SIXTH FRAMEWORK PROGRAMME, SCIENTIFIC SUPPORT TO POLICIES

Case-study Report for the Work package No 4. of Project RAMSOIL

„Identification of geographical risk area” Deliverable 4.2.3

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Risk Assessment Methodologies for Soil Threats

GLOSSARY

Erosion:
A physical phenomenon that results in the displacement of soil and rock particles by water, wind, ice and gravity.

Risk:
The probability of an unfavourable effect in a system by exposure to a threat.

Risk assessment:
A process to calculate or estimate the risk to a system, following exposure to a particular threat.

Abbreviations

CORINE   Coordination of Information on the Environment
DEM   Digital Elevation Model
EU   European Union
GLASOD   Global Assessment of Soil Degradation
INRA   Institute National de la Recherche Agronomique
MOPT   Ministerio de Obras Públicas y Transporte, the Ministry of Infrastructures and Transportation in Spain
PESERA   Pan European Soil Erosion Risk Assessment
RAM   Risk Assessment Methodology
SIDASS   an acronym for a spatially distributed simulation model predicting the dynamics of agrophysical soil state
WEPP   Water Erosion Prediction, the acronym of a Project and a model

1. Introduction

In this report we give an account of case-studies using methodologies for the identification of geographical areas at risk in the European Union. From among the five “soil threats” studied in the project RAMSOIL (erosion, compaction, landslide, soil-organic-matter decline, salinization) soil erosion was selected for the following reasons: a) abundant information was available on this soil threat, b) most of the European countries have problems related to soil erosion and the relevance of this soil degradation is well known, c) there were databases related to soil erosion easily available for the project members.

The risk assessment and the quantification of erosion risk at national and at EU level is important for the elaboration of environmental, agricultural and silvicultural policies. Good spatial information on risk is needed for the actions combating erosion (Sanchez et al., 2001). At present there is very scarce information on the severity of actual erosion in Europe (Evans, 2002). The reason is that erosion varies much in space and time. On the other hand there is good spatial information available on several factors which affect erosion, like relief, land use, land cover, soil parameters, geology, climate; listed here in order of decreasing spatial detailedness.

The risk chain in general includes the following subsequent steps: data collection, data processing, threshold value and risk perception (van Beek et al., 2009) as shown in Fig 1.

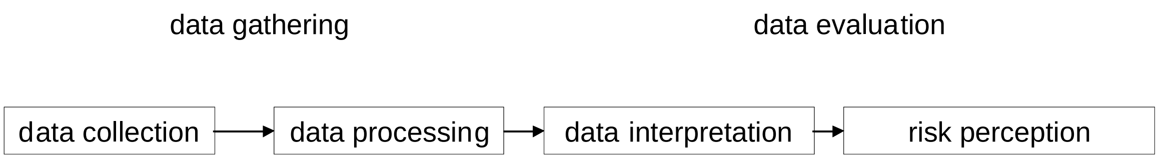


Figure 1. The risk assessment chain from data collection towards risk perception steps.

Data collection refers to the collection of indicator values for the soil threat, which may be field measurements, remote sensing images and/or data statistics. Data processing involves the derivation of a rate or state of the soil threat using simulation modelling, statistical processing or expert interpretation of the data. During the data interpretation step the indicator values are compared with some kind of threshold (e.g. a minimum amount of soil loss) and in the final step the risk related to (exceeding of) the threshold value is quantified resulting in a sense of urgency and related actions.

The use of various RAMs within the EU complicates interpretation of areas at risk in an unequivocal way. Eventually the use of different, unharmonized, RAMs may result in contrasting (governmental) statements with regard to similar exposures to a system. An example of this ultimate consequence of unharmonized RAMs originates from the Great

Lakes in the USA where advices on sport fishing from different States sharing the same Great Lake conflicted (Kamrin 1997). Harmonization is here defined as making results compatible or comparable, hence consistent, and thereby minimizes the differences between standards or measures with similar scope. Harmonization emphasizes ‘the combination of two or more things so that they go together, without loss of individual identities yet constitute a frictionless or pleasing whole’ according to Webster’s New Dictionary of Synonyms. However, the meaning of harmonization in environmental assessments differs depending on the field of reference. For instance harmonization may refer to uniforming parameters and toxicological data in simulation models, for instance in the field on soil contamination (Theelen 1997). In the same field of study Provoost et al. (2006) recommended that model algorithms should be harmonized, but that critical levels will remain different. Although the authors indicate that harmonization of critical levels would be beneficial, they realize that differences in geography, ethnology and political situation may complicate the implementation of harmonized standards. Also, Wagner et al. (2001) and Theocharopoulos et al. (2001) conclude that harmonization can be beneficial, but they focus on the physical environment of – in this case- sampling and sample treatment, whereas Green et al. (2000) also discusses risk-communication and risk-perception in the light of harmonizing environmental protection strategies. Hence, harmonization may cover quite a range of issues, going from choosing your sampling points to finally perceiving the actual risks.

Regarding the erosion, the threat chosen for this report, the theoretical and practical relevance of a specified threshold values is very important. One way to approach this threshold is to consider the rate of soil formation, by which the natural process compensates for the soil volume lost from time to time, therefore the tolerable erosion threshold cannot be greater than the rate of soil formation. This **soil formation** is determined as 2 t ha^{-1} $year^{-1}$ as an **average** by experts (Stefanovits, 1966). The higher limit of “low category of soil erosion” is the most important among threshold values because soil conservation can be linked to this limit. This limit should be defined as the rate of soil formation, because if the rate of soil loss is equal or higher than the rate of soil formation, there is acceptable risk of soil erosion. In the US, the tolerable rate of soil loss is defined as the **potential rate of soil formation** that have been determined as 11 t ha^{-1} $year^{-1}$ (Hall et al., 1985). Centeri and Császár (2003) follow this approach and uses these limits (0-2, 2-11, >11 t ha^{-1} $year^{-1}$). However, different authors use various category systems (Tables 1). The categories of Stefanovits (1992) differ significantly from that of all the other category systems. In his system there are three categories: low (0-40 t/ha/y), moderate (40-100 t ha^{-1} $year^{-1}$) and strong (higher than 100 t ha^{-1} $year^{-1}$). Also the erosion assessment techniques, GLASOD (Oldeman et al., 1991), MOPT (MOPT, 1992) and CORINE (CEC, 1991) differ very much as shown by Table 2. The background of these categorizations is not known. In spite of these results still there is a lot of discussion about relevant thresholds in erosion.

Table 1. Existing "low soil loss" categories according to different authors. After Centeri and Császár (2003).

Category	**Soil loss (**t ha^{-1} $year^{-1}$**)**	**Author**
No erosion	0-1	MOTOC et al. (1992) cit Centeri and Császár, 2003
	0-2	CENTERI and CSÁSZÁR (2003)
Without erosion	0-4	JAMBOR et al. (1998) cit Centeri and Császár, 2003
Very low	0-5	DE LA ROSA et al. (1998)
		SPAROVEK et al. (1998), WEILL et al. (1998)
No or low	0-10	FAO-UNEP-UNESCO (1979) cit Centeri and Császár, 2003
Low	0-40	STEFANOVITS (1992)

Table 2. Equivalency of soil erosion severity categories as shown by the legends of GLASOD, MOPT and CORINE maps, after Table 1 of Sanchez et al. (2001).

GLASOD	**MOPT**	**CORINE**
Extreme	Extreme Very high	Extreme
Strong	High	
Moderate	Moderate	Moderate
Low	Low Very low	Low

There are several aspects and consequences of harmonization, such as scientific, technical, administrative, social, environmental and political issues. In order to facilitate the harmonization of RAMs interdisciplinary studies are needed. For example, cost-benefit analysis of RAMs may be carried out at two levels: 1) at the level of specific policies or conservation programs, and 2) at national/international level, and the issues arising at the two levels are different; due to the increasing complexity at larger administrative units and increased number of stakeholders. There are also socio-economic factors playing an important role in the efficiency of risk perception, for example personal attitudes (Boardman and Poesen, 2006), which must be incorporated in the assessment of RAMs.

In our work first questionnaires focusing on separate soil threats were distributed to experts and policy makers living in every EU member state, as detailed in RAMSOIL, 2007a. In a subsequent step a database was constructed from the answers received to the questionnaires (RAMSOIL, 2007b). Many answers of policy makers and scientists from our policy questionnaires on RAMs highlighted that the communication and information transfer between science and policy is not effective in European countries. Out of 11 total answers, there were only seven answers "science" and only three "legislation" given by policy makers to the question "For what reason was the RAM developed?" (RAMSOIL, 2007b). To the question "Is the RAM linked to community policy targets, objectives or legislation?" out of ten answers there were only three stating "Yes, directly" (RAMSOIL, 2007b). Consequently the RAMs have been developed mostly with scientific aims by academic institutes in Europe. To the question "What is the legal status of the RAM?" out of ten answers there were only two stating "Officially recognized assessment" (RAMSOIL, 2007b). It shows that the output of RAMs is rarely used for land use planning, soil management or conservation strategies in most European countries, therefore policy regulations use only a small part of scientific achievements.

1.1. Erosion RAMs selected for the work package

In the case studies we aimed at studying the effect of the use of different RAMs (PESERA and SIDASS-WEPP) with some systematic modifications along the risk assessment chain (changing the input scale for slopes [either 100 m or 1 km grid] and using different "soil loss severity" category systems) on the output of risk assessment (area of land characterized with the different soil loss categories). The used PESERA model is "a physically based and spatially distributed model for quantifying soil erosion and assess its risk across Europe" as described by Kirkby et al., 2004. According to Simota et al., 2005 "SIDASS model is linking under the same umbrella of a spatially distributed information framework, the experimental and theoretical researches from various fields of soil physics directly to farming practices (soil mechanics, soil compaction, soil erosion, and soil hydrology) in order to have a tool for recommendations of site-specific land use and management practices, and to evaluate agriculture policies at local and regional scales". As it is shown by Fig 2., SIDASS is focusing on the particular mechanisms which affect soil erosion. This soil physics model was linked to the WEPP model for predicting soil loss. The Water Erosion Prediction Project (WEPP) model is a process-based, distributed parameter, continuous simulation, erosion prediction model developed at the United States Department of Agriculture. It can be used in both hill-slope and watershed applications. The major inputs to WEPP are climate data, slope characteristics, soil data, and cropping/management data (WEPP, 2008).

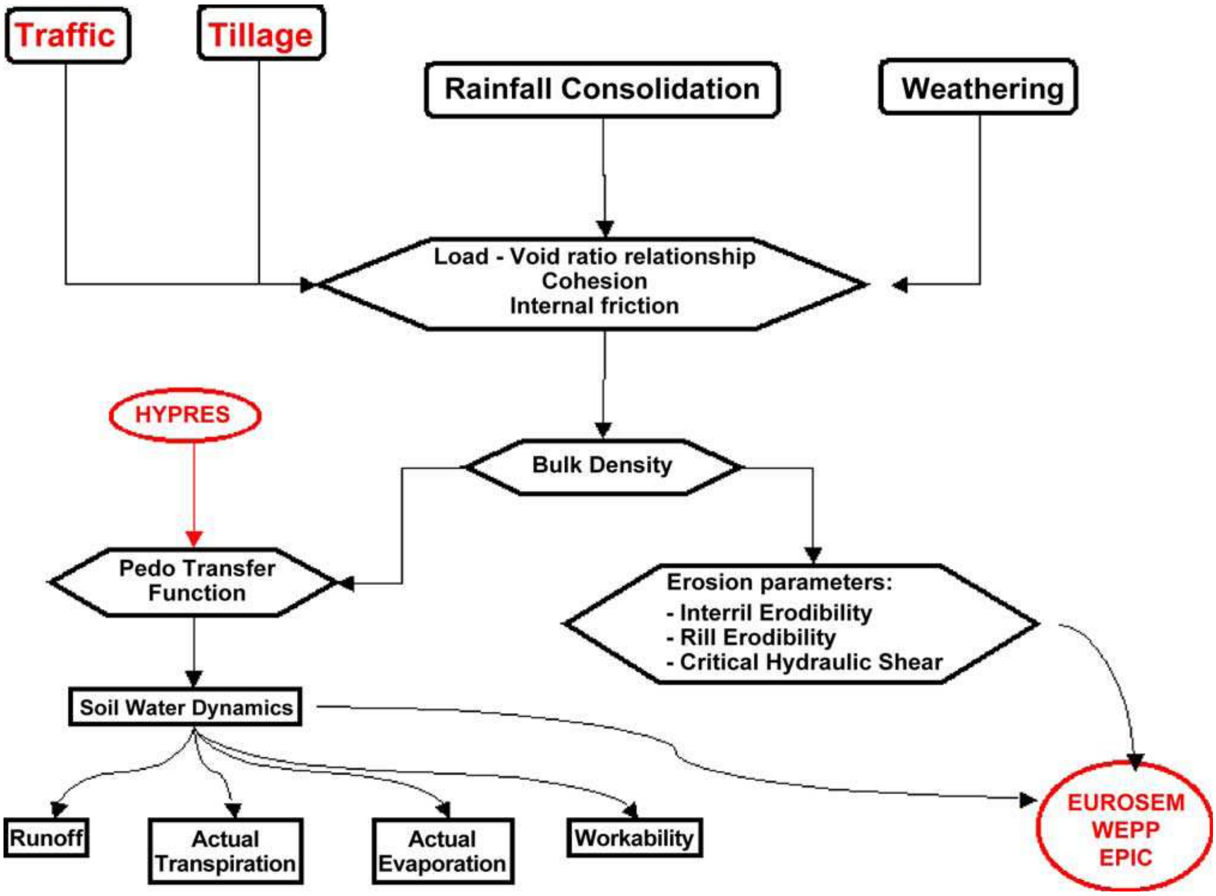


Figure 2. Flowchart of SIDASS Model as shown by Simota et al., 2005

The evaluation was carried by comparing the severity of erosion predicted by different methods for distinct territorial units in a Geographical Information System.

Our specific objectives in this report were to compare the predictions of different models (PESERA vs SIDASS-WEPP), to compare the predictions provided by the same models for different spatial detailedness (spatial scale), to compare the predictions when differing categories of soil loss are used, to show the conflict arising when there are different assessment criteria used for erosion at the plot scale, to enumerate the potential impacts and benefits of using harmonized thresholds in EU, to list the suspected impact of the harmonization of RAMs on the different stakeholders and to list the order of importance of factors of RAMS for policy makers.

2. Materials and methods

2.1. Study areas

The EU wide assessment with PESERA and SIDASS-WEPP was carried out for the EU member states. With the input parameters collected, the erosion severity, expressed as soil loss (t ha^{-1} $year^{-1}$) was calculated by PESERA and SIDASS-WEPP.

Beyond the country level of Romania, we studied the different RAMs for the Romanian smaller administrative units, the counties (or “judetul” in Romanian), for which the extension and effects of erosion are typically reported in national and EU wide administration and legislation.

2.2. Methods

We differentiated scientific, social, environmental and political impacts of implementation of soil erosion RAMs. We have performed two case studies.

We analysed the results of an EU wide assessment, comparing the results of two RAMs, the PESERA and the SIDASS-WEPP. PESERA is a process-based model to quantify water erosion and delineated areas in Europe at risk of erosion. It was developed by the Pan-European Soil Erosion Risk Assessment (PESERA) project. It was considered to be most appropriate for European wide application as a result of the comparison of the official RAMs, provided in Project report 2.1. (Geraedts et al., 2008) of RAMSOIL project.

In the second case study two RAMs and some changes along the risk assessment chain were tested for the area of Romania. We calculated the spatial extension (area) of the different “soil loss severity“ categories using the PESERA and the SIDASS-WEPP methodology at national and at county level. The soil loss calculations were complemented using two different input scales. The following variations have been implemented:

- PESERA modelling (JRC simulations) using the raster with 1 km grid for soil properties coming from the EU-soilGIS scale 1:1,000,000, raster from Corine Land Cover with 1 km grid and DEM with the grid space of 1 km.
- PESERA modelling with raster for soil properties (grid 100m) derived from soil map 1:200,000, raster from Corine Land Cover with 100 m grid and DEM with the grid space of 100m.
- SIDASS modelling (WEPP methodology) with slope based on Slope index linked with each polygon in soil map of Europe at the scale of 1:1,000,000.
- SIDASS modelling (WEPP methodology) with soil map of Romania at the scale of 1:200,000 and DEM with the grid space of 100 m.

We tested also the differences caused by the use of various category systems for Romania at national and county level. We calculated the spatial extension of land characterized with the 'lowest' soil loss category ("no soil erosion", "without erosion" or "very low erosion", the nomenclature depends on the category system as shown by Table 2) and the spatial extension of land with higher risk of soil loss, using the category systems described by Centeri and Császár (2003).

2.3. Scientific impacts

We tested the scientific consequences of using the two RAMs. These RAMs were very different regarding the mechanisms considered. Whereas PESERA has the input parameters of rainfall characteristics, temperature characteristics, potential evapotranspiration, plot geometry, texture, slope and land use, there is much longer list for SIDASS-WEPP. First of all basic soil physical properties are needed, based on which soil water retention curve, saturated and unsaturated hydraulic conductivity, soil cohesion, angle of internal friction, precompression stress, concentration factor, void ratio versus load, soil bulk density profiles considering various loads on the soil surface corresponding to characteristics of machinery (axle load, inflation pressure) are estimated. Based on the calculated parameters the WEPP modelling is performed in a subsequent stage. de la Rosa et al., 2005 writes that "WEPP is a simulation model with a daily time step. When rainfall occurs, the plant and soil characteristics important to the erosion process are considered in determining if a runoff event occurs. This model computes soil detachment, transport and deposition at closely spaced points on a slope, in channels or small reservoirs. A catchment is represented by a series of slopes, channels and reservoirs that are linked. The main processes considered are: plant growth and residues, water use, hydraulic and soil properties. In relation to plant growth, many annual and perennial crops and the corresponding management practices have been parameterised. The soil component provides to the hydrology component several variables important for the estimation of surface runoff rates and volumes and for the estimation of infiltration and percolation. Soil tillage effects are expressed in terms of bulk density, random roughness, oriented roughness and residue cover".

2.4. Social impacts

We have prepared a list of stakeholders affected by soil erosion RAMs and considered their possible impacts. The list of persons who would be affected in some way by the use of harmonized soil erosion RAM in member states is presented in Table 3. The possible impacts are listed in Chapter 3.4.

Table 3. List of stakeholders affected by the harmonization of soil erosion RAMs

Land users (Persons most directly concerned by soil erosion)

⊗ land renter

⊗ small land owner without registration for subsidies

⊗ landowner with registration for subsidies

⊗ specialist agronomist working for an agricultural company

Consultants

⊗ consultant working for a company

⊗ extension specialist working for a nonprofit organization, university or government

Educational specialists

⊗ kindergarten/elementary or secondary school teachers

⊗ University teachers

Researchers

⊗ researchers at Universities and Colleges

⊗ researchers at Research Institutes

⊗ R&D specialists at commercial companies

(such as conservation tillage equipment developer engineers)

Government authorities

⊗ “village” community agronomists

⊗ soil protection station specialists

⊗ authority for protection of water quality

⊗ Central Agricultural Office, Directorate of Plant Production and Horticulture

⊗ Ministry of Agriculture and Rural Development

⊗ European Union authorities

Society

⊗ housekeepers in the way of muddy flow

⊗ neighbouring landowner/user (where the sediment settle)

⊗ village/town community

⊗ in a broad sense the whole society

Financial sector

⊗ Insurance companies

Other media

Voluntary and non-government organisations

⊗ ESSC, IECA, European Soil Bureau

2.5. Political impacts

In the questionnaires of RAMSOIL project the policy makers have been asked about “what the most important factors about RAMs are for them”. The answers for the question of the questionnaire intended for politicians “Could you please rank the following arguments from 1 to 8 (1 being the most important and 8 being the least important) for using or preferring your RAM for each soil threat?” were analysed. Results are shown in Chapter 3.5.

3. Results

3.1. Results for study areas

When we analysed the data collection and data processing stages we found that the data requirements depend on the requirements of the particular RAMs. The measurement methods can vary and the measurement errors differ. Harmonization of the data collection (measurement methods) cannot (or hardly could) be implemented at European level. Most countries have traditions, existing instruments, sampling and laboratory techniques. Knowledge is also diverse in Member States. It would be complicated and expensive to harmonize.

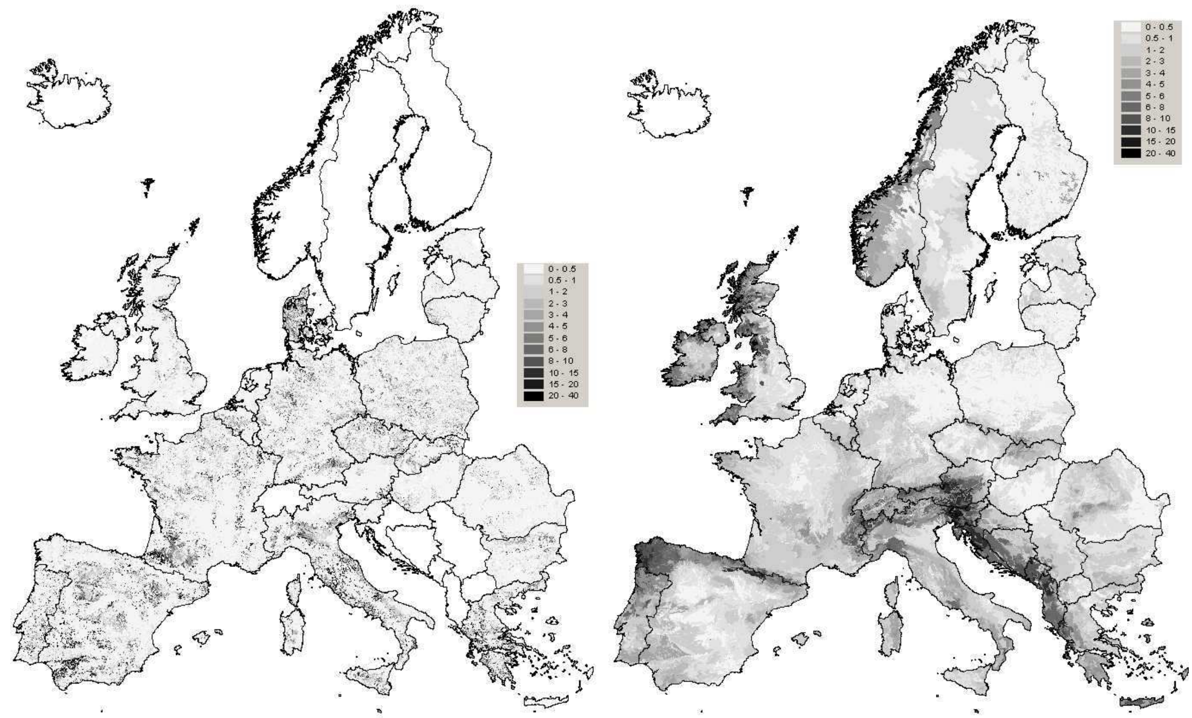
Regarding the potential impacts of harmonization of data collection we found that many countries could not implement the data collection in the absence of instruments, financial support, experts, knowledge. In order to solve this problem financial and professional (technical) support would be needed for these countries.

Erosion is caused by different factors and processes in different countries, regions and areas. Consequently the applied RAM has to be sensitive for all those factors. As data collection depends on those factors it has to be considered during harmonization. Only objective and quantitative data can be acceptable for a RAM (after Sanchez et al.2001).

In the case-study the effects of **different scales of input data** were studied on area of land characterized with no/low risk (soil loss of 0-2 t ha^{-1} $year^{-1}$) and higher erosion risk (soil loss of 2-10 t ha^{-1} $year^{-1}$).

To test the effects of **data processing** the output of PESERA and the SIDASS-WEPP methodology were compared.

3.2. Results of European-scale comparison



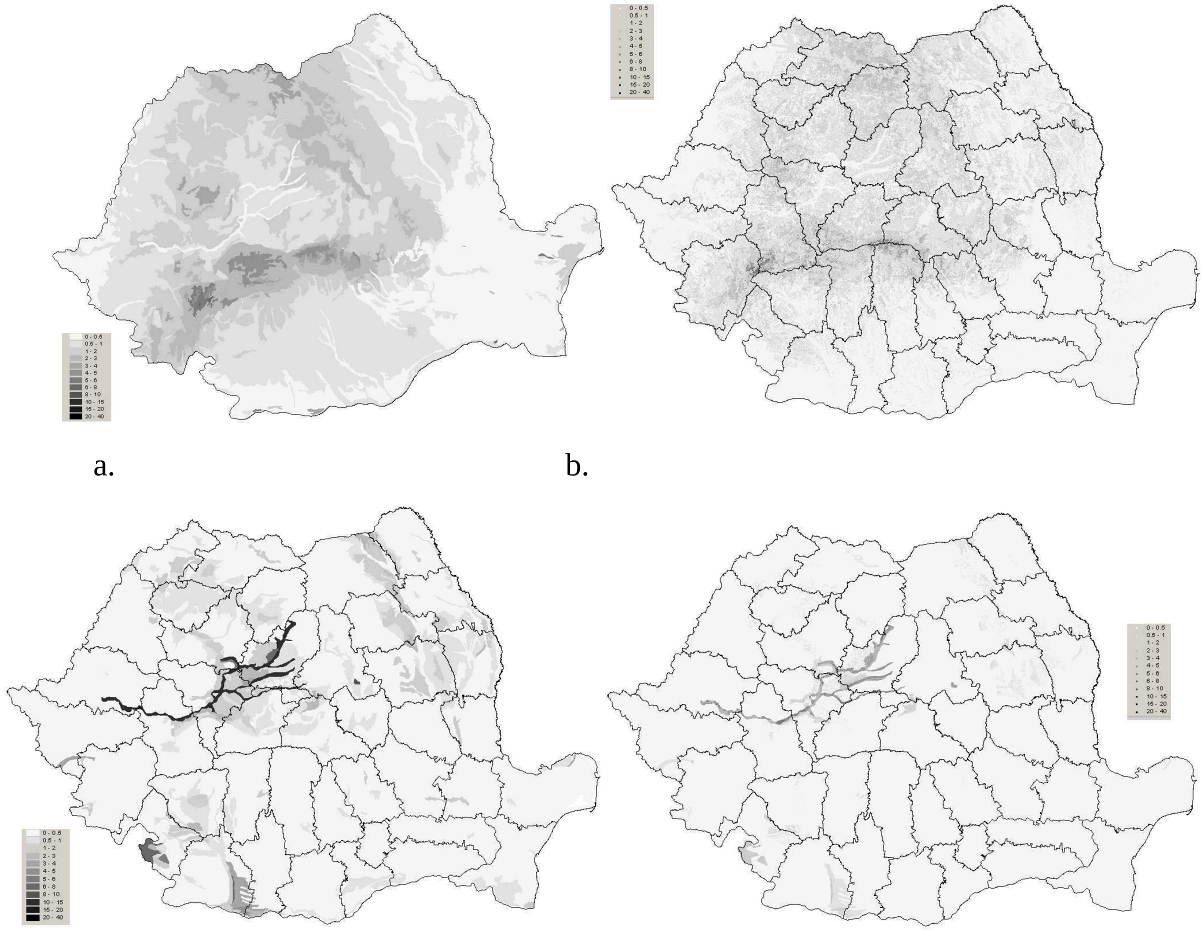
a. b.

Figure 3. Soil loss (t ha^{-1} $year^{-1}$) evaluated using PESERA model with 1 km grid (a.), and SIDASS model (WEPP methodology) (b.). Soil map of Europe scale 1:1,000,000; Climate data: ATEAM interpolation for 1960-1990 time series

The comparison of the two modelling showed that SIDASS-WEPP predicted higher soil loss rates than PESERA. Also the spatial variability provided by SIDASS-WEPP is greater than that given by PESERA (Fig. 3).

3.3. Results of country-scale comparisons

At **country level** the following maps show the differences derived from using different RAMs and scale of input data.



a. b.

c. d.

Figure 4. Soil loss (t ha^{-1} year^{-1}) in Romania evaluated using *a.* SIDASS model (WEPP methodology). Soil map of Europe scale 1:1,000,000; *b.* with SIDASS model (WEPP methodology). Soil map of Romania scale: 1:200,000; 100m grid for slope, *c.* PESERA model with 1 km grid, *d.* PESERA model with 100 m grid. Soil data 1:200,000. Climate data: ATEAM interpolation for 1960-1990

The change in the scale of input data resulted in differences in the output of the RAMs with both models. The area with erosion risk was higher using more detailed data with both models. The difference was higher in case of WEPP model (Table 4, Figure 4, 5 and 6).

Table 4. Areas characterized by distinct categories of soil loss (t ha-1 year-1) in Romania calculated with the four variations of RAMs: ***Wepp1m***: SIDASS model (WEPP methodology) with slope based on Slope index linked with each polygon in soil map of Europe scale 1:1,000,000. ***Wepp100***: SIDASS model (WEPP methodology) with soil map of Romania scale: 1:200,000 and DEM with the grid space of 100 m. ***Pesera1km***: PESERA model (JRC simulations) using the raster with 1 km grid for soil properties coming from the EU-soilGIS

scale 1:1,000,000, raster from Corine Land Cover with 1 km grid and DEM with the grid space of 1 km. ***Pesera 100***: PESERA model with raster for soil properties (grid 100m) derived from soil map 1:200,000, raster from Corine Land Cover with 100 m grid and DEM with the grid space of 100m.

Soil loss (t ha^{-1} $year^{-1}$)	Wepp100	Wepp1m	Pesera100	Pesera1km
0-2	23,217,756	21,419,364	23,568,694	23,205,241
2-10	621,344	2,419,736	270,406	633,859

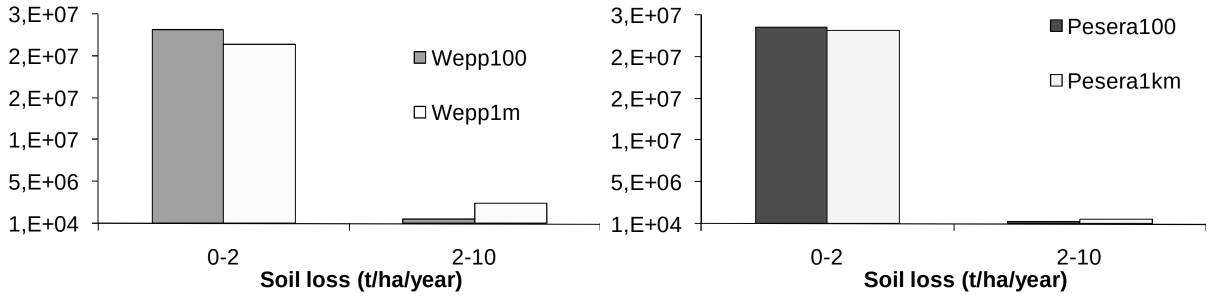


Figure 5. Area of land (ha on the y-axis) characterized with "soil loss category" of 0-2 and 2-10 t ha^{-1} $year^{-1}$ in Romania, using *a*. WEPP (Wepp100, Wepp1m) and *b*. PESERA models (Pesera100 and Pesera1km) with different input data. Columns are paired according to erosion model used.

The difference between the area obtained with PESERA and SIDASS (WEPP methodology) was smaller when using the models with more detailed data.

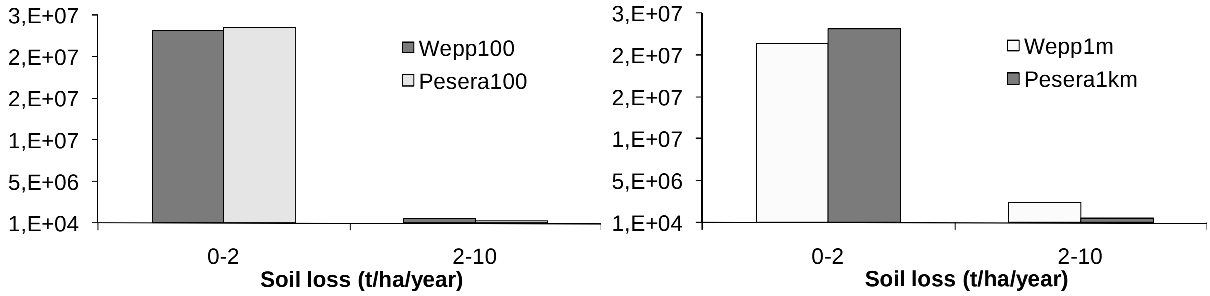
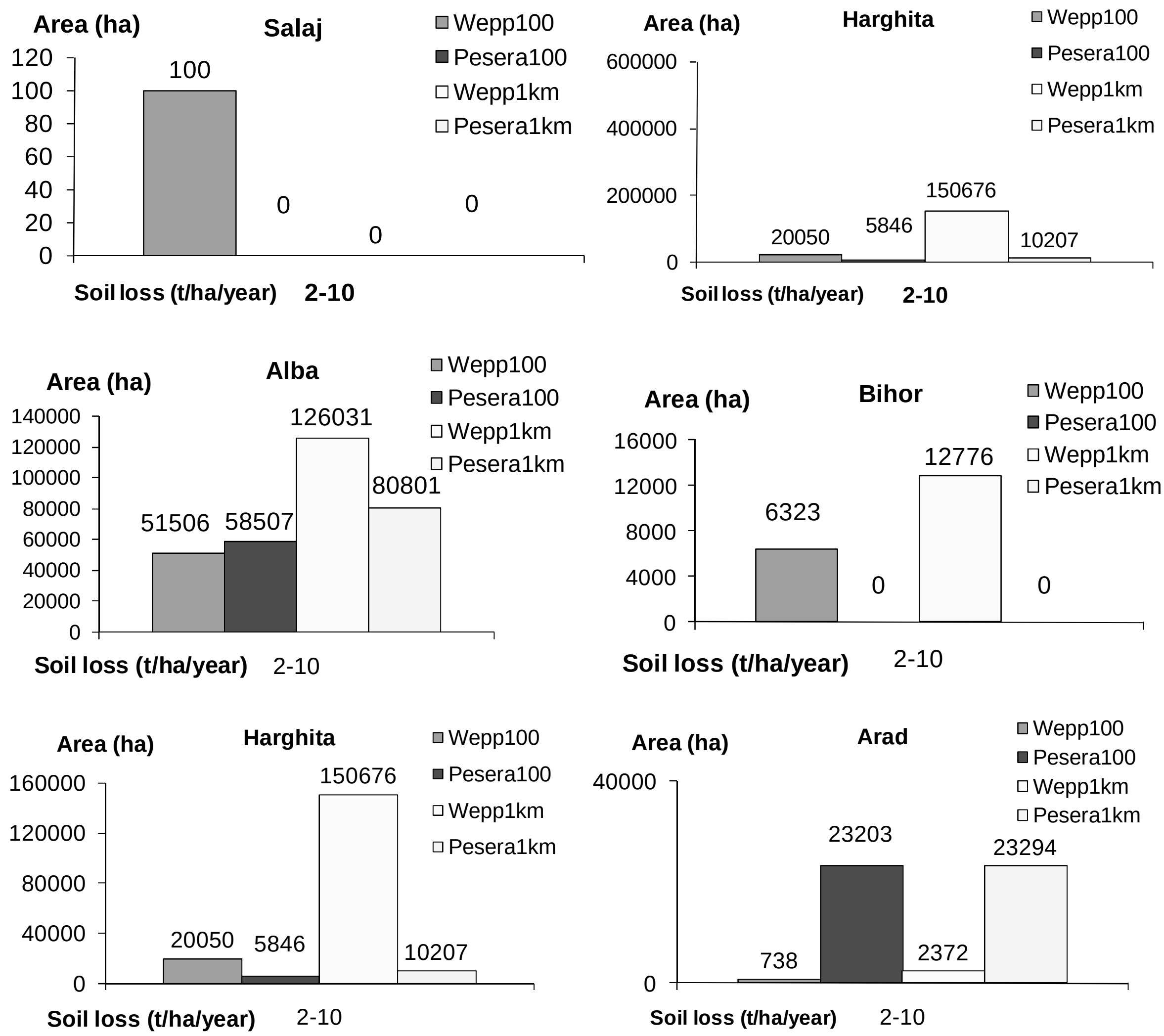


Figure 6. Area of land (ha on the y-axis) characterized with "soil loss category" of 0-2 and 2-10 t ha^{-1} $year^{-1}$ in Romania, using WEPP and PESERA models *a.* with (Wepp100, Pesera100) and *b.* and with (Wepp1m, Pesera1km) with different input data. Columns are paired according to similar spatial detailedness.

The results received at **county level** are presented in Fig 7. We compared the area characterized by soil erosion of 2-10 t ha^{-1} year^{-1} simulated with PESERA and WEPP methodologies with both input data resolutions. The use of different RAMs resulted in differences in output in all counties.

In some counties there are no great differences (Figure 7, for the Romanian counties of *Cluj*, *Alba*, *Timis*). PESERA underestimates compared to WEPP in the counties *Harghita* and *Bistrita-Nasaud*, even it happens that the area is zero with PESERA and higher than zero with WEPP in *Bihor*. PESERA overestimated the area compared to WEPP in *Arad*.



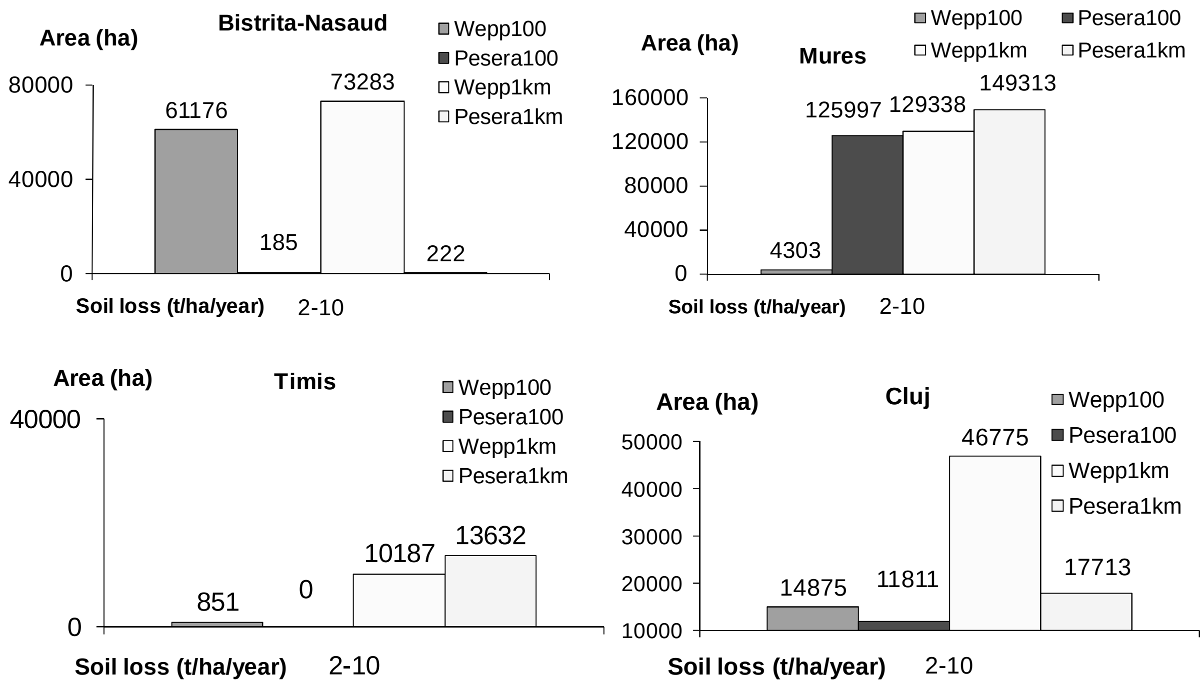
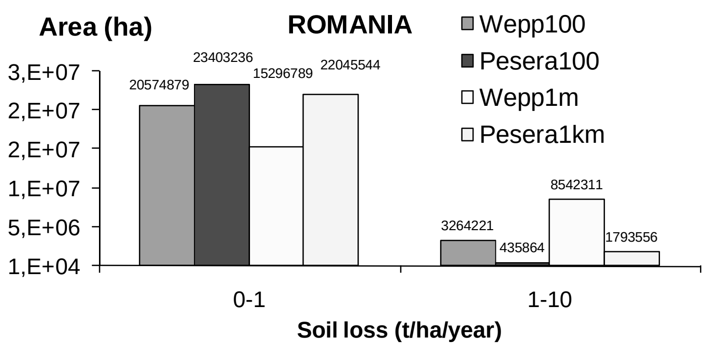


Figure 7. Area of land (ha on the y-axis) characterized with soil loss of 2-10 t ha^{-1} $year^{-1}$ in various counties, using the four different variations of RAMs (Wepp100, Wepp1m, Pesera100 and Pesera1km).

The importance of using **different threshold** values is shown in Fig 8.



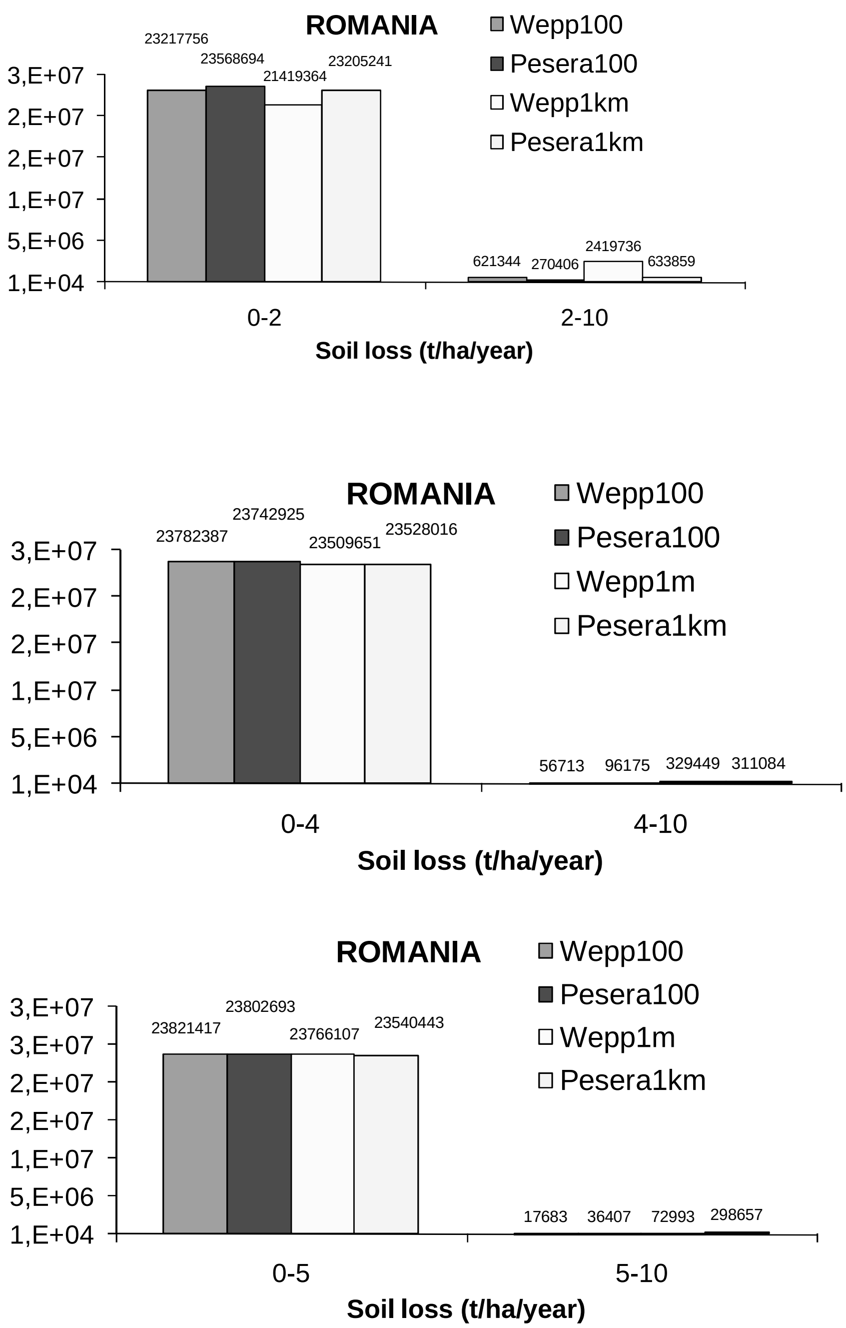


Figure 8. Area of land (ha on the y-axis) characterized with differing categories of soil in Romania, using the four different variations of RAMs (Wepp100, Wepp1m, Pesera100 and Pesera1km).

The chosen threshold values have a great impact on output of RAMs (Figure 8). The greatest difference was received when shifting from the threshold system of "0-1 and 1-10" to the one with "0-2 and 2-10", because in Romania the low erosion rate is most widespread. Among other environmental conditions very different changes of such sequences of figures can be obtained.

Although in scientific erosion RAMs the threshold is defined as soil loss (t ha^{-1} $year^{-1}$), in the Hungarian legislation there are exclusively officially defined **thresholds of slope** for parcel scale, because of the complexity of determining soil loss rate. When experts have to decide if there is risk of erosion in an area, no thresholds are given for them. On the other hand scientists and soil conservation experts have some consensus about thresholds, but it is not definite. There is variability in measures and also in amounts.

For example: two answers returned for the questionnaire from Hungary which are very similar but not the same:

Respondent No. 1.

Threshold(s) is (are): 0-2; 2-11; 11< t/ha/year

What is the qualitative range which belongs to these thresholds?

0-2: According to Hungarian estimates, 2 t/ha/y is the average rate of soil formation. If the soil loss is below, agricultural production can be considered sustainable.

2-11: Moderate, economically allowable nutrient loss limit (for US farmers);

>11 : High risk, arable farming should not be allowed at all, or only with strict regulations

Respondent No. 2.

a) 11-15 t/ha/year is the higher limit of allowable soil loss

b) loss of the original soil depth 0-30% = low rate, 30-70% = medium rate, >70% = high rate of erosion

When considering the **potential impacts/ benefits of using harmonized thresholds in EU** it can be stated that the measure of threshold can be harmonized. There is no problem of accepting the unit of “t ha^{-1} $year^{-1}$“as used already in most RAMs. The lower threshold can be defined for example as the average rate of soil formation – a complication is that the value of this is different for different areas/countries. The acceptance of harmonized threshold values is more complicated than that of the unit.

For example in Hungary there is existing legislation on soil protection. There are rules in order to apply subsidies for economic lost due to soil protection, or measures taken against erosion, but there are few exact thresholds given.

In the "Erosion protection" target programs of the Agrarian Environmental Management Support System together with the application for subsidy, a documented verification has to be attached from the regional Soil Protection Authority, about that the parcel is located on a land with minimum **5%** slope or is in risk of erosion. The method for further risk perception is not given in the decree of the Ministry of Agriculture and Rural Development, it is the responsibility of experts who make the certifications.

In the EU-wide utilized "Good Agricultural and Environmental Condition" it is stated that row crops cannot be grown in fields with inclination higher than **12 %**

There are some thresholds according to slope among the rules of supports, for restoration of silvicultural potential (that is funded by European Agricultural Fund for Rural Development): support can be given for bench construction in slopes with higher inclination than **10 degree** or to construct dikes on slopes with higher inclination than **15 degrees.**

3.4. Social and environmental impacts

Table 5 shows the suspected impact of the harmonization of RAMs on the different stakeholders.

Table 5. The potential impacts of harmonization of erosion related RAMs on different persons/institutions

STAKEHOLDERS	IMPACTS OF THE HARMONIZATION
Persons	
Persons most directly concerned by soil erosion	
Land renter	His/her possibility of registration for subsidies can change – as the categorization of a given land for erosion severity can change
Small land owner without registration for subsidies	Farm resale value can change with erosion-related condition of topsoils
Landowner with registration for subsidies	Conditions for subsidy may change into easier comparison
Specialist/agronomist working for an agricultural company	He/she will have to care about the problems originating from the changes
Housekeepers in the way of muddy flow	He/she may expect fair compensation
Land owners of land where the sediment	He/she may expect fair compensation

settles	
Citizens	Education of harmonized RAMs would help to focus attention on the importance of soil conservation. By increasing public awareness people will be more informed and can better knowledge on soil erosion
	Food prices may change according to possible changes in subsidy (increase due to deprived conditions) and/or increased spending on soil conservations (if legislation obliges the land user)
Consultants	
Consultant working for a company	He/she has to learn the harmonized RAM
The company	He/she has to employ experts who know the harmonized RAM
Extension specialist working for a non-profit organization, university or government	He/she has to learn the harmonized RAM
Educational specialists (kindergarten/elementary or secondary school teachers, university teachers)	He/she will have opportunity to teach RAMs because a harmonized method can be involved in the curricula more easily, and it can spread into public understanding
Researchers	
Researchers at Universities and Colleges	Easier international technical communication
Researchers at Research Institutes	Easier international technical communication
R&D specialists at commercial companies (developers of machinery for organic soil management)	Better possibilities of developing machinery for international market
Government authorities	
"Village" community agronomists	He/she has to learn the harmonized RAM
Soil protection station specialists	He/she has to learn the harmonized RAM
Central Agricultural Office, Directorate of Plant Production and Horticulture	Possibility for clear and transparent transboundary assessment of erosion threat

Ministry of Agriculture and Rural Development	Possibility for clear and transparent transboundary assessment of erosion threat
Authority for protection of water quality	Possibility for clear and transparent assessment of the effect of erosion in a transboundary setting.
European Union authorities	Clear and transparent way of ranking soil erosion related disadvantages of particular plots, farms, settlements, regions, countries.
Financial sector	
Insurance companies	Good evaluation of physical conditions for pricing the crop insurance
Machinery manufacturer companies/factories	Better possibilities of developing machinery for international market
Commercial companies selling agricultural machinery	Better possibilities of selling on the international market
Voluntary and non-government organisations	
(ESSC, IECA, European Soil Bureau)	Possibility for clear and transparent assessment of erosion threat

3.5. The order of importance of factors in relation with RAMs as told by policy makers

Answers to the question of Chapter 2.5 came from Hungary, Czech Republic, Belgium, The Netherlands, Denmark, Germany, Greece and Serbia. In summary the most important factors are efficiency and costs. Data availability, transparency, public acceptance and knowledge demand are also important in most countries. The less important factors are the difficulty of methodology and ambiguity as shown in Fig 9.

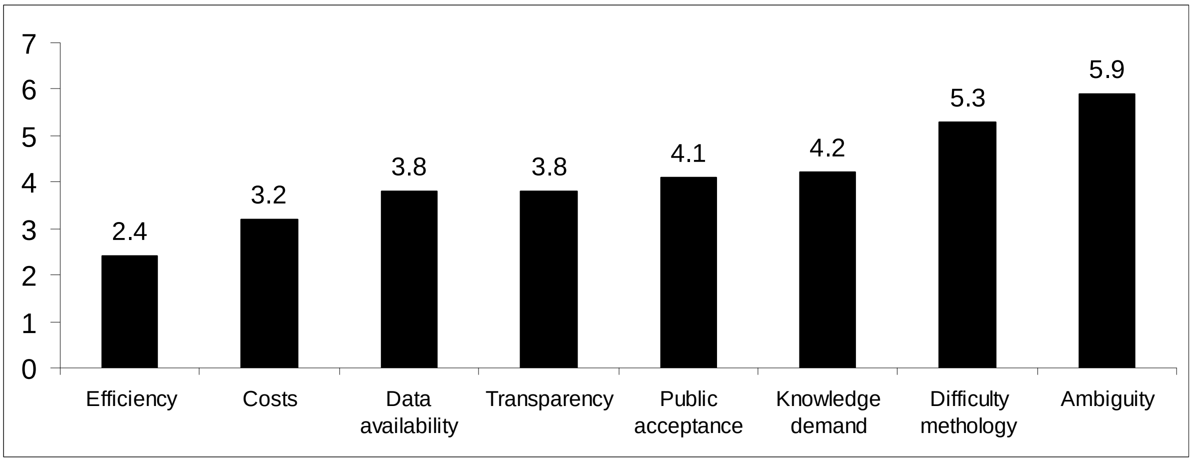


Figure 9. Mean ranking value (on the scale of 0-8) of some factors in relation with an official RAM obtained from the answered questionnaires for policy makers. Height of bars is in inverse relationship with the positive acceptance of the factors. It means that the most highly ranked factor was efficiency and the least highly ranked was ambiguity.

4. Conclusions

When considering the scientific consequences of harmonization it can be stated that by the means of harmonizing the Europe-wide erosion-related RAMs, the identification of priorities in research, monitoring and mapping could be more effective, and that would help the decision-making process related to the prevention and remediation of soil erosion in the EU.

At national level the amount of EU subsidy and the relevant tasks can depend on the areas affected by different levels of erosion in a given Member State. If a harmonized methodology would be accepted, there would be a transparent and clear system of either giving subsidy to land users to compensate them for the unfavourable environmental conditions, and/or to require soil conservation measures in order to maintain soil fertility.

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