SOIL-PLANT INTERRELATIONS: THE SIGNIFICANCE OF SOIL DEGRADATION AND THE THE RISK ASSESSMENT METHODOLOGY FOR SALINIZATION

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Abstract: Numerous methodologies are used in the EU Member States to assess the risk for different soil threats related to various agricultural practices (erosion, salinisation, organic matter decline, compaction and landslides). Our aim was to evaluate the risk assessment methodologies (RAMs) utilized for salinization in the Member States based on questionnaires sent to experts and policy makers. A first analysis of the obtained information reveals that most countries affected by the problem do not have official methodology and some countries do not have any methodology at all. Hungary has an officially recognized assessment. Slovakia and Spain has a RAM used by scientists. Greece and Cyprus provided information about RAM that they would prefer. Salt-affected soils occur in Bulgaria, France, Italy and Romania also, but we didn't get answer from these countries. To fill the information gaps we need a further analysis on scientific papers.

Keywords: soil degradation, salinization, risk assessment, European Union

Introduction

The threat of soil salinization has been recognized since long ago. Salt-affected soils (SAS) are soils in which the influence of cations and anions dominates with regards to physical, chemical, and biological properties. The basic problem encountered with SAS is that the balance between the inputs and outputs of salts is upset, leading to an increase of generally soluble salts or leading to an inproper composition of salts in soil. Commonly, salinity involves the alkali and earth alkali cations and anions such as chloride, sulphate, and (bi)carbonates. The basic problems associated with salinization may be diverse. A rather direct effect is that increasing salinity leads to higher osmotic values of soil water, which is considered to contribute to water stress of plants, as they are unable to extract the available water (Farooq and Azam, 2007). As SAS are the best examples of strong soil-plant interrelations, the relationship between crop yield and soil salinity can be described by simple equations (Maas, 1990).

Different countries use various methodologies for risk assessment, as local circumstances vary (soil, climate, political framework) and interests of countries differ. Similar problems may have varying causes or comparable problems may be approached differently by each country.

A first step in risk assessment involves general identification of the threat and areas at risk. Subsequently, within the delineated zones, specific locations with high salinity risks have to be identified, preferably using process-based models at high resolutions and other areas must be taken out of scope (Tóth et al., 2006). Eckelmann et al (2006) named this procedure the tiered approach, where tiers refer to the different levels of scale and related level of information detail. They distinguish three types of approaches to identify areas at risk: qualitative, quantitative and model approach.

Our objective was to compare the existing RAMs of Europe and point to their most common features as a basis for their future harmonization.

Materials and methods

We constructed two questionnaires, one for scientific experts and one for policy makers. The questionnaires have been sent to researchers and policy makers within EU25 member states in order to proceed to an inventory of methodologies used for assessing salinization risks.

The questionnaire for policy makers consists of general and specific questions about RAMs related to the five soil threats involved in the EU thematic strategy for soil protection (soil erosion, landslides, organic matter decline, compaction and salinization) and ranking of their priorities about RAMs.

The questionnaires for experts are divided by soil threats and are more detailed. The questionnaire for salinization is consisted of seven main questions about RAMs for salinization. The main topics of the questions were:

- General information: if the country has a risk assessment methodology at present or in development and if yes, how long has it already been in use. We asked for references and/or weblinks about the RAM.
- Input data: we offered possibilities to indicate what data are used by the RAM.
- Description of the RAM: questions allowed to evaluate the relations with policy, the sensitivity, the type of methodology and used techniques, the data quality, availability and time resolution, the geographical coverage of the RAM
- Output documents of the RAM: these questions allowed to describe the output type, scale and comprehensibility.

Results and discussion

We received filled questionnaires from five countries. There are salinity RAMs in use in Hungary, Slovakia and Spain (Table 1.). Hungary has an officially recognized assessment. Slovakia and Spain has a RAM used by scientists. Greece and Cyprus do not have an implemented RAM, but they provided information about their preferred RAM. Salt-affected soils occur in Bulgaria, France, Italy, Austria and Romania also and there are areas at risk of salinization also in further countries (Macedonia, Ukraine), but we haven't got answer from these countries.

The questionnaire from Hungary can be divided into two RAMs. RAMHU1 is the evaluation of the Tisza River irrigation project (Szabolcs et al., 1976). It includes the survey of salinity and alkalinity status of soils and potential factors of salinization and alkalinization processes. RAMHU2 (Kovács et al., 2006) is the evaluation of TIM (Soil Protection Information and Monitoring System), a quantitative expert analysis based on temporal changes of monitored data covering the whole country representing all regions and soil types. The method uses statistical analyses between the groundwater depth and soil salinity. Conclusions are made based on the detected changes. RAMSL, the Slovakian RAM has been in use for 14 years. It is a qualitative weighting-rating system. It is used for monitoring purposes and has a geographical coverage for the whole country. The scale was not indicated and there was not any references given. RAMSP, the Spanish RAM (De Paz et al., 2004) is not used yet for monitoring purposes but it is planned. Spain does not have a national system; there are only case studies. They have regular data source for the implementation. For now, there are data for two years in time resolution of four periods plus irrigation periods and after heavy rain events per year.

The range of input parameters of the studied RAMs are similar, the observation density is similar in RAMHU2 and RAMSP and much higher in RAMHU1, the data is mainly obtained by field observation and laboratory analysis, in RAMSL by remote sensing and in RAMSP also GIS technique is used (Table 2). The output type and scale depend on the goal of each research activity (Table 3).

Table 1. General characteristic of RAMs

	Type of methodology
RAMHU1 (TISZA)	Salt balance calculation
RAMHU2 (TIM)	Measurement of soil salinity changes
RAMSP (VALENCIA)	Assumed effect of of irrigation waters on soils
RAMSL (SLOVAK)	Remote sensing of salinization

Table 2. Inputs of RAMs based on the filled questionnaires

	Range of input variables	Data source	Observation density (data per ha)
RAMHU1 (TISZA)	Soil type, soil texture, chemical properties of irrigation water, soil characteristics, groundwater information, soil hydraulic properties, land use, spatial soil information	-Field observation -Laboratory analysis	ca 100 obs/km2
RAMHU2 (TIM)	Climate, soil pH, soil salinity, groundwater depth	-Field observation -Laboratory analysis	1236/100 000km2 i.e. 0.013 obs/km2
RAMSP (VALENCIA)	Soil type, soil texture, chemical properties of irrigation water, climate, soil characteristics, soil hydraulic properties, groundwater information, pedotransfer functions, land use, spatial soil information	-Field observation -Laboratory analysis -Geographical information systems	66/380 000ha i.e 0.017 obs/km2
RAMSL (SLOVAK)	Soil typological unit (STU) (soil type), soil texture (STU level), climate, soil characteristics, groundwater information, pedotransfer functions, soil hydraulic properties, land use (crop system)	-Remote sensing	-

Table 3. Outputs of RAMs based on the filled questionnaires

	Type of output	Scale of the mapping presentation of risk
RAMHU1 (TISZA)	Salinization risk	1:25,000
RAMHU2 (TIM)	Salinizaton risk	1:1,000,000
RAMSP (VALENCIA)	Risk zone map Other susceptibility map	regional
RAMSL (SLOVAK)	Elements at risk	no information

Conclusions

We have received filled questionnaires from five countries, from which three have RAM for salinization. The questionnaires don't contain detailed information about the methodologies so we used the original scientific publications also. All RAMs use soil characteristics and groundwater information in their assessment. Soil typological, soil texture, chemical properties of irrigation water, climate, soil hydraulic properties, and land use are used in most of the RAMs and pedotransfer function and combinations with models are also used in some RAMs. From this we can say that there are common criteria in all RAMs. Most of the RAMs have been used in case studies. Hungary and Slovakia have RAMs which are used at national or regional scale. Three countries use field observations in combination with laboratory analysis. Two of them use also GIS as third technique. Slovakia is the only country with a different approach, they use remote sensing. Comparing the collected RAMs to the guidelines of Eckelmann et al. (2006) we concluded that these RAMs can be used at Tier 2, that is for the measurements and implementation within the risk zones identified by Tier 1. RAMHU2 and RAMSL give medium-scale maps (1: 50,000 – 1: 10,000) that are recommended for more detailed classification than country or continental scale. RAMHU1 and RAMSP provide large-scale maps (1: 50,000 – 1: 10,000) that are needed only for practical operations at hot spots. The used input parameters agree with those recommended by Eckelmann et al., 2006. The temporal resolution is equivalent or higher than given in the guidelines for the large-scale mapping (1-3-6 years, depending on the variable). Since we haven't received answer from more countries that have areas at risk of salt and/or sodium damage we must complete our review from scientific literature. The harmonization of RAMs and the subsequent EU-wide protection of soils will improve soil quality and the conditions of crop production.

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