Soil Degradation and Soil Value in Slovakia – Two Problems with Common Denominator

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Summary

Soil use is often accompanied by its degradation. Immediate reason of soil degradation in agriculture is the non-respecting the principles of good agricultural practice. Giving long-term precedence to production function over remaining ecological ones as well as supporting the land consumption for economy development by governmental bodies are next reasons of soil degradation and mirror the societal values and priorities.

Soil provides many services that in soil science are defined as soil functions. Besides biomass production the soil provides ecological and socio-economic functions. Use of soil and its functions is closely linked to soil ecological, societal and economic values. Preference to economic interests together with reluctance to search compromise solutions is often manifesting in soil degradation. Economic valuation of soil and its ecological functions is considered a possible way for improvement of soil protection especially in modification of soil price at its permanent consumption. In spite of that financial values can not be used as a base for forming of ethical values, which are imminently connected with human approach towards soil and its degradation, and which are essentially needed by global society. Ethical human values, based on basic beliefs and convictions, influence of human attitude to the soil, and they influence on soil use can be considered as common denominator of soil degradation and soil value, respectively.

Key words

soil, soil functions, soil degradation, soil value, economic valuation

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Introduction

Human beings have always been existentially connected to the soil as a base for biomass production and space for human activities, and this dependence will undoubtedly continue for future generations. Soil use in the landscape has economic, environmental, aesthetic and other cross-societal mutually merged aspects. This natural issue plays an important role in biomass production and functioning of ecosystems as well as human life quality, and thus it fundamentally influences the development of society. These facts have been reported in papers and documents since the last decade of the previous century (e.g. Blum, 1990; Council of Europe, 1992; European Commission, 2006).

Many documents and papers (e.g. European Commission, 2006; Van Camp et al., 2004) refer to soil degradation as a prominent environmental problem, and the necessity to sustain this resource in the long-term. Processes of soil degradation decrease its capacity to provide ecological functions essential for human life (e.g. Bujnovský and Juráni, 1999; Warkentin, 1997; Yaalon and Arnold, 2000). Moreover, soil degradation has a close relationship with other environmental and societal problems, such as occurrence of floods/drought, food and water availability/quality and human health.

Recently, a significant part of soil science activity has focused on understanding the evolution of soil parameters and properties under given soil use and management, as well as on the evaluation of soil state through monitoring. This provides information to support the development of legislation and the realisation of necessary soil protection measures. Although this area of activity is still under development, the analysis of the driving forces that directly or indirectly initiate/promote soil degradation is perceived as essential (e.g. EEA 2005; Van Camp et al., 2004).

Soil provides many services that in soil science are called soil functions. Besides biomass production that is economically valuable, soil provides other ecological functions priceless for society. Proposal of EU Frame Directive on soil protection (European Commission, 2006) considers the following ecological, socio-economic and cultural soil functions:

- biomass production, including agriculture and forestry
- storing, filtering and transforming of nutrients, substances and water
- biodiversity pools, such as habitats, species and genes
- a physical and cultural environment for humans and human activities
- a source of raw materials
- acting as a carbon pool
- an archive of geological and archaeological heritage.

As introduced by Fernandes et al. (2006) the long-term use of landscape services (and of course of the soil as basic landscape component) creates the basic framework for their pricing.

On the global level, the valuation of ecosystem services and functions has a great information deficit in the area of agricultural land except for food production (Constanza et al., 1997). The spatial definition and pricing of soil ecological functions can serve as a support for the modification of existing legal norms in permanent soil consumption (soil sealing), and provide a more objective basis for soil price definition.

Understanding soil value for society together with understanding human activities and societal forces that cause them is essential for the development of the necessary measures.

Material and methods

The examination of the driving forces that cause soil degradation represents part of Driving Forces-Pressures-State-Impacts-Responses (DPSIR) analysis (European Commission, 1999). According to Loveland and Thompson (2002), the drivers of environmental change are socio-economic factors, while physical, environmental and natural factors are considered rather as pressures. In the paper, basic/accustomed and more complex views of the reasons that directly or indirectly cause the soil degradation are presented. In line with Lambin (2005), the second approach is based on an *in depth analysis* of factors that cause environmental degradation or that may impede the adoption of more sustainable management practices, also including behaviour with respect to natural resource use and management. In the broader context, the environment deterioration mentioned below includes soil degradation.

In next part the fundamentals and principles of economic valuation of selected ecological functions on example of agricultural land of Slovakia are presented. The economic valuation of selected environmental soil functions on the entire agricultural land area is based on previous index evaluation of agricultural soils (Bujnovský et al., 2009). These are ranked into five classes, where existing or derived data on soil parameters accessible from databases contained in the Soil information system of Soil Science and Conservation Research Institute in Bratislava. Assumptions used as the starting-point for the economic valuation are shown in next part of this paper.

Results and discussion

Causes of soil degradation

Immediate causes

Analysis of soil degradation causes is perceived as the basic precondition for elimination of driving forces that finally have negative impact on soil quality and subsequently for adoption of efficient measures.

The immediate reasons for soil degradation are often remarkable and attract the attention of soil scientists and policy makers. First of all, it is necessary to mention the insufficient attention to the principles of good soil management practice and relevant legislation (erosion, compaction, loss of soil organic matter (SOM), and partially acidification as well pollution in agriculture).

Until now, soil has been considered as the basic production tool through which the farmer can gain economic benefit. It is necessary to stress that, principally; soil preservation is not consistent with permanent increases of benefit from its production use. Even today there is still, around the world, pressure on the need to sustain the soil production function to feed the growing world population. However, the real problem is somewhere else: a regional surplus of agricultural commodities does not always meet the threatened group of the global population.

Building of infrastructure and industrial enterprises for the provision of permanent economic growth has often been often

realised at the expense of permanent consumption of agricultural soils of high quality. It seems that meeting social needs in the future is not practicable without continuing (agricultural) soil consumption, and the intensity of sealing and quality of sealed soil will have substantial significance.

Economic activities affect soil quality not only in industrial and urban areas (compaction, pollution), but also surrounding soil in agricultural sector (acidification, pollution).

Also of importance is the clarification of ownership issues relating to the soil. It is necessary to mention that property rights to the soil in Slovakia are often connected with its economic use. The types of ownership alone cannot satisfactorily solve the problem of soil/land degradation because this problem is strongly influenced by attitude of human to the soil.

As Cairns (2002) introduces, property rights, even private, should encompass also duties and responsibility, especially in the case of natural resources, because the consequences of deterioration of ecological soil functions have impact on other people.

It is possible to state that the importance of the soil for the human society is still not adequately appreciated (e.g. Bouma, 2000; Warkentin, 1997; Yaalon and Arnold, 2000). Although the results of soil science research are usually used for the development of soil protection legislation and relevant educational/methodology publications, much of the expert and scientific knowledge does not have satisfactory application in practical life. In line with this, the proposal for an EU Directive for soil protection (European Commission, 2006) stresses the problem of public awareness and the need to address it.

Standard methods and tools widely used at present to address soil degradation causes include *i)* creation of information support for strategic and operative decision making, *ii)* ensuring the education of students and soil users in the area of causes and consequences of soil degradation, *iii)* creation of new knowledge in the area of causal-consequent relationships, soil degradation and impairment of other natural resources within national and international research projects, *iv)* development of new measures for the elimination or mitigation of existing damage of soil and other natural resources.

Traditionally, policy regulations in hand with the market are considered as major tools to solve current environmental problems (e.g. EEA, 2006; OECD, 2005). In fact, the market has only limited capacity to solve these problems that cannot be solved by internalisation of external costs, as they have deeper social roots.

Broader view on causes of soil degradation

Despite the broad lack of peoples` willingness to search for and solve the primary causes of soil degradation (including other environment components) and the long-term tendency to ascribe results of human activities to the general global changes, insufficiency of finances or lack of other capacities, the problem of gradual soil degradation still persists and has local and global consequences. As follows from many sources (e.g. Cairns, 2002; Gatzweiler et al., 2001; Meadows et al., 1993; Raskin et al., 1998), no matter what reasons of land degradation, they are closely related to the human activities.

There exist more societal forces and phenomena, which directly or indirectly affect state and evolution of the environment, and so they become politically significant. Besides economic, political, social and cultural factors, market, advertising, demographic factors and technical developments, it is necessary to mention human convictions, beliefs, values, attitudes and behaviours at the level of individuals, households, communities and whole public (Bechtel and Churchman, 2002; Goodwin et al., 1997; Meadows et al., 1993; Raskin et al., 1998; Stern, 2000; Wachtel, 1998). It is important to point out that the individual groups of driving factors have a different hierarchical position and the common denominator of all these drivers is the satisfaction of human needs.

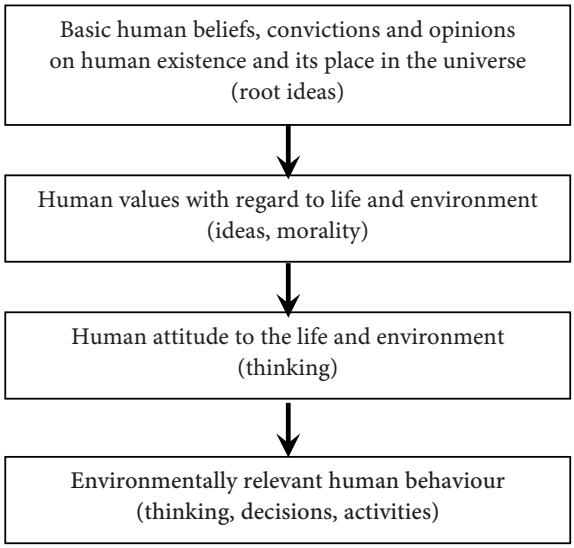

Figure 1. Hierarchy of causal factors at environmentally oriented human behaviour

Topicality of thinking and human behaviour, as illustrated above, is confirmed by many authors (e.g. Howard, 2000; Stern, 2000). According to these, for most people more than a simple change in ecological awareness is required. Rather a more fundamental reassessment of basic beliefs and thinking algorithms is needed, because environmentally relevant behaviour is at the end of long causal chain involving a spectrum of personal and relevant factors. As follows from the next simplified scheme (Figure 1), human beliefs and convictions influence behaviour.

People permanently try to change their living and environmental conditions, instead of changing the convictions/opinions responsible for the existing inappropriate state. Soil/land preservation should start with the change of attitude of mind, preferences, motivation, behaviour, desires and attitudes of humans to the environment that support sustainable life. Soil preservation against degradation should be a matter for the whole society, not only the soil scientists, farmers and policy makers. Hence, measures that aim to moderate soil/land degradation should have a cross-cutting character to provide a more complex and deeper insight into the system (human thinking and activities embracing the whole ecosystem). Soil/environmental research should also have a sociological dimension, as several writers suggest.

People place value to things they want as individuals and as a part of society. One of root questions is what the people want

and what they will really do to achieve it. Recent decisions of people lead to soil and environmental degradation.

Every system is maintained until the people decide to change it. Until now, people have intensively changed the environment state reflected in the degradation of soil and other natural resources. For the reasons mentioned, now is an important time to start positive changes of human beings from both a system and individual level.

Value system of society with regard to soil

In relation to the humans, the soil has some ecological, social and economic values. Typical example of ecological soil values are the soil ecological functions. It is not only the matter of water and substances cycles regulation but also aesthetic values with respect to landscape and human life conditions. Thereby, social values can be identified two ways: through sufficient quality of food and water concerning human health as well as through alternative soil uses maintaining with regard to creation of human life conditions for future generations. The most frequently is soil related to economic values. Activities in agricultural sector are primarily based on use of soil production function. Most of socio-economic functions are often based on permanent soil consumption, mostly on agricultural one. The soil use in relation to the development of human society and soil functions in simplified form is illustrated in Table 1.

It is necessary to mention that in given system economically oriented societal interests usually dominate despite the fact that society claims for many ecological and social values of soil and landscape. Preference to economic interests together with reluctance to search compromise solutions is often manifesting in soil degradation.

Table 1. Societal interests linked with soil use and societal values as starting point for sustainable societal development

Societal values relevant to soil	Societal interests relevant to soil use
Ecological values corresponding with water storage, substances immobilisation and transformation, buffering soil changes (pH), biodiversity pool, carbon pool	Maintenance of soil quality and other affected environmental issues
Social values corresponding with biomass production and partly with other ecological functions	Provision of sufficient amounts of safe food as contribution to the creation of good health state of population Maintenance of potential possibility for alternative soil and landscape use
Socio-economic values corresponding with soil functions as space for economic activities of humans (source of raw materials, space for infrastructure and residential development) and with biomass production	Development of economically oriented activities with aim to promote regional development, employment, living and economical standard of people

Table 2. Framework for economic valuation of selected soil ecological functions

Soil function	Benefit or remediation saved costs
Water storage capacity	Soil is regarded as a reservoir. Average costs of artificial basins are considered to be 2 € per 1 m^3. Cost information related to building of water reservoirs was undertaken from data of Vodohospodárska výstavba š.p. Bratislava available on www.vvb.sk.
Immobilisation of pollutants	Soil is regarded as a water treatment plant and price of waste water collection approximately 0.80 € per 1 m^3 is taken as price for the soils category with very high capacity for substance immobilisation (this cost information was taken from data of the Slovakian Regulatory office for network industries, valid for 2007). Mentioned price is equally divided into risk elements and organic pollutants. Although the unit price for both types of pollutants is the same, there are spatial differences in index values for them.
Transformation of organic pollutants	It is assumed that the very high ability of soil to transform the organic pollutants can be identical to costs for soil decontamination (over 1000 $\mu g.kg^{-1}$ PAH). Average PAH content in the soils of Slovakia is around 200 $\mu g.kg^{-1}$. The assumed costs for decontamination are 20 € per tonne (as introduced in Čík et al., 2004) and 0.1 m soil layer is assumed.

The soil value can be expressed in monetary form. The official soil price occurring in national (Slovak) legislation is usually based on the economic valuation of its production function. On the other hand, market price of the soil, often much higher than official price, is mostly affected by demand and offer relations in given area.

Economic valuation of soil ecological functions creates more complex view on soil value. Analogous to ecosystem services, indirect market economic valuation of ecological soil functions can be based on the estimation of *i)* saved or avoided costs due to the provision of a given soil function or *ii)* replacement costs related to returning damaged soil into its original state or quality (deGroot et al., 2002; Faber et al., 2002; Daily, 1997; Hawkins, 2003; Hackett, 2006). Thus the value of the majority of soil's ecological functions is classified as indirect non-consumption utility value. The economic valuation of selected soil functions is based on the previously mentioned assumptions set out in the Table 2.

Preliminary average values of selected ecological functions of agricultural soils in Slovakia are based on previous index evaluation of these functions and on defined assumptions. They represent 5300 € per hectare for water retention, 4300 € per hectare for immobilisation of risk elements and organic pollutants and 4000 € per hectare for transformation of organic pollutants, respectively. Spatial distribution of such evaluation is illustrated on the example of water retention (Figure 2).

Brodová (2008) expressed functions of the agricultural land from 2002 to 2006 at 669 to 804 €·ha^{-1}., while Linkeš et al.

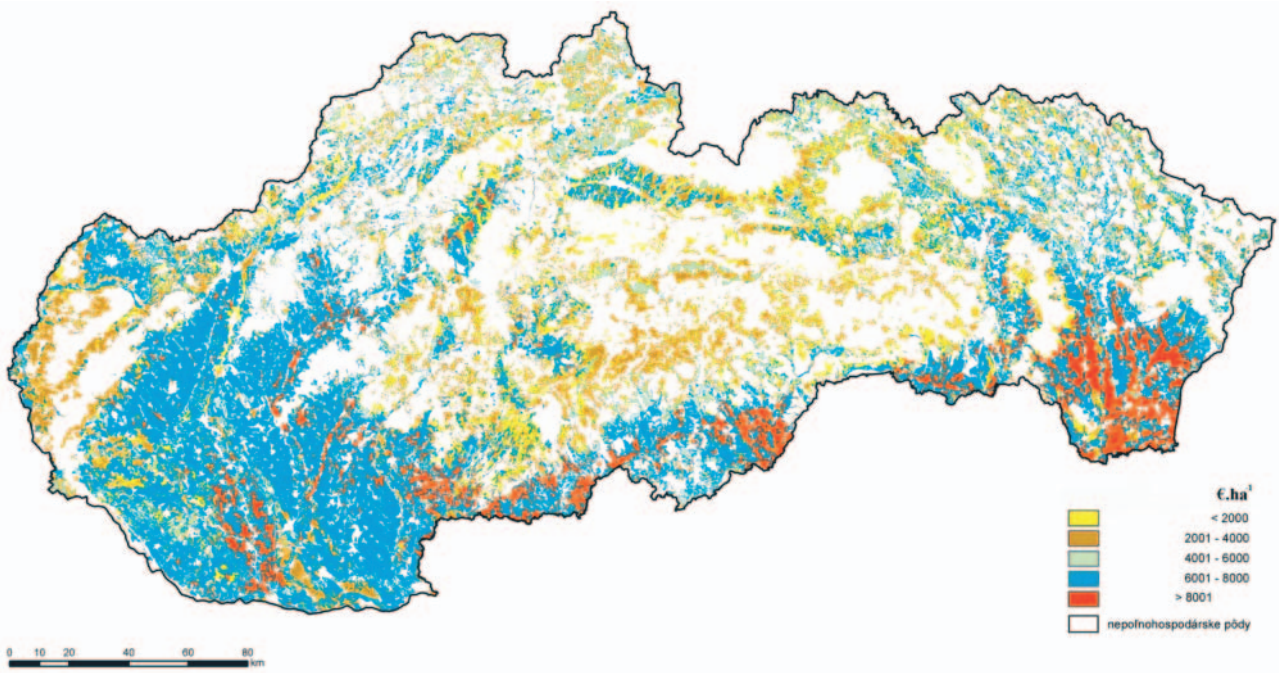

Figure 2. The price of the potential soil capacity to store water

(1996) estimated the value of the non-production soil functions in Slovakia at 780 € per hectare. The estimation of the values of ecological soil functions presented here significantly exceeds pre-existing estimations.

According to many papers, pricing environmental services seems to be a possible way of improving the preservation of given resources, including soil, through the support or stimulation of it,s preservation and sustainable use.

In general, the price of environmental services, as for soil ecological functions, does not reflect its societal importance because the economy is normally focused on market oriented prices, and not on the value or significance of these services for society. Based on existing human preferences, the economic assessment of natural issues, including soil, is anthropogenic by nature, and therefore it can not objectively express their societal importance. In fact, human preferences can not address the importance of environmental services from the view-point of ecosystem functioning (Heal, 2000; Winkler, 2006).

The economic valuation of soil's ecological functions offers a broader view of the actual importance and subsequent value of soil for society. Accordingly, the valuation of soil and its ecological functions appears to be a possible way of improving soil protection, especially in the modification of soil price at its permanent consumption. Obtained price relations can be used also for estimation of site position coefficient at determination of general value of agricultural land in Slovakia. Despite this, in harmony with Sciama (2007), economic valuation should not be used as a basis for forming ethical values that are imminently connected to human approaches towards soil and its degradation, since these are essential for the global society.

Conclusions

Persistent problems of soil degradation indicate that the current use of this natural resource is not sustainable. The reasons are as follows: *i)* insufficient attention is paid to the principles of good soil management practice and relevant legislation, *ii)* the agricultural soil is often considered only as the basic production tool, *iii)* economic growth is realised through permanent consumption of agricultural soil often of high quality, *iv)* economic activities in industrial and urban areas affect also surrounding soil in agricultural sector. The types of ownership alone cannot satisfactorily solve the problem of soil degradation. There exist more societal forces and phenomena, which directly or indirectly affect state and evolution of the environment (soil including), and so they become politically significant. Besides economic, political, social and cultural factors, market, advertising, demographic factors and technical developments, it is necessary to mention human convictions, beliefs, values, attitudes and behaviours at the level of individuals, household, communities and whole public.

Use of soil and its functions is closely linked to soil ecological, societal and economic values. Preference to economic interests together with reluctance to search compromise solutions is often manifesting in soil degradation. Economic valuation of soil ecological functions offers a broader view on the real importance and the subsequent value of soil to the society. Economic valuation of selected soil ecological functions is directly usable in Slovakia, because of in other countries prices are different. But philosophy of evaluation can be used as a basic platform in other countries.

Valuation of soil and its ecological functions appears to be a possible way of improving soil protection, especially in the modification of the soil price at its permanent consumption. Obtained price relations can be used also for estimation of site position coefficient at determination of general value of agricultural land in Slovakia. Economic valuation should not be used as a basis for forming ethical values that are imminently connected to human approaches towards soil and its degradation, since these are essential for the global society.

Ethical human values, based on basic beliefs and convictions, influence of human attitude to the soil, and they influence on soil use can be considered as common denominator of soil degradation and soil value, respectively.

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