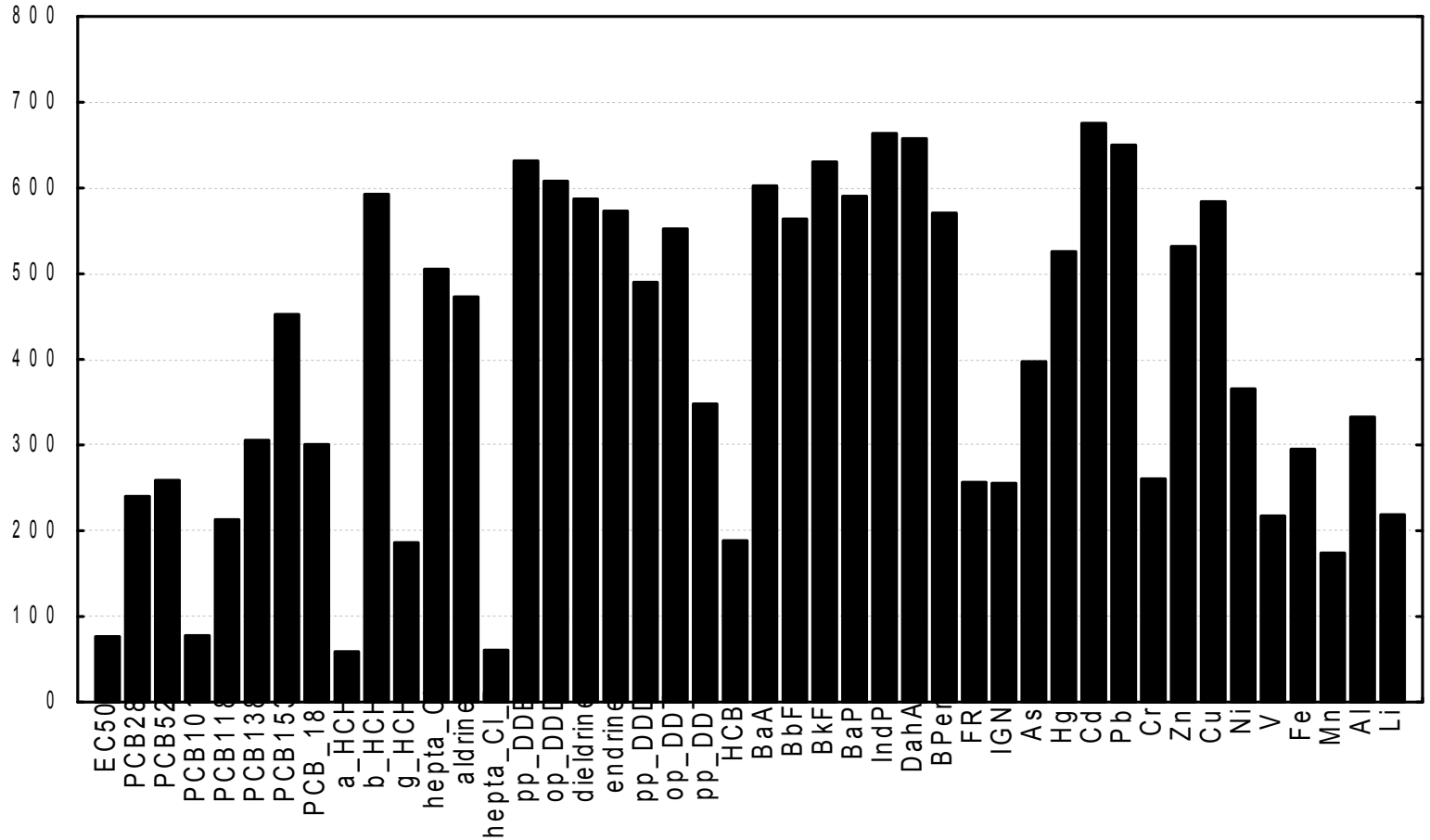




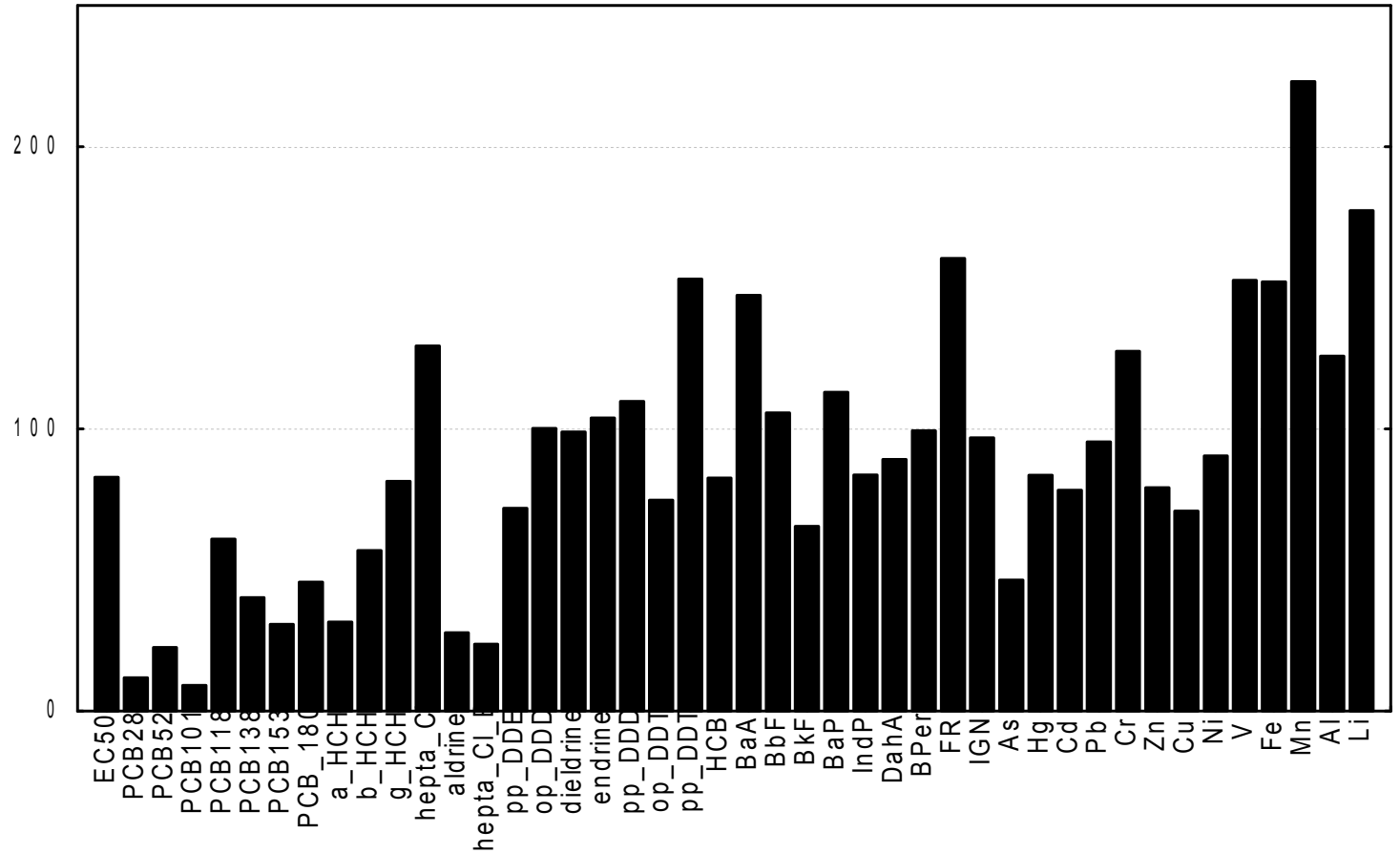
Indices distribution for all parameters with respect to EC50 (group 1)



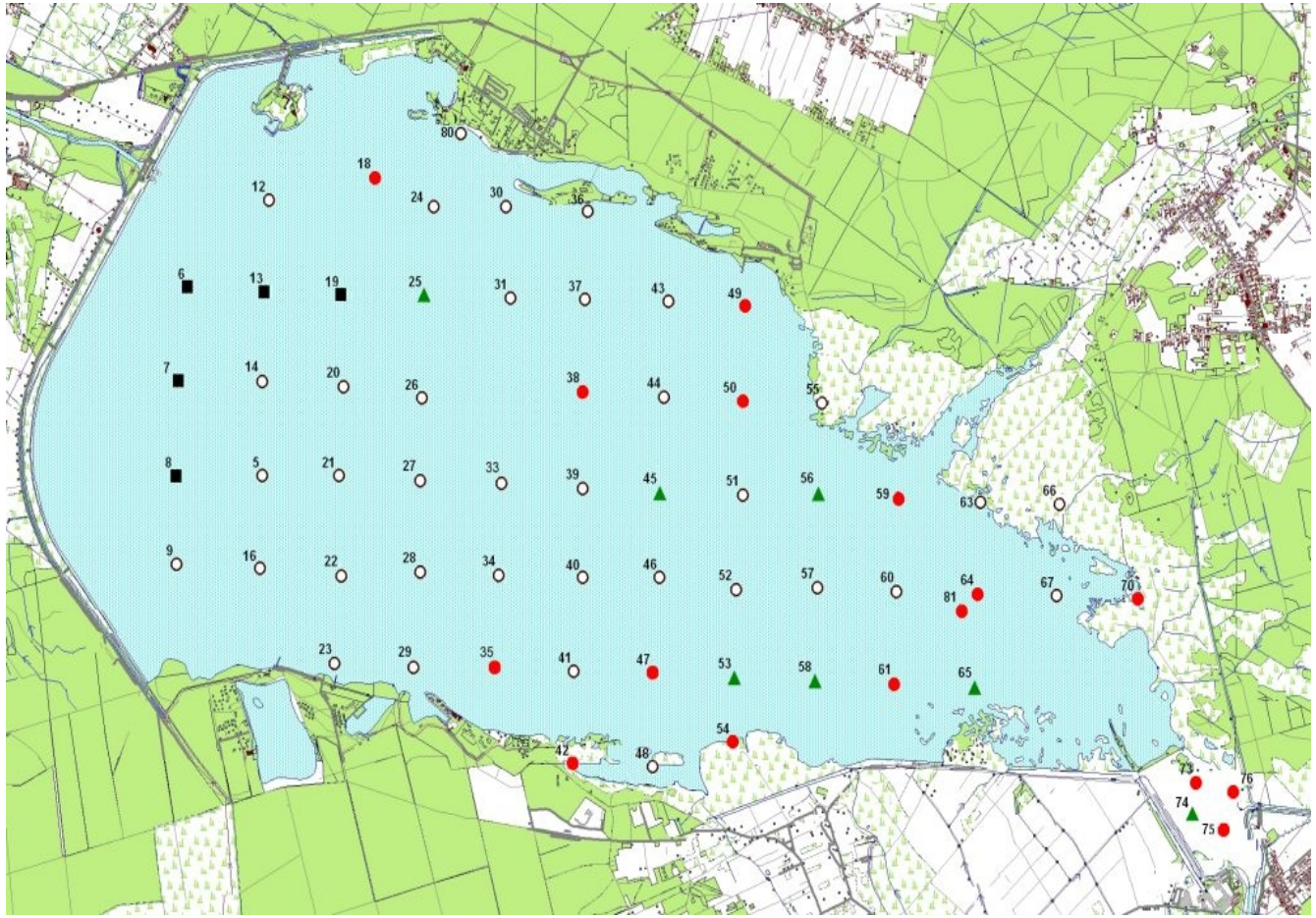
Indices distribution for all parameters with respect to EC50 (group 2)



Indices distribution for all parameters with respect to EC50 (group 3)



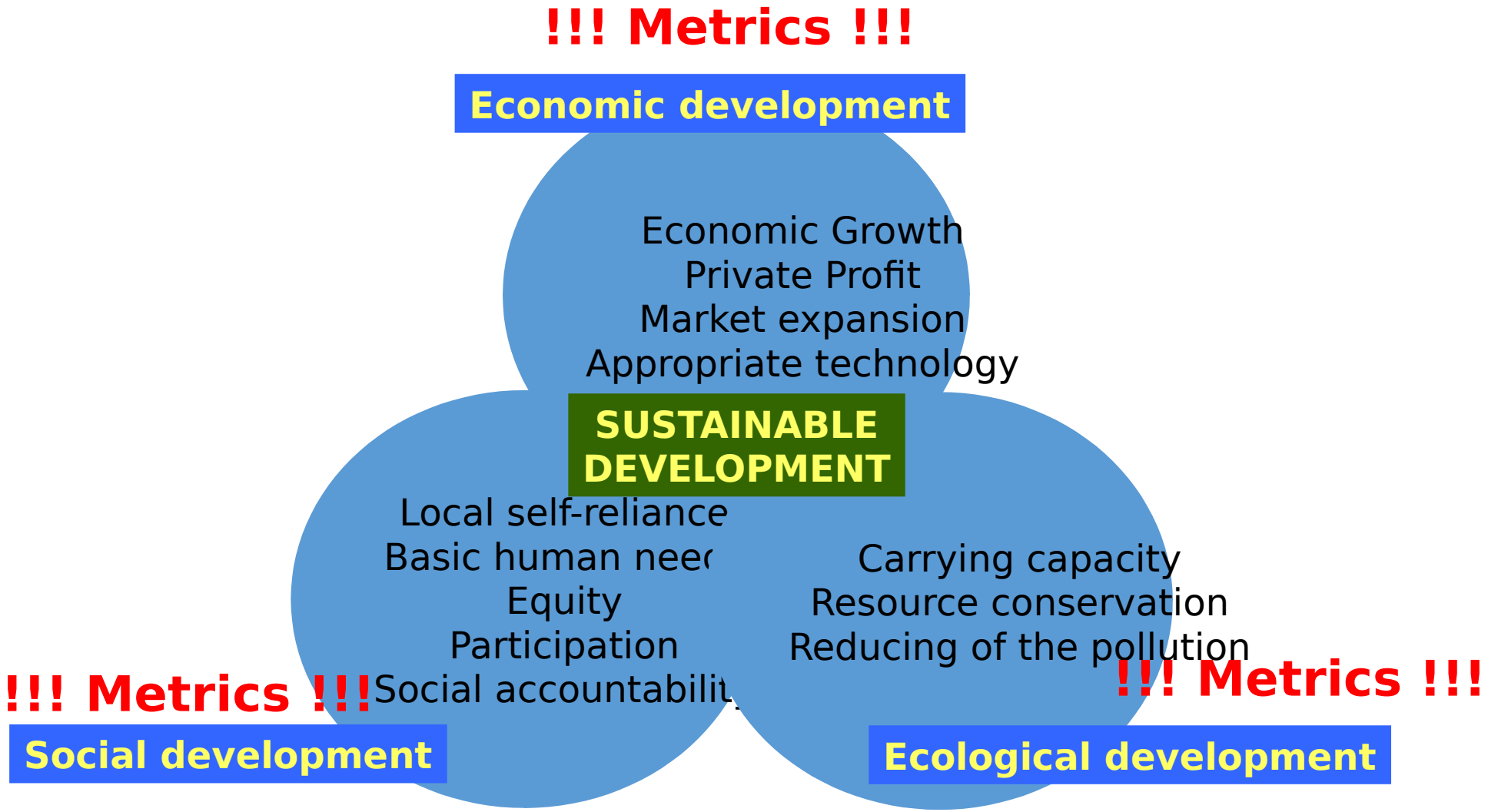
Location of the sites according to the acute toxicity mode



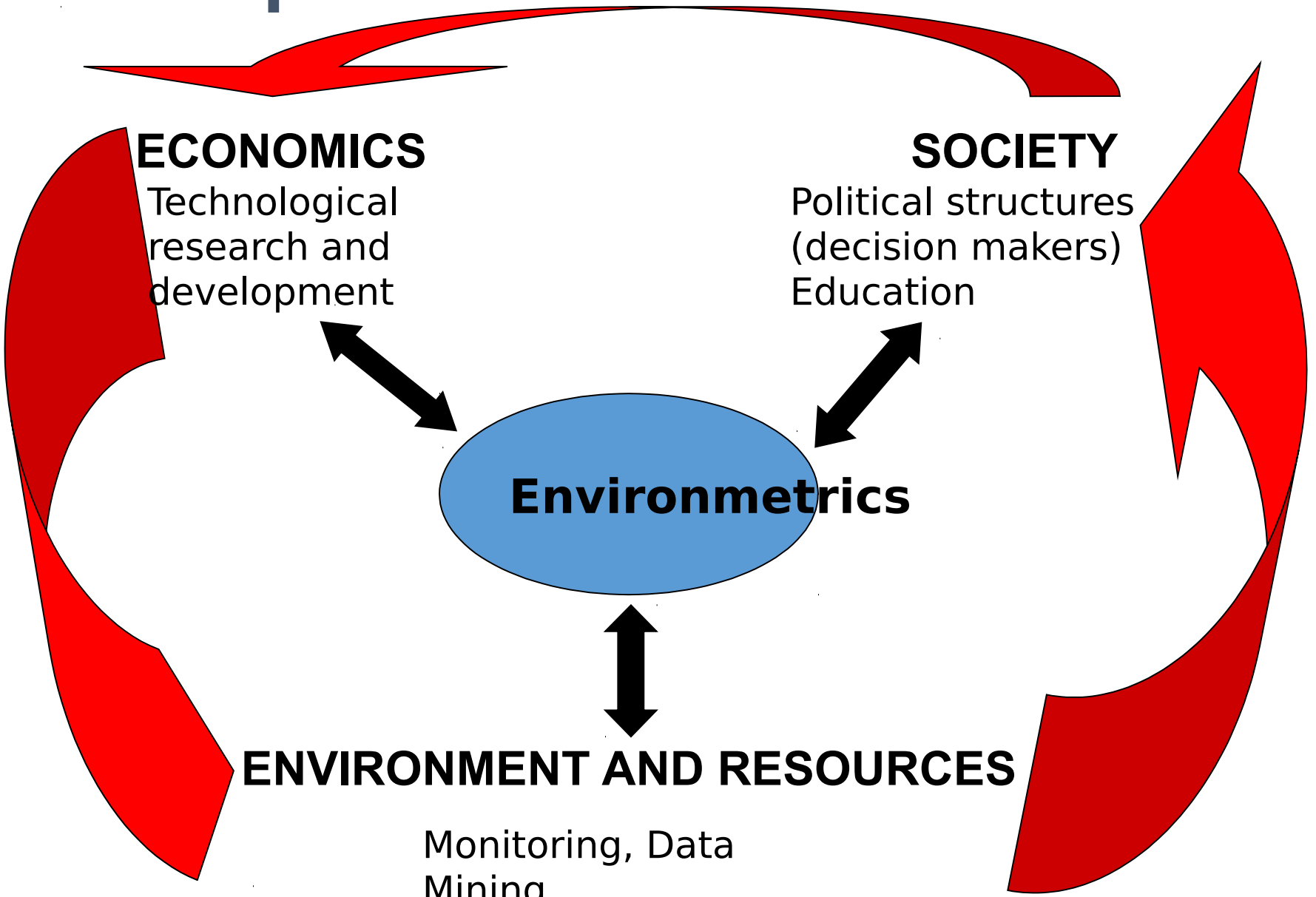
STATEMENT

- Everyone has the right of a safe and sound environment being protected by the law and available for the future generations and ensuring ecological sustainable development and use of natural resources with the condition to support the economic and social progress.

The pillars of sustainable development



The place of Environmetrics



- Thank you for your attention