Risk assessment methods of salinization in Europe

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RAMSOIL

Risk Assessment Methodologies for Soil Threats

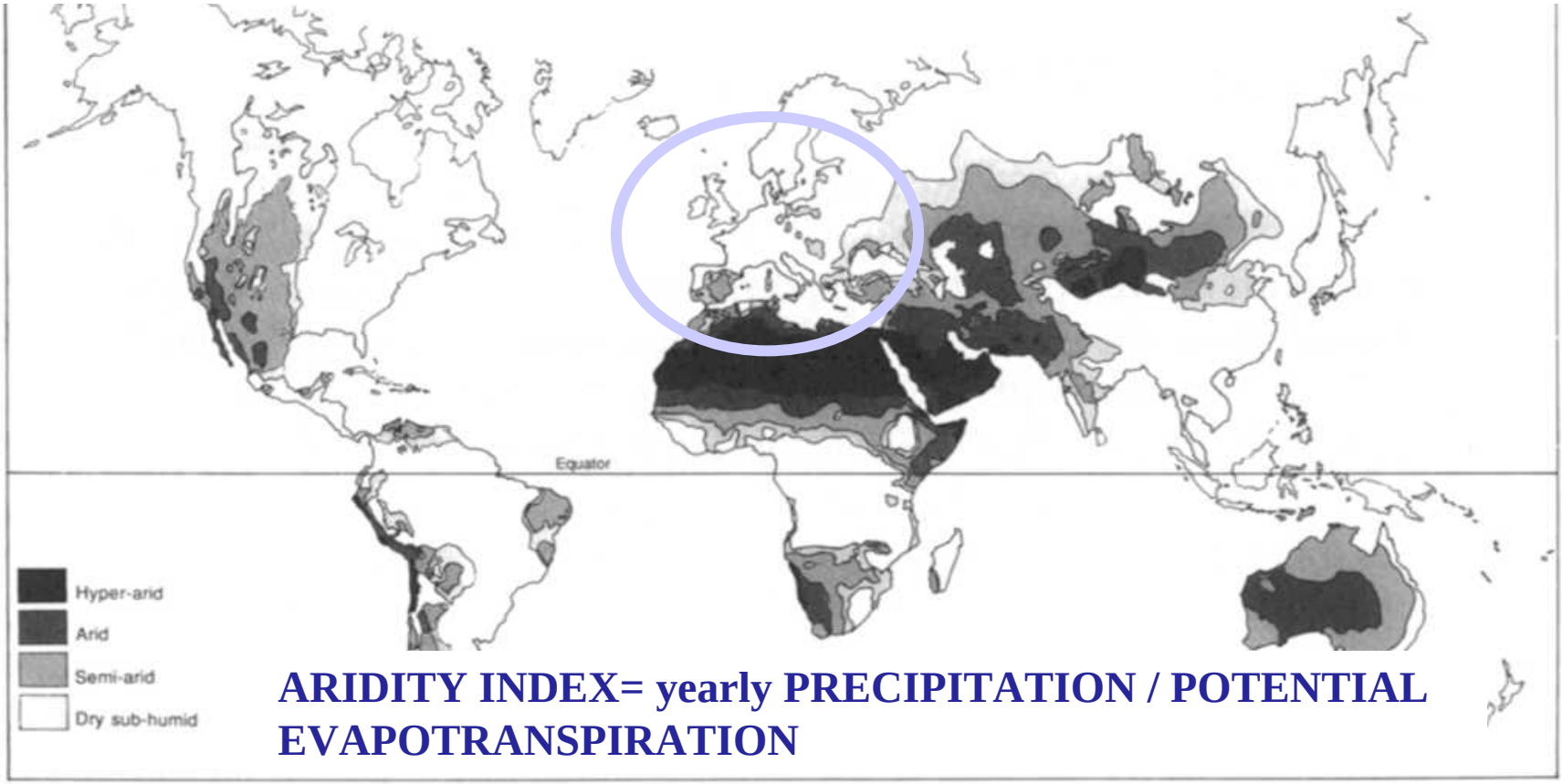
MTA TAKI

SCHEME OF THE PRESENTATION

- Occurrence of Salt-Affected Soils in Europe
- Research on Salt-Affected Soils during Last Ten Years in Europe
- Risk Assessment Methodologies of EU Countries based on the Answers to the RAMSOIL Questionnaires
- Options for Harmonization and Risk Perception
- Conclusions

Occurrence of Salt-Affected Soils in Europe

SALINIZATION IS RELATED TO NEGATIVE SOIL WATER BALANCE AND PRESENCE OF MOBILE SOLUBLE SALTS IN THE SOIL/SUBSOIL/GROUNDWATER. THE MAP OF ARIDITY INDEX SHOWS AREAS WHERE SALINIZATION IS EXPECTED TO OCCUR DUE TO CLIMATIC CONDITIONS.



ARIDITY INDEX= yearly PRECIPITATION / POTENTIAL EVAPOTRANSPIRATION

Hyperarid < 0.05 // Arid 0.05-0.2 // Semiarid 0.21-0.5 // Dry subhumid 0.51-0.65 //

Moist subhumid & humid >0.65

Source: Ghassemi et al. 1995

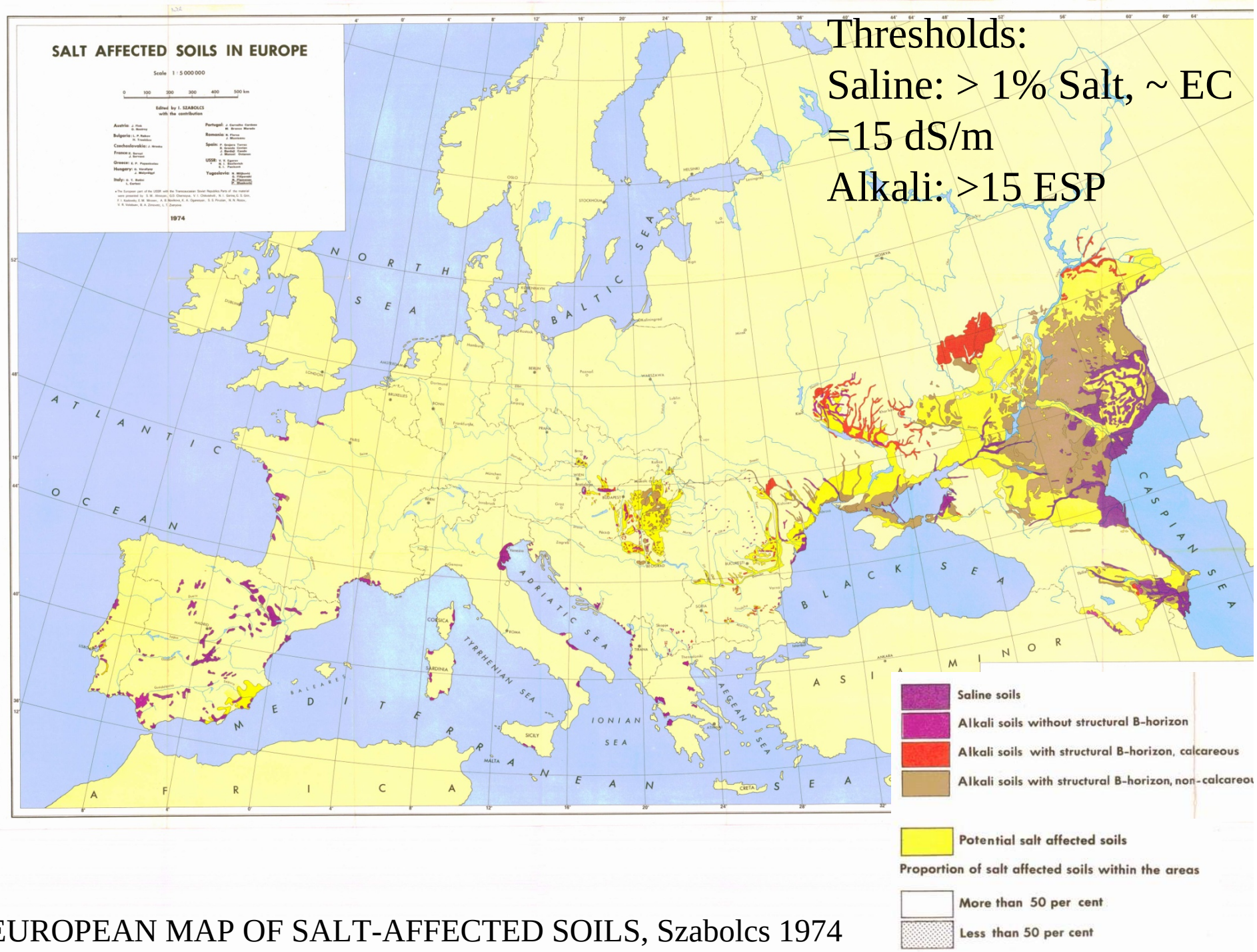
Generally accepted categorization of field soils

Soil category	**EC_e (dS m^{-1})**	**ESP**	**SAR_e**	**pH_e**
Non saline, non alkali/sodic	< 4	< 15	< 13	< 8.5
Saline	> 4	< 15	< 13	< 8.5
Alkali/sodic	< 4	> 15	> 13	> 8.5
Saline - alkali/sodic	> 4	> 15	> 13	> 8.5

AREA (M ha) COVERED BY SALT-AFFECTED SOILS IN EUROPE

TYPE		SODIC SOIL	SALINE SOIL	HUMAN-INDUCED SALINE SOIL
AREA	EUROPE	73	7	4
	ASIA	249	195	53

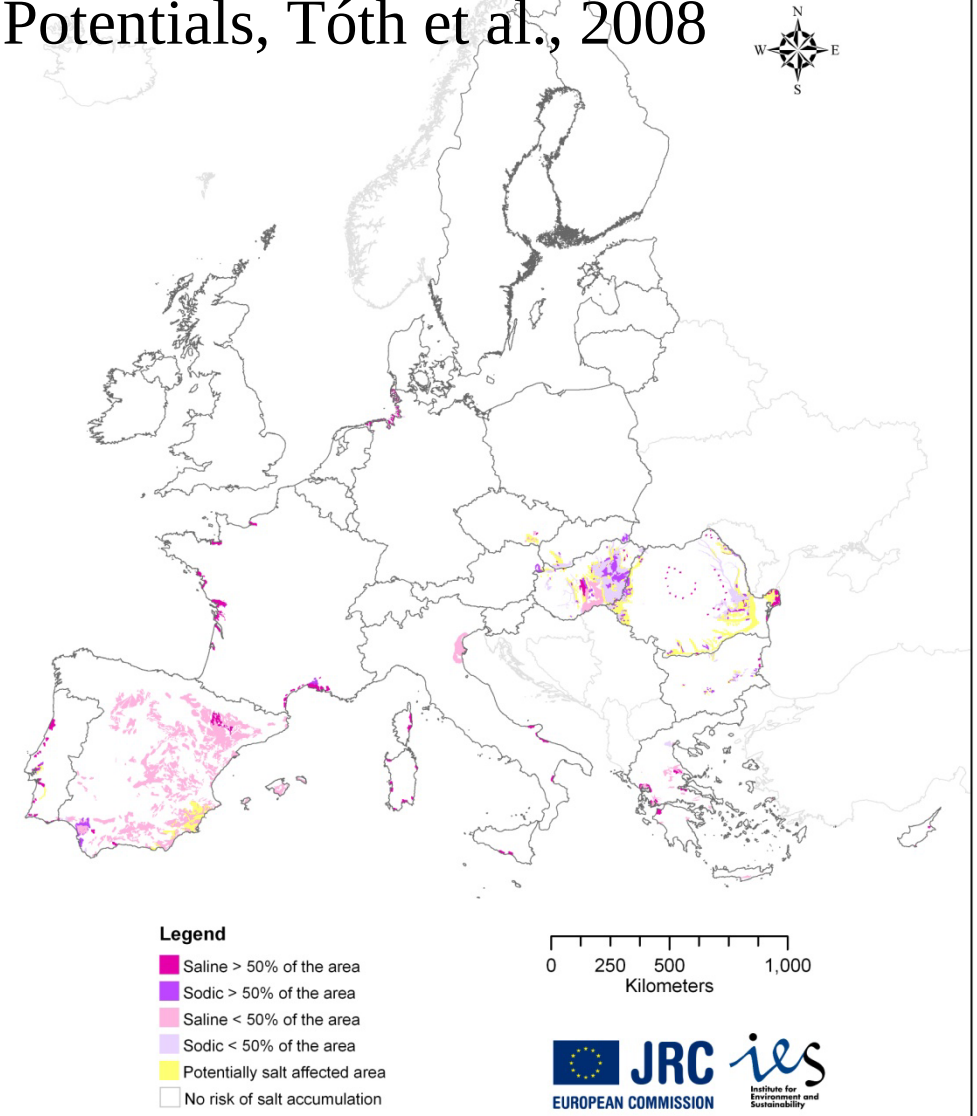
Tanji, 1991



EUROPEAN MAP OF SALT-AFFECTED SOILS, Szabolcs 1974

Country	Mapping unit of the Map of Szabolcs, 1974					Total area. in 1000 ha
	Saline soil	Alkali soil without structural B-horizon	Alkali soil with structural B-horizon		Poten-tial salt affected soil	
			non-calc.	calc.		
Austria	0.5	–	–	–	2.5	3
Bulgaria	5.0	–	20.0	–	–	25
Czechoslovakia	6.2	7.5	2.7	4.3	85.0	105
France	175.0	–	75.0	–	–	250
Greece	...	...	...	...	...	3
Hungary	1.6	58.6	294.0	31.9	885.2	1271.6
Italy	50.0	–	–	–	400.0	450
Portugal	...	...	...	...	...	25
Romania	40.0	100.0		110.0	–	250
Spain	...	...	...	...	...	840
U.S.S.R.	7546.0	1616.0	20382	–	17781.0	47325
Yugoslavia	20.0	50.0	110.0	75.0	–	255

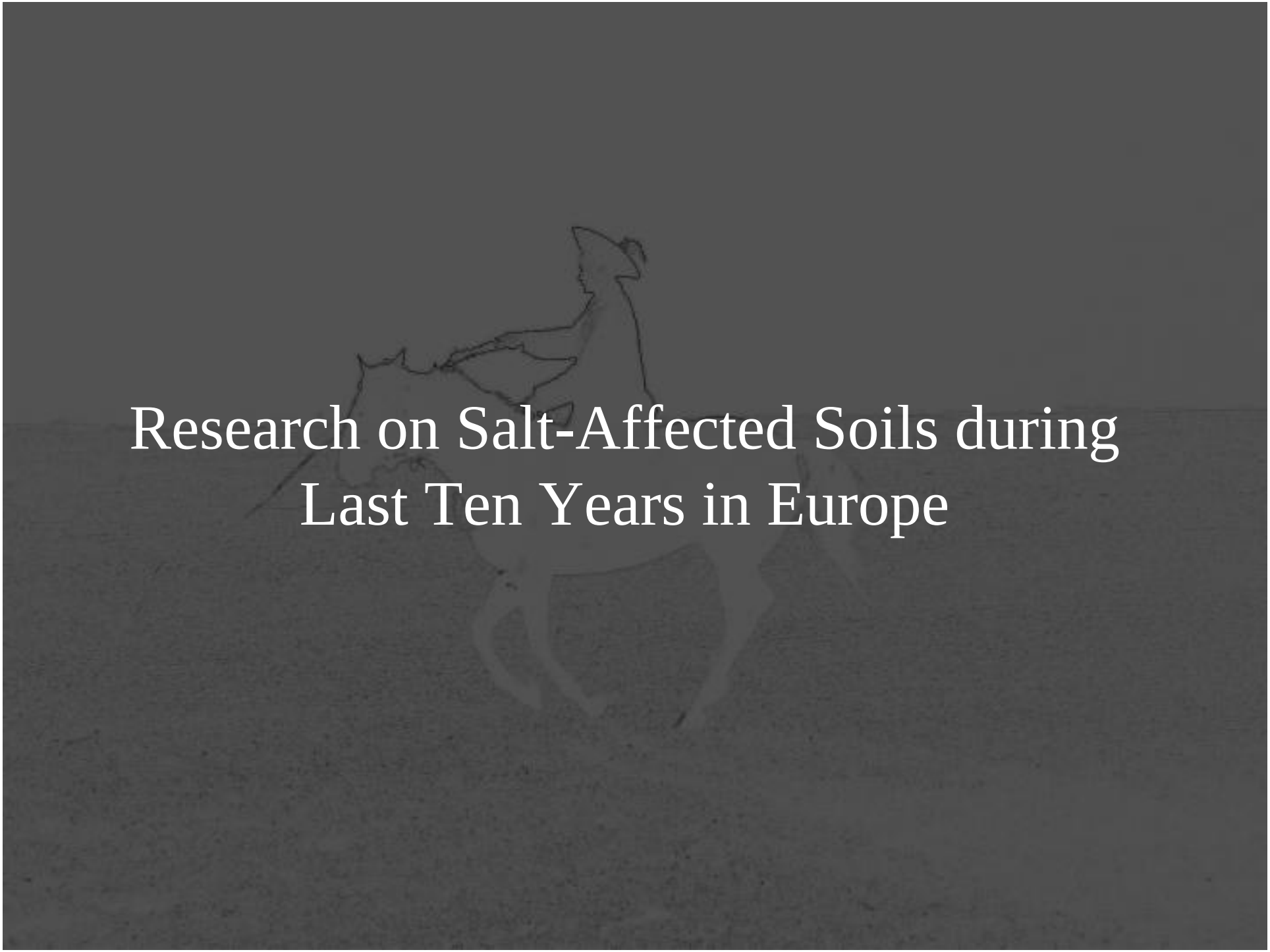
Map of Saline and Sodic Soils in the European Union: Status and Potentials, Tóth et al., 2008



Legend

- Saline > 50% of the area
- Sodic > 50% of the area
- Saline < 50% of the area
- Sodic < 50% of the area
- Potentially salt affected area
- No risk of salt accumulation

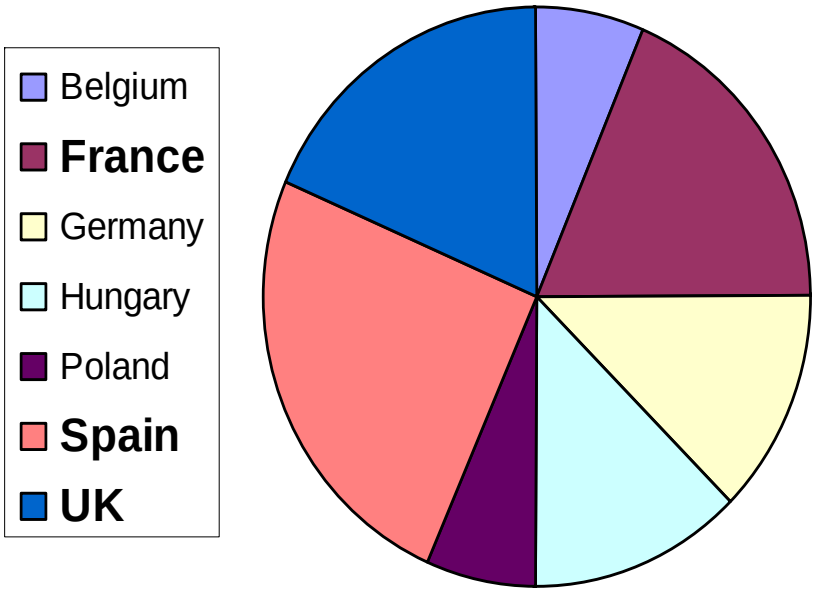
Thresholds:
Saline: > EC =15 dS/m or >4 dS/cm if pH >8.5
Sodic: > 6 ESP

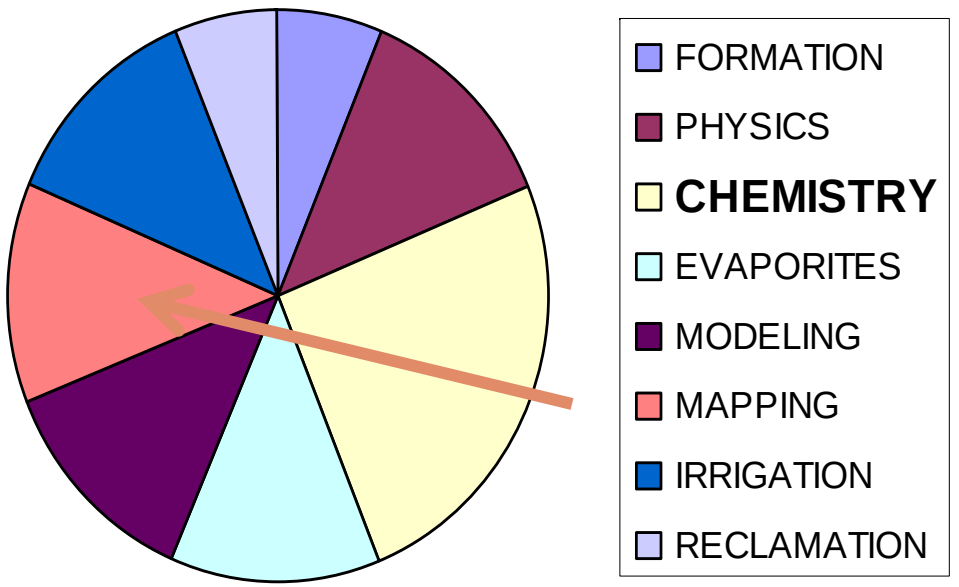


Research on Salt-Affected Soils during Last Ten Years in Europe

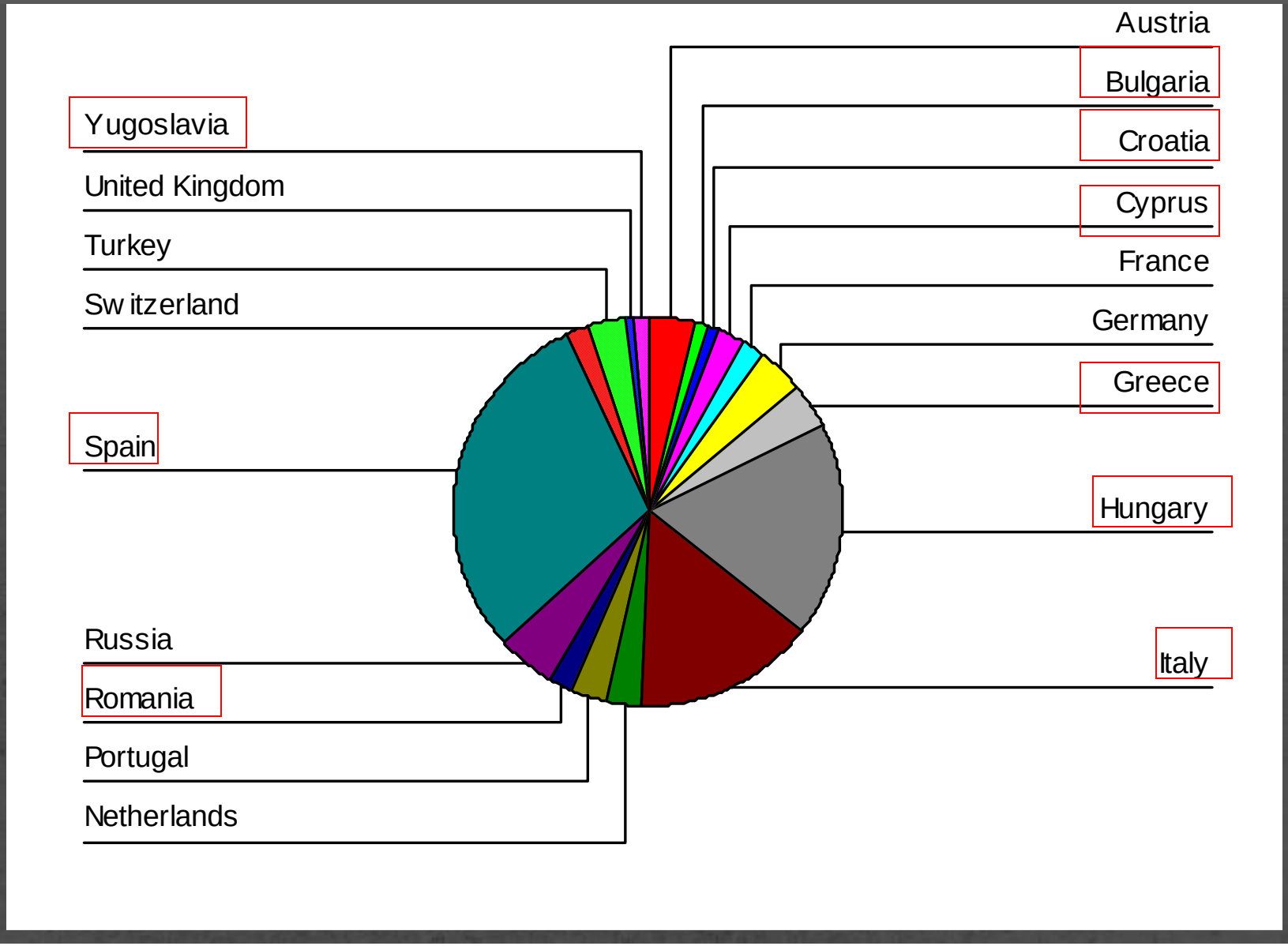
FREQUENCY OF TOPICS AND EU CONTRIES IN PAPERS OF EUROPEAN INTERNATIONAL SOIL SCIENCE JOURNALS ON ISSUES RELATED TO SALINIZATION AND SODIFICATION

(n=15 from Geoderma and European Journal of Soil Science)

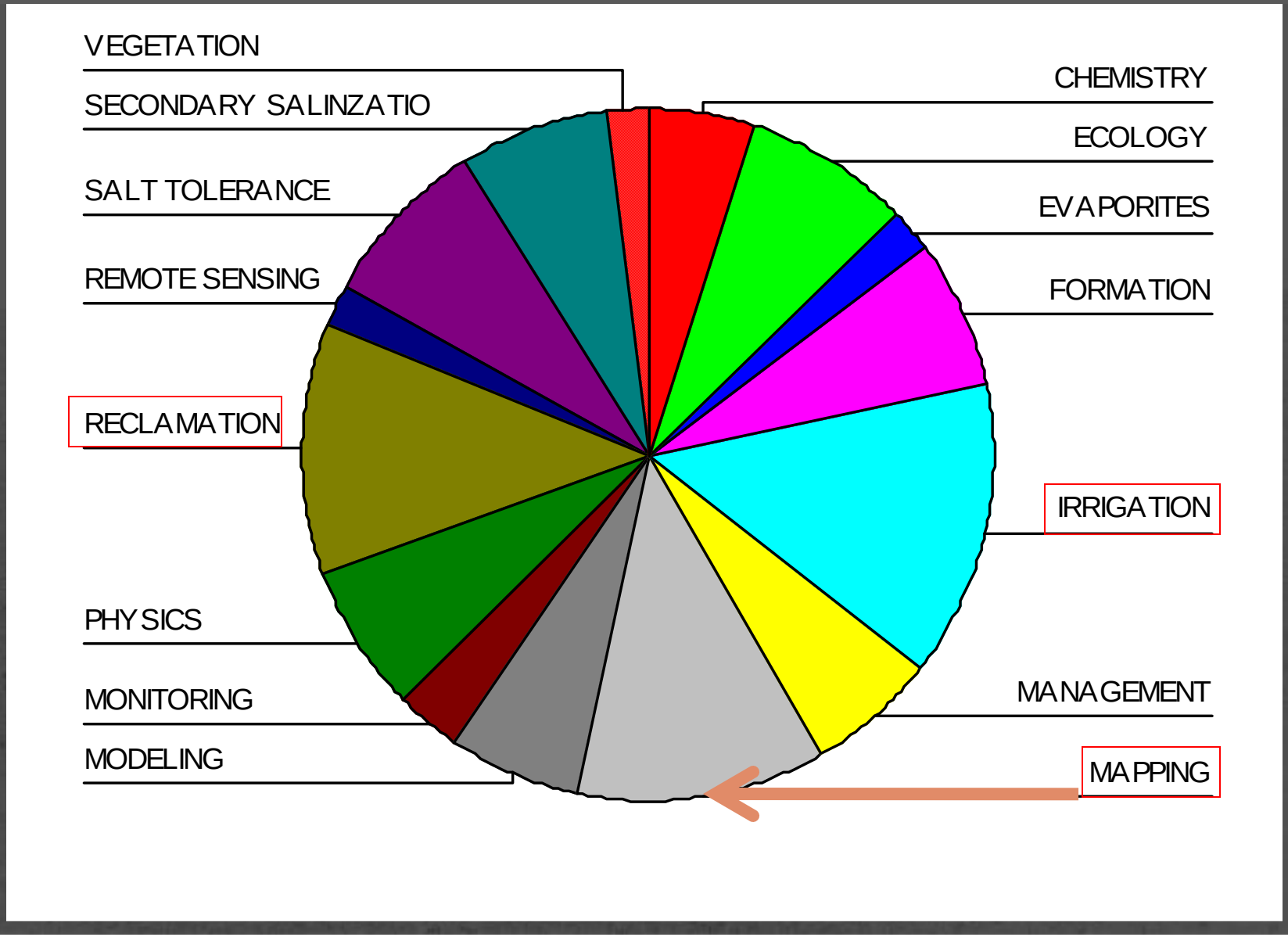


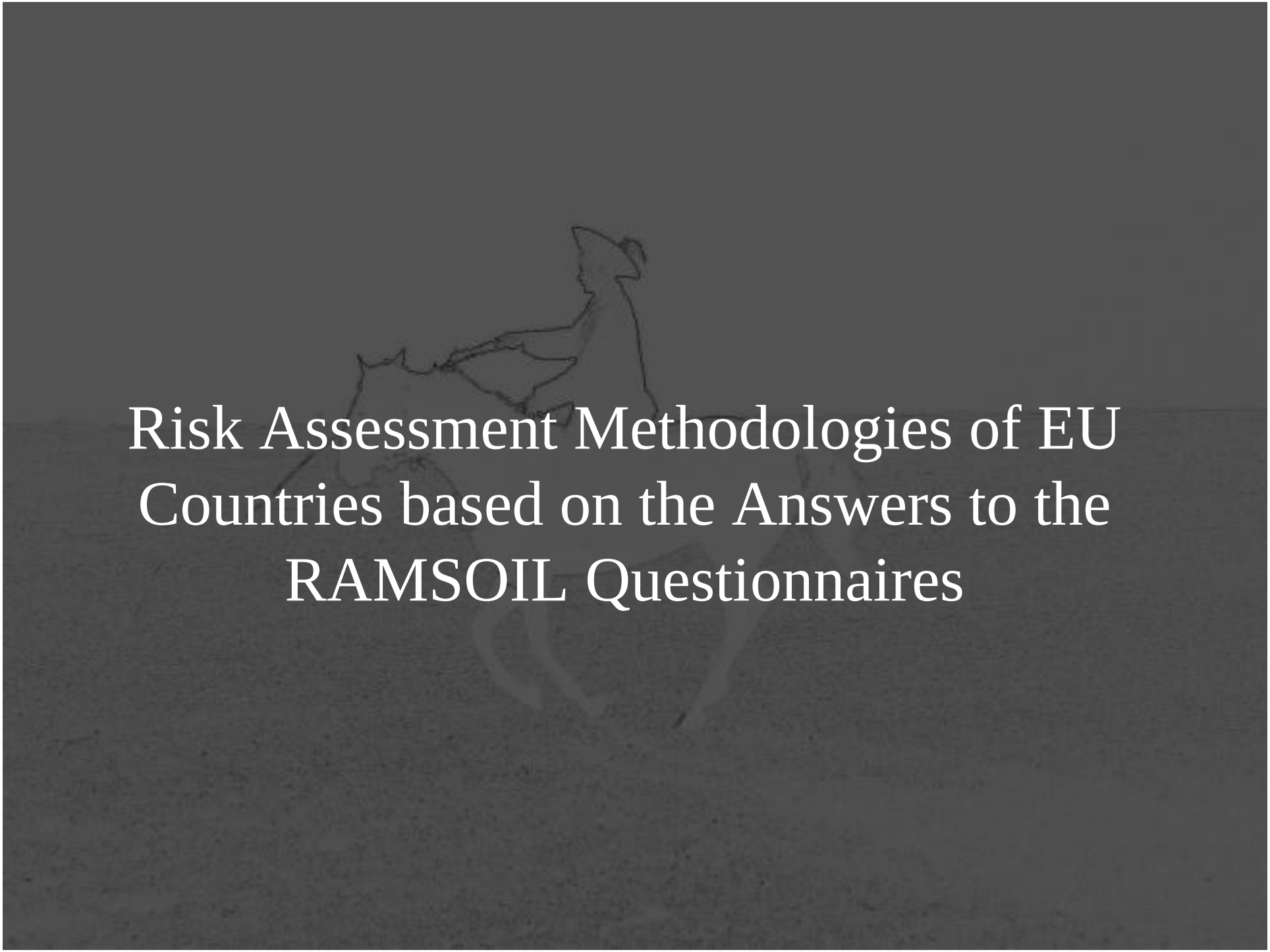


FREQUENCY OF EU CONTRIES IN PAPERS OF SPECIALIZED MEETINGS RELATED TO SALINIZATION AND SODIFICATION (n=101)



FREQUENCY OF TOPICS IN PAPERS OF SPECIALIZED MEETINGS RELATED TO SALINIZATION AND SODIFICATION (n=101)





Risk Assessment Methodologies of EU Countries based on the Answers to the RAMSOIL Questionnaires

1.6 *The EU has identified several factors ('common criteria') that can be used for risk assessments for salinization. Please indicate (by putting a 'x' in the table) which information is used for the risk assessment of salinization in your country.*

Common criteria		Salinization	Comments
Soil typological unit (STU) (soil type)			
Soil texture (STU level)			
O Irrigation areas, chemical properties of irrigated water and type of irrigation techniques			
	Chemical additions		
	Irrigation water quatity		
	Irrigation water sodicity		
	Other		
Climate			
Soil characteristics	Soil [illegible] description		
	Soil salinity in different layers		
	Soil sodicity in different layers		
	Soil moisture balance		
	Soil texture in different layers		
	pH in different layers		
	soil calcium carbonate content		
	SOM levels		
	Other:		
Groundwater information	Groundwater depth (fluctuation)		
	Groundwater salinity		

Aim, Methodology, Data, Techniques, Application scale, Documents, Website, Literature, Spatial & Temporal Resolution Data requirements, Use of models, Existing data & scale, Sensitivity,

Inventory of current RAMs on salinization throughout the EU

Questionnaires with answers were received:

- Cyprus (preferred, not implemented)
- Greece (preferred , not implemented)
- Hungary (2)
- Slovakia
- Spain

+ *Romania*

- RAMs indicated by the countries are all different
- only Hungary has an officially recognized assessment

Country		Cyprus
Aim		Vulnerability and risk mapping
Performing institution		Government, Department of Agriculture
Methodology		Quantitative- process based-model, expert analysis
	Data	Soil texture, chemical properties of irrigation water, climate, soil characteristics, groundwater information
	Techniques	Field observations and laboratory analysis
	Application scale	1:25000
Documents		Vulnerability zone map Risk zone map
Comments		The available data derive from previous projects and studies.
Website		Not available
Literature		Calcareous Soils of Cyprus (Cypriot- German Geological and Pedological Project, BGR)
Resolution	Spatial	1:25000
	Temporal	The time interval deperds on the sort of data
Data requirements		
Use of models & calibration/validation data		
Existing data & scale		Only case studies
Sensitivity		xx
Estimated results		

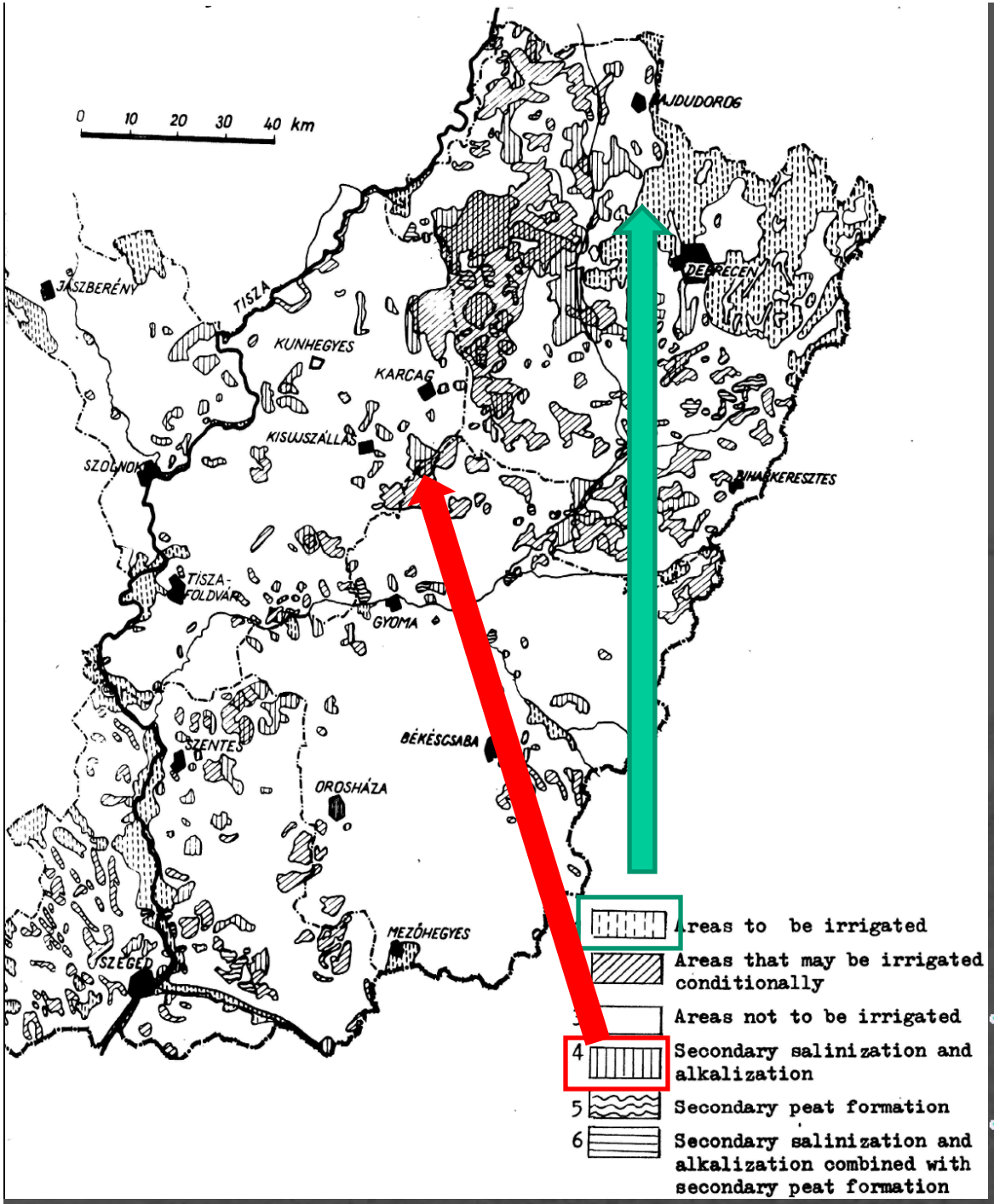
Cyprus

Country		Greece
Aim		Vulnerability mapping
Performing institution		Soil Science Institute of Athens (National Agricultural Research Foundation)
Methodology		Qualitative expert based, Quantitative empirical model, Expert analysis
	Data	Soil typological unit (STU) (soil type), chemical properties of irrigation water, climate, soil characteristics, groundwater information, pedotransfer functions, soil hydraulic properties, land use, simulation model
	Techniques	Field observations and laboratory analysis
	Application scale	1:5000
Documents		Vulnerability zone map
Comments		RAM for salinization in Greece can be based on parameters such as topography, soil texture, hydrogeology, ground water level and quality, water usage, distance from the sea and balance of rainfall vs. evapotranspiration. Direct measurements of soil electrical conductivity either in the field or in the lab might be an acceptable approach.
Website		http://www.science.org.au/nova/032/032sit.htm http://www.kcl.ac.uk/projects/desertlinks http://www.ciheam.org/index.jsp http://www.fao.org/ag/agl/aglw/aquastat/regions/neast/index9.stm
Literature		
Resolution	Spatial	1:5000
	Temporal	Once every 5-10 years
Data requirements		Direct measurements of a [illegible]nd
Use of models & calibration/validation data		
Existing data & scale		Only case studies
Sensitivity		Fast, immediate response
Estimated results		

Greece

Country		Hungary (Tisza irrigation project evaluation)
Aim		Hazard mapping, risk mapping
Performing institution		Research Institute for Soil Science and Agricultural Chemistry (RISSAC) of the Hungarian Academy of Sciences
Methodology		Quantitative process based-model
	Data	Soil typological unit (STU) (soil type), soil texture (STU level), chemical properties of irrigation water, soil characteristics, groundwater information, soil hydraulic properties, land use, spatial soil information
	Techniques	Field observations, geographical information systems, and laboratory analysis
	Application scale	1:25000
Documents		Hazard zone map Risk zone map
Comments		xx
Website		xx
Literature		Szabolcs, I., Várallyay, Gy., Darab, K., 1976. Soil and hydraulic survey for the prognosis and monitoring of salinity and alkalinity. In: Prognosis of Salinity and Alkalianity. Report of an Expert Consultation, Rome, 3–5 June, 1975. Soil Bulletin No. 31. 119–129. FAO. Rome.
Resolution	Spatial	1:25000
	Temporal	Annually, once every 1-5 years or once every 5-10 years: Depending on the variability of parameters
Data requirements		Direct measurements, [illegible]
Use of models &		
Existing data & scale		Regional
Sensitivity		Fast, immediate response

Hungary 1



Example map created for the eastern part of the Hungarian Plain

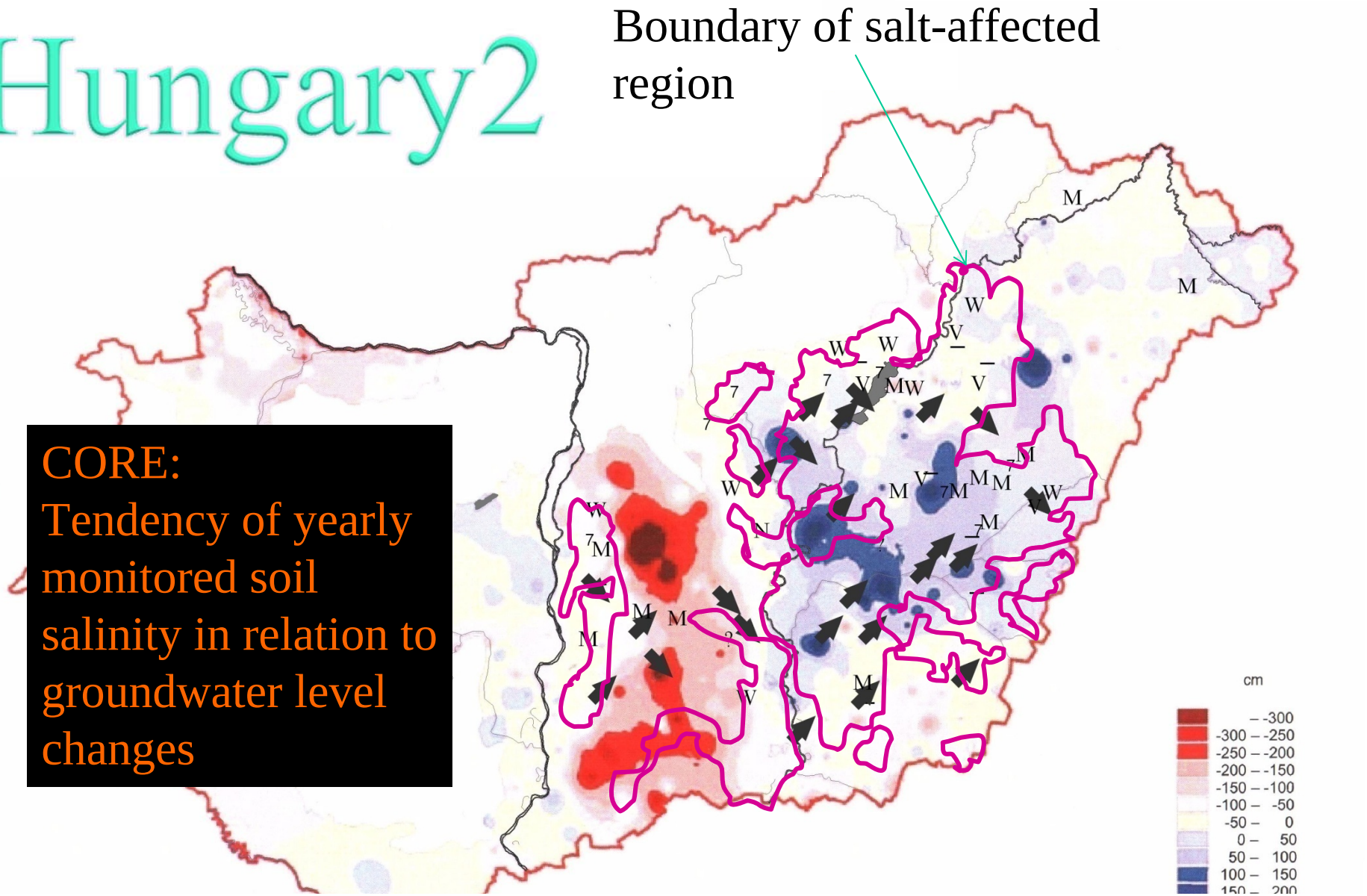
CORE:
Prediction of the effect of field irrigation on soil properties in view of groundwater depth & salinity through the estimation of salt balance

Hungary 1

Country		Hungary (TIM evaluation)
Aim		Hazard mapping (monitoring)
Performing institution		Hungarian Soil Conservation Service
Methodology		Quantitative process based-model
	Data	Climate Soil pH Soil salinity Groundwater depth
	Techniques	Field observations, laboratory analysis
	Application scale	1236/93.000km2
Documents		Kovács et al., 2006
Comments		
Website		http://www.taki.iif.hu/english/soilsci/toth/abstr/KTM2006_2_FULL.pdf
Resolution	Spatial	1: 1 000 000
	Temporal	annually
Data requirements		Direct measurements of a state
Use of models & calibration/validation data		
Existing data & scale		National
Sensitivity		Fast, immediate response

Hungary2

Hungary2



The extent of groundwater drop and rise in Hungary compared to the baseline years of 1956-60, and the clear tendencies of soil salinity changes at 23 monitoring points during 1992 and 2000. Arrow "↘" indicates decreasing and arrow "↗"indicates increasing yearly soil salinity. Other, (W, M etc.) monitoring points (42) signs indicate not clear tendency of yearly soil salinity changes.

Country		Slovakia
Aim		
Performing institution		Soil Science and Conservation Research Institute
Methodology		Qualitative expert-based
	Data	Soil typological unit (STU) (soil type), soil texture (STU level), climate, soil characteristics, groundwater information, pedotransfer functions, soil hydraulic properties, land use
	Techniques	Remote sensing
	Application scale	
Documents		Elements at risk
Comments		
Website		
Resolution	Spatial	
	Temporal	Annually
Data requirements		Direct measurements of a state/trend
Use of models & calibration/validation data		
Existing data & scale		National
Sensitivity		Don't know
Estimated results		

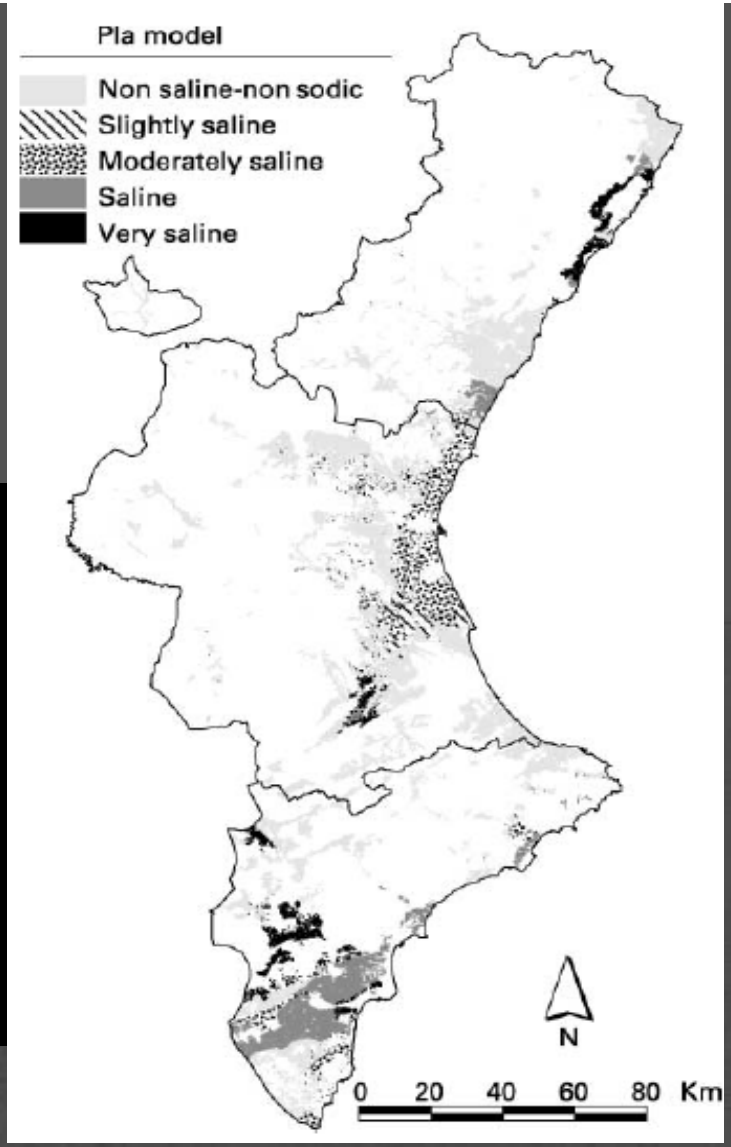
Slovakia

Country		Spain
Aim		Risk mapping
Performing institution		Desertification Research Centre
Methodology		Quantitative – process based model Qualitative – weighting-rating
	Data	Soil typological unit (STU) (soil type), soil texture (STU level), chemical properties of irrigation water, climate, soil characteristics, groundwater information, pedotransfer functions, soil hydraulic properties, land use, spatial soil information
	Techniques	Using three base maps (drainage map, climate classification map, and irrigation water quality map) in GIS program. Field observations, geographical information systems, and laboratory analysis
	Application scale	Regional (1:?)
Documents		Risk zone map
Comments		
Website		xx
Literature		De Paz, J.M., Visconti, F., Zapata, R. & Sánchez, J. (2004) The Use of Two Logical Models Integrated in a GIS to Evaluate the Soil Salinization in the Irrigation Land of Valencian Community (Spain). Soil Use and Management, 20: 333-342
Resolution	Spatial	Regional (1:?)
	Temporal	At the moment 2 years data in four period/year+irrigation periods+after intense rain events
Data requirements		Modelled and direct measurements of a state/process
Use of models & calibration/validation data		
Existing data & scale		Only case studies
Sensitivity		Intermediate response
Estimated results		

Spain

Spain

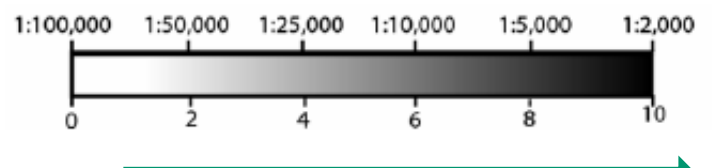
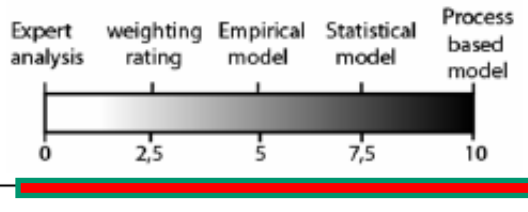
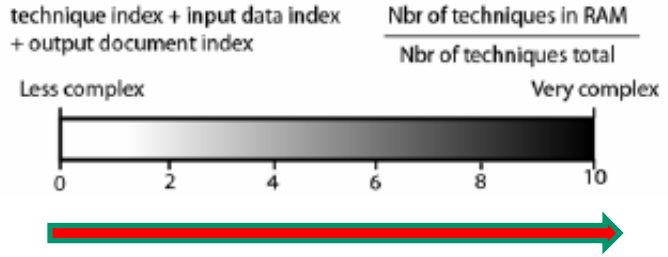
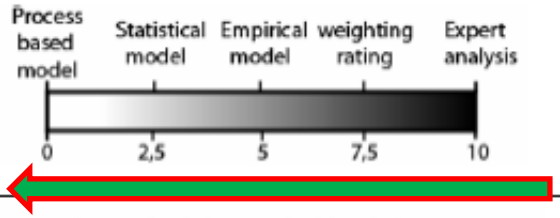
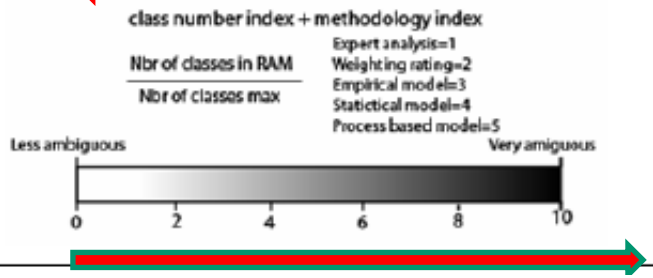
CORE:
Expert based prediction of the effect of local irrigation water on local soil profiles

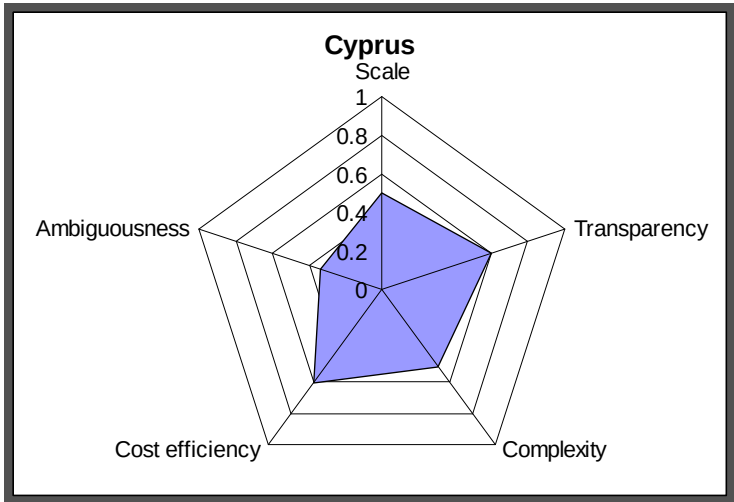


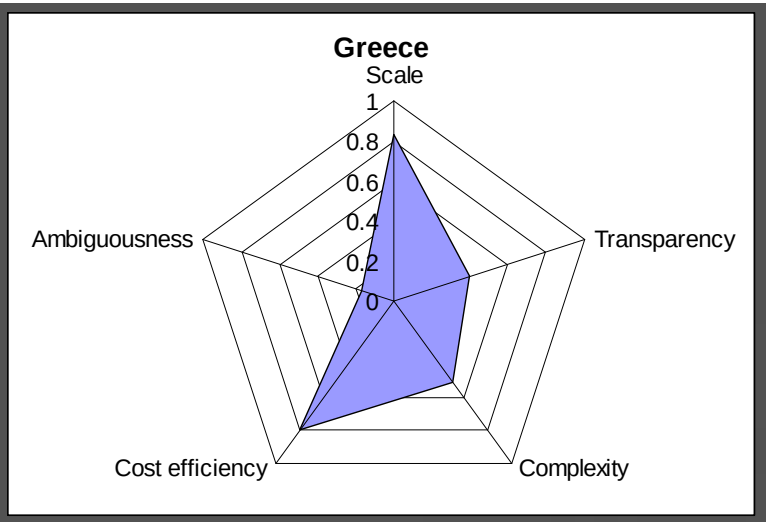
Location of the soil samples used for the model validation (at the left) and map of the salinity predictions obtained by applying the Pla model for Valencia (at the right) (De Paz et al., 2004)

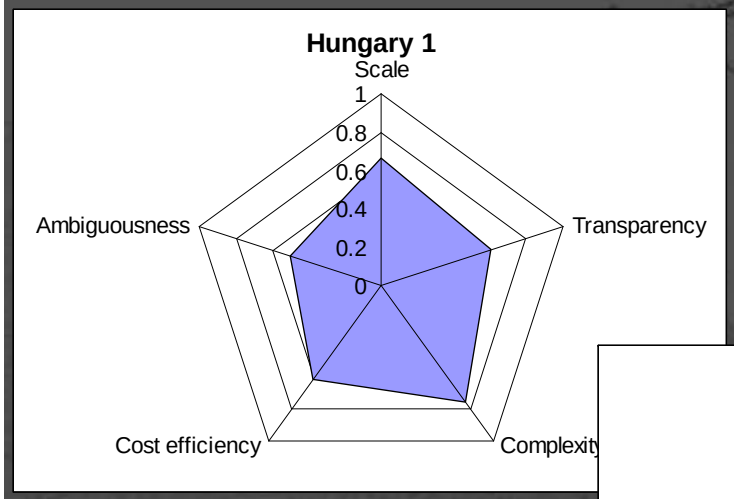
Definition of the indicators used to compare the RAMs,

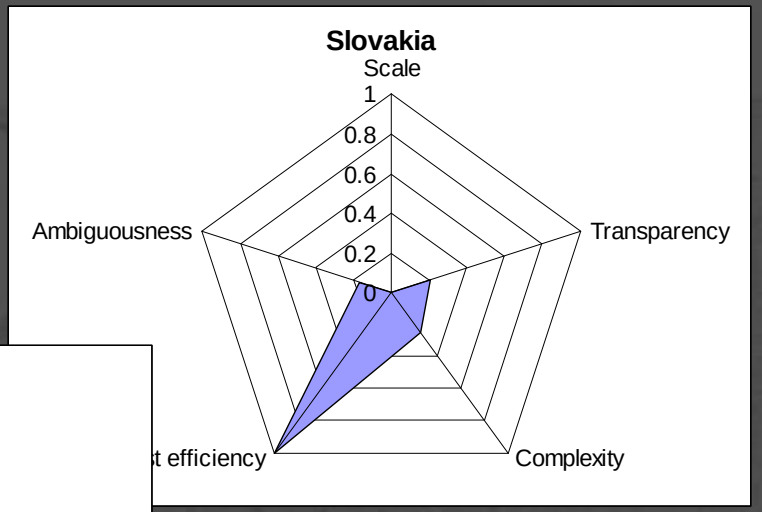
arrows show increasing difficulty

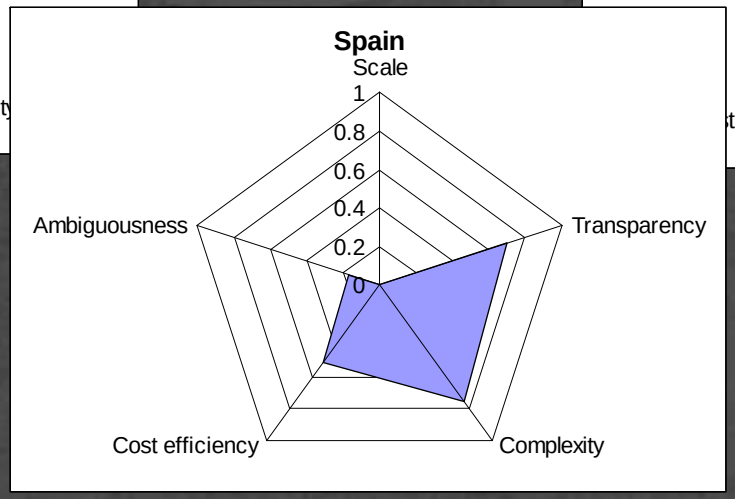
Indicators	Definition	Coding value / indicator
Scale	This indicator is linked to the availability of documents and the scale of the maps to be produced.	
Transparency	It corresponds to the transparency of the human thought and so it depends of the experience of the expert in charge of the assessment. This indicator reveals the applicability of the methodology.	
Complexity	The complexity of the methodology is linked to the processing of the input data and the number of output information. The more input data are used, the more complex is the methodology.	
Cost efficiency	This indicator presents the profitability of the methodology in terms of means and costs to achieve the objective.	
Ambiguousness	This indicator represents the uncertainty in the delineation of hazard and risk zones.	



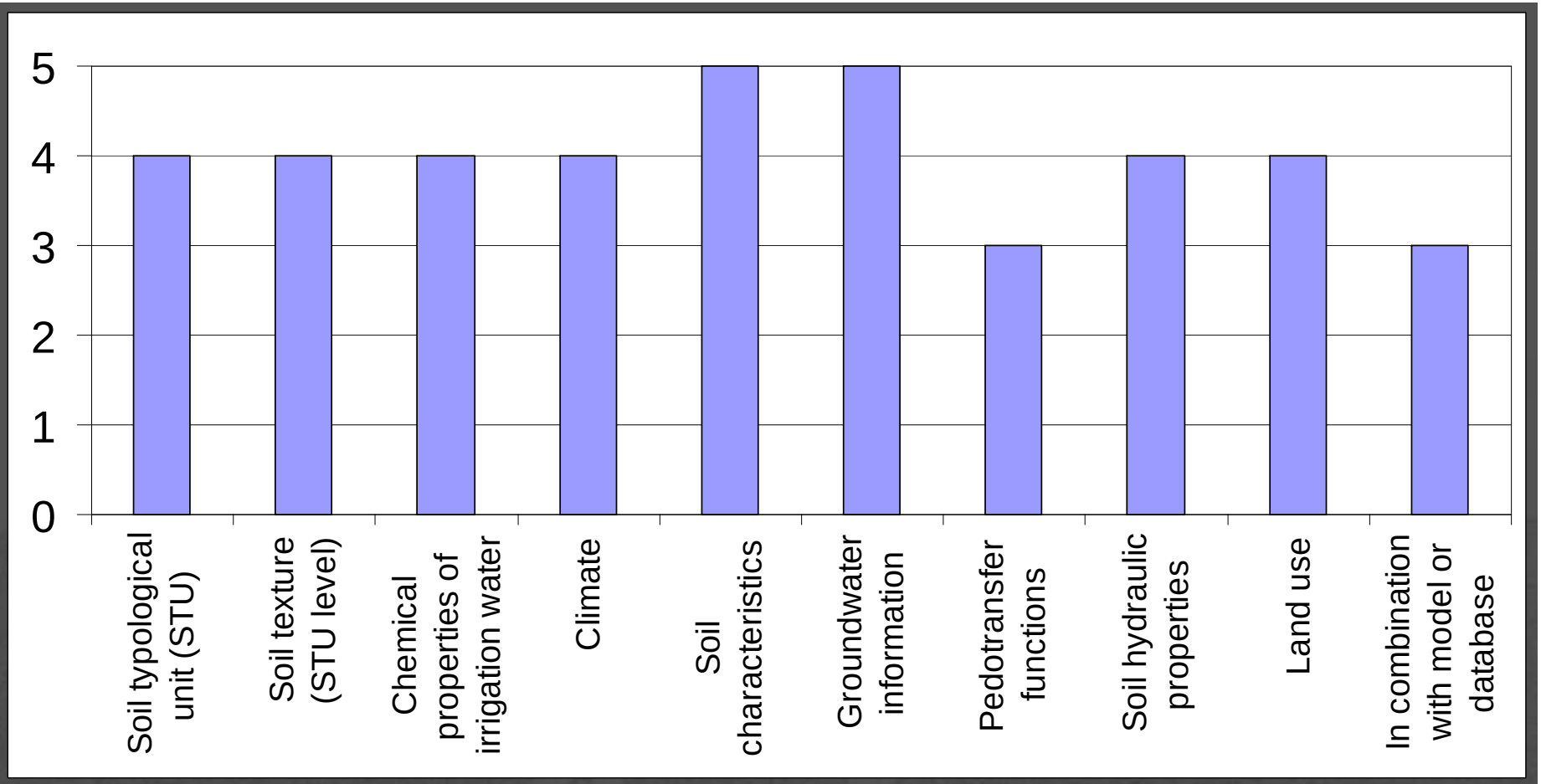




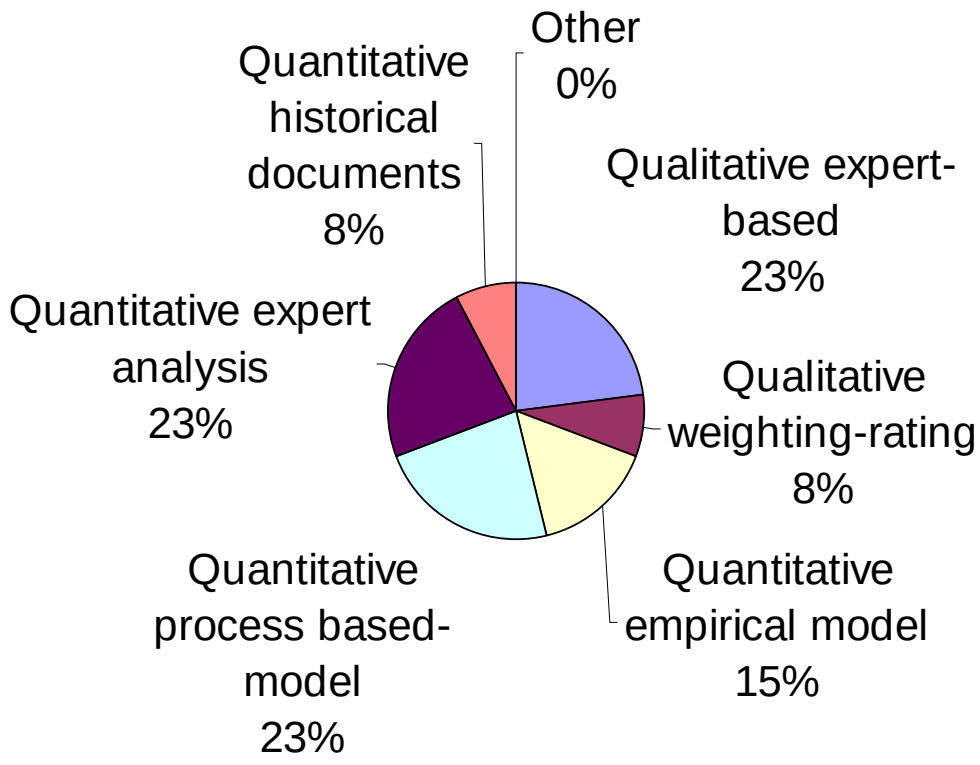




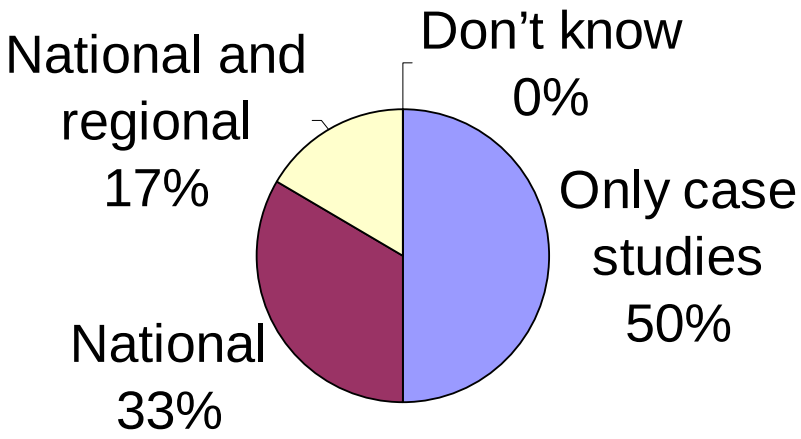
Spider analyses for the available questionnaires



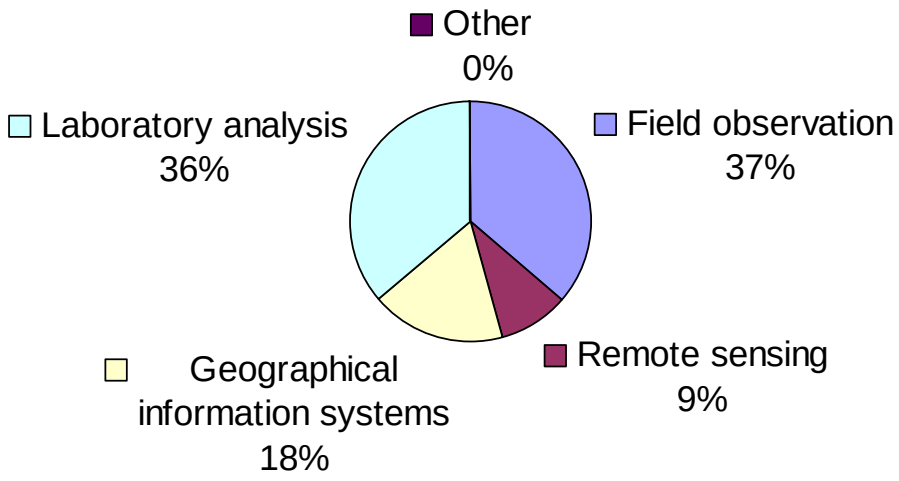
Common criteria in the RAMs analysed



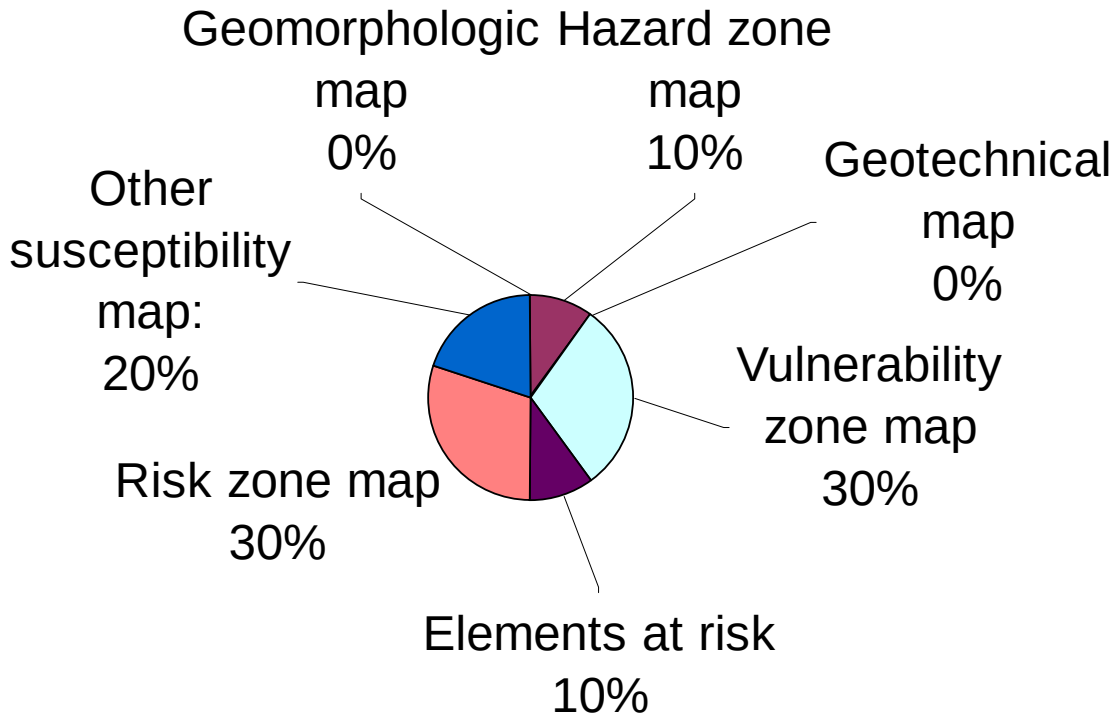
Type of methodology


Don’t know
0%
National and
regional
17%
Only case
studies
50%
National
33%

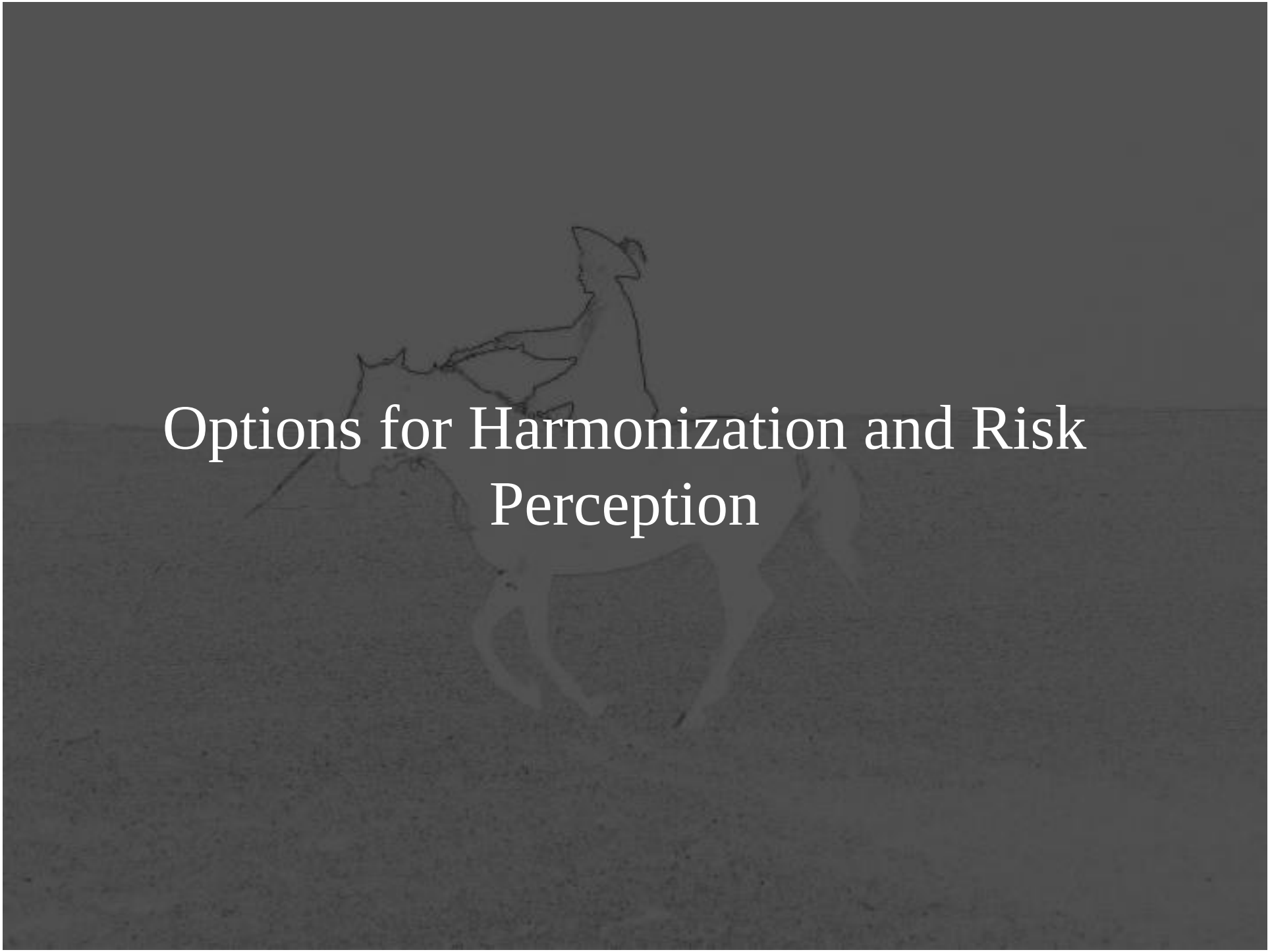
Coverage



Type of techniques



Output documents



Options for Harmonization and Risk Perception

Options for harmonization

- RAMs suitable in all countries?
- Consequences

The hazard of SAS-formation, and the problem of SAS remediation may differ regionally quite significantly, due to differences in

- Sources and quality of rainfall and irrigation water
- The evapotranspiration demand of crops and vegetation
- The quality and proximity to the soil surface of ground water
- Soil textural and mineral composition
- Temporal and seasonal variations in soil desiccation
- Managed or natural leaching of salts towards drainage infrastructure or groundwater.

Data interpretation and risk perception in one step: generalized “progressive degradation threshold values” combined with “sensitivity zoning”

EXAMPLE TAKEN FROM HUNGARIAN LEGISLATION ON GROUNDWATER POLLUTION

Sensitivity (1st, 2nd, 3rd Class) zoning of areas/settlements

„1st Class” Areas of great sensitivity, $c_i = C_1$

Ecological corridors, internationally registered wildlife reserves, lakeshores, shallow karstic areas, drinking, mineral and medicinal water bases, national parks

„2nd Class” Sensitive area, $c_i = C_2$

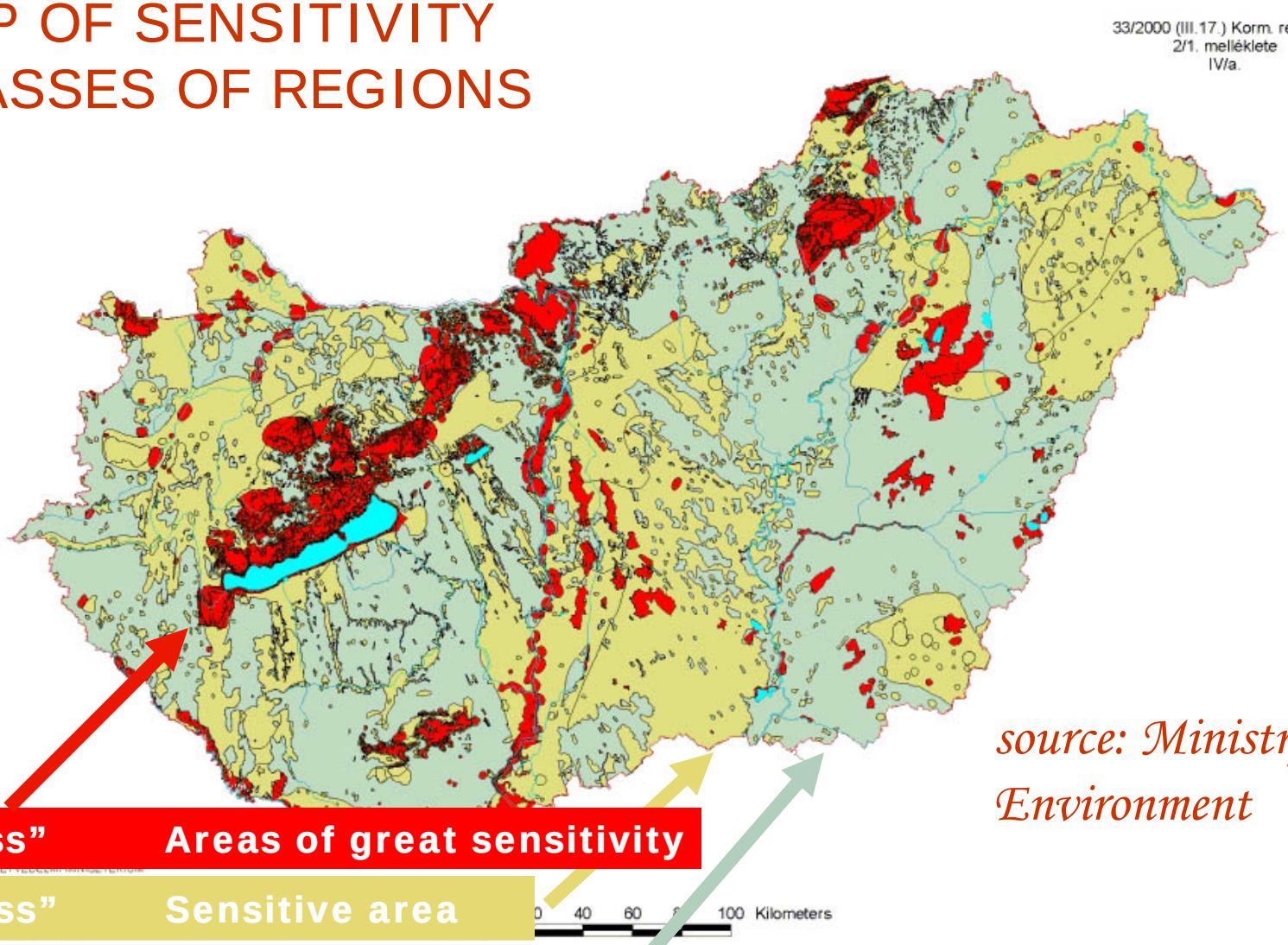
Protection zones of lakeshores, deeper karstic areas, protection zones of drinking, mineral and medicinal water bases, national parks, areas with porous aquifer.

„3rd Class” Less sensitive areas, $c_i = C_3$

Other areas.

source: law

MAP OF SENSITIVITY CLASSES OF REGIONS



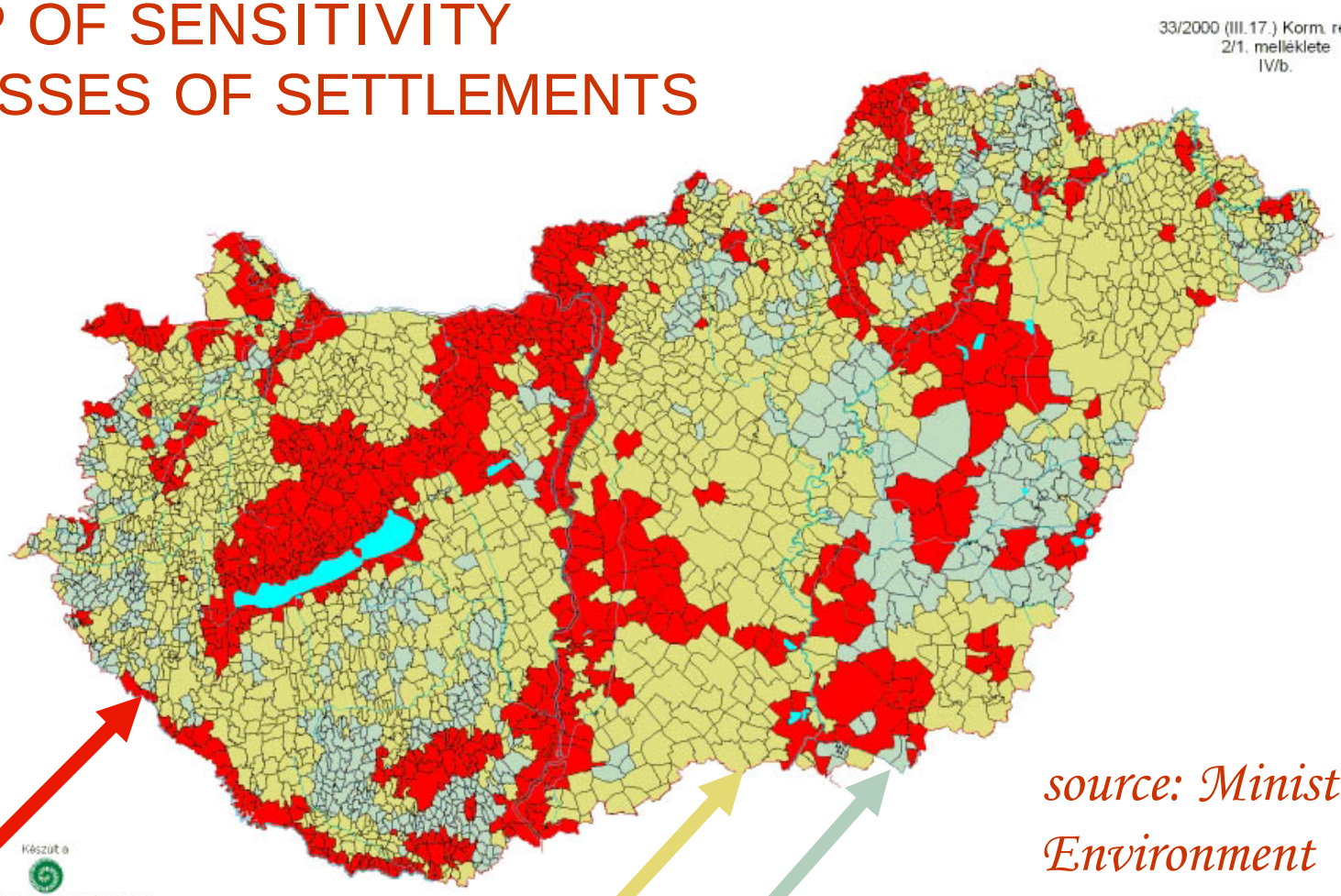
source: Ministry of Environment

„1st Class” **Areas of great sensitivity**

„2nd Class” **Sensitive area**

„3rd Class” **Less sensitive areas**

MAP OF SENSITIVITY CLASSES OF SETTLEMENTS



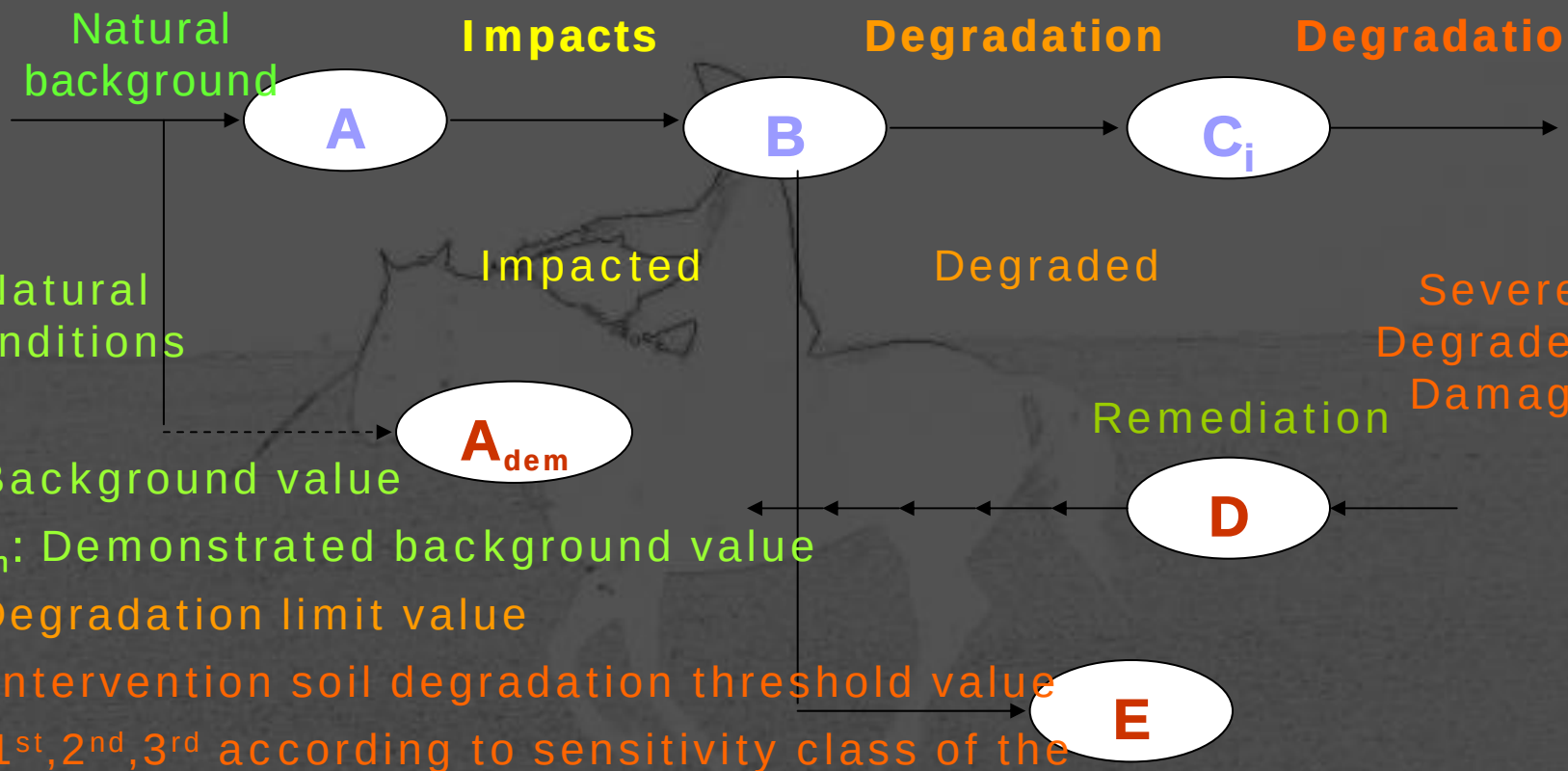
source: Ministry of Environment

„1st Class” **Areas of great sensitivity**

„2nd Class” **Sensitive area**

„3rd Class” **Less sensitive areas**

LEGAL THRESHOLD VALUES FOR SOIL DEGRADATION/THREAT SEVERITY



A: Background value

A_{dem}: Demonstrated background value

B: Degradation limit value

C_i: Intervention soil degradation threshold value

(i= 1st,2nd,3rd according to sensitivity class of the area)

D: Target value of soil remediation

E: Site specific soil degradation limit value

source: L. Balásházy

A: Background value=*representative value close to the natural condition*

A_{dem}: Demonstrated background value =*typical for the region*

B: Degradation limit value=*risky for drinking water, ecosystems, the multifunctionality of soil and the contamination of groundwater from soil*

C_i: Intervention degradation threshold value=*at this value the authorities must intervene (i= 1st, 2nd, 3rd according to sensitivity class of the area)*

D: Target value of remediation=*which has to be reached*

E: Site specific degradation limit value=*larger than B and less than D, calculated based on the land use and risk assessment*

source: law

LEGAL THRESHOLD VALUES FOR

TOTAL DISSOLVED CONTENT OF INORGANIC POLLUTANTS IN GROUNDWATER (mg/liter)

		A	B	C_{1st}	C_{2nd}	C_{3rd}	
	nitrate	10	25	80	120	200	
	ammonium	0.25	0.5	1	3	4	
	PO_4^{3-}	0.2	0.5	1	1.5	2	
	sulfate	200	250	500	700	1000	
	fluoride	0.5	1.5	2	3	4	
	thiocianate	-	0.05	0.1	0.3	1.5	

Exemplary possible threshold values for soil salinity in different land uses and zones

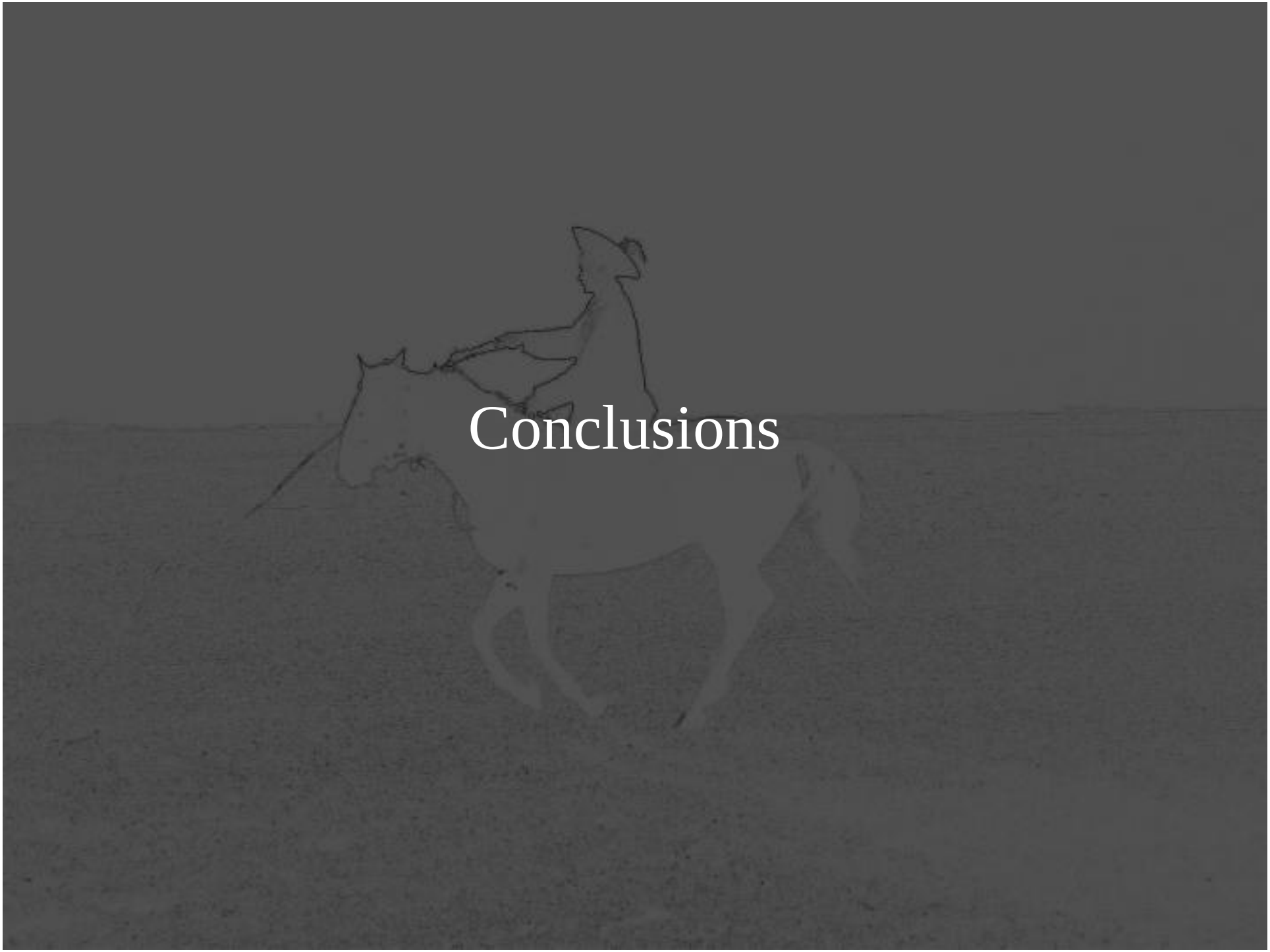
LAND-USE	Threshold		EC_e dS m^{-1}		
sampling depth	A	B	C_{1st}	C_{2nd}	C_{3rd}
Cropland / 0-30 cm	1	2	4	6	8
Orchard / 0-120 cm	0.5	1	2	3	4
Forest / 0-120 cm	0.5	1	2	3	4
Vineyard / 0-90 cm	0.5	1	2	3	4
Grazeland / 0-30 cm	2	4	6	8	10
Reedland/fishpond	Not Applicable				
Protected native vegetation on natural salt-affected soils	Not Applicable				

For administrative registration of plots/parcels/land unites

- Land registry identification number
- Geographic coordinates
- Map
- Acreage
- Proprietor
- Land use permitted
- Land value
- ***Soil thematic strategy rating for*** ***Rating***
  - ***Salinization IF IRRIGATED*** ***1st class***
  - ***SOM decline*** ***2nd class***
  - ***Compaction*** ***1st class***
  - ***Erosion*** ***not applicable – no class***
  - ***Landslide*** ***not applicable – no class***

Possible method for rating of risk perception in Hungary for salinization of irrigated fields

- It is done mostly based on existing soil maps
- 3rd class: soils from the group (Main type=*Order*) of "***Salt-affected soils***" AND if …..
- 2nd class: ***Chernozem with saline/sodic subsoil***, ***Meadow soil with saline/sodic subsoil*** and ***Alluvial soil with saline/sodic subsoil*** AND if …..
- 1st class: each soil different from 2nd and 3rd class soil AND if …..


Conclusions

• Salinization is a very serious *soil threat* in several EU countries

• Due to widely varying geographical and economical conditions the RAMs are rather different

•There is common understanding on the basic concepts and input parameters of risk assessment in European saline/sodic areas

• Main focus must be put on harmonized risk perception, since it is linked to operative decisions most directly

IUSS Salinization Conference, September 20-23, 2009, Budapest

HOME REGISTRATION POSTERS/PAPERS BACKGROUND ORGANIZERS CONTACT

IUSS Salinization Conference, September 20-22, 2009, Budapest

IUSS Working Group

WG SAS

Salt-Affected Soils

MTA TAKI

Registration

Registration opens: May 1, 2008

Deadlines

Abstract submission: April 30, 2009

Registration and payment: April 30, 2009

Registration will be confirmed by May 15, 2009

http://www.taki.iif.hu/sasconf/home.html


Thank you for the attention, any questions, please?