

IMPORTANCE AND VALUE OF SOIL ENVIRONMENTAL FUNCTIONS

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Abstract: Similarly as ecosystem soil provides many services and goods that in soil science are named as soil functions. Besides biomass production, that is possible economically evaluate, the soil provides other ecological functions that are priceless for the society. Sustainability of societal development requires maintenance of soil quality and soil functions - especially the ecological ones. Principles and results of economic valuation of selected soil ecological functions are presented. Average values of selected ecological functions of agricultural soils in Slovakia are based on previous index evaluation of these functions and defined assumptions and represent 4943 € per hectare for water retention, 4720 € per hectare for filtration of organic and inorganic pollutants and 4336 € per hectare for transformation of organic pollutants, respectively. Valuation of soil and its ecological functions seems as possible way for improvement of soil protection especially in modification of soil price at its permanent sealing but financial values should not to be used as a ground for forming ethical values, which are imminently connected with human approach towards soil and its degradation, and which are essentially needed by global society.

Key words: soil, soil functions, economic valuation

INTRODUCTION

Soil as environmental component plays important role as at biomass production and functioning of ecosystems as well as human life quality and thus primarily influences the development of society. This fact can be mentioned in papers and documents since last decade of previous century (e.g. Blum, 1990; Council of Europe, 1992; European Commission, 2006).

Similarly as ecosystem soil provides many services and goods (de Groot et al., 2002) that in soil science are named as soil functions. Besides biomass production, that is possible economically evaluate, the soil provides other ecological functions that are priceless for the society. Recently elaborated proposal of EU Frame Directive on soil protection (European Commission, 2006) considers the following ecological, socio-economic and cultural soil functions:

- biomass production, including in agriculture and forestry
- storing, filtering and transforming nutrients, substances and water
- biodiversity pool, such as habitats, species and genes
- physical and cultural environment for humans and human activities
- source of raw materials

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- acting as carbon pool
- archive of geological and archeological heritage.

Sustainability of societal development requires maintenance of soil quality and soil functions - especially the ecological ones. Besides definition of basic principles for evaluation of selected soil functions it is necessary to search also ways for economic valuation (pricing) that can be considered with regard to modification of agricultural soil taxation.

MATERIALS AND METHODS

The paper is oriented on evaluation the importance of soil functions for the society and benefits from selected environmental functions of agricultural soils. The economic valuation is based on general evaluation of soil functions through accessible or basic set of indicators often called "minimum data set" of indicators (e.g. Doran, Parkin, 1994; Larson, Pierce, 1994) that can embrace as soil as well as site parameters. Individual ecological soil functions are placed into hierarchical system of soil function values. Subsequently suitable frame method of economic valuation is chosen. Economic valuation of selected environmental soil functions is based on previous index evaluation of agricultural soils (Bujnovský et al., 2008), ranked into 5 classes, where existing or derived data on soil parameters that are accessible from databases of Soil information system of Soil Science and Conservation Research Institute Bratislava. The assumptions used as start-point for economic valuation are introduced in Table 2 in next part of paper.

RESULTS AND DISCUSSION

Soil use in relation to development of human society and soil functions in simplified form illustrates Tab. 1.

Tab.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 retention, substances filtration and transformation, buffering soil changes (pH), biodiversity pool	Maintenance of soil quality and other affected environmental constituents
Social values corresponding with biomass production and partly with other ecological functions	Provision sufficient amount 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 function as space for economic activities of human (source of raw materials, space for infrastructure and residential development) and partly with biomass production	Development of economically oriented activities with aim to promote regional development, development of employment, living and economical standard of people

Source: authors

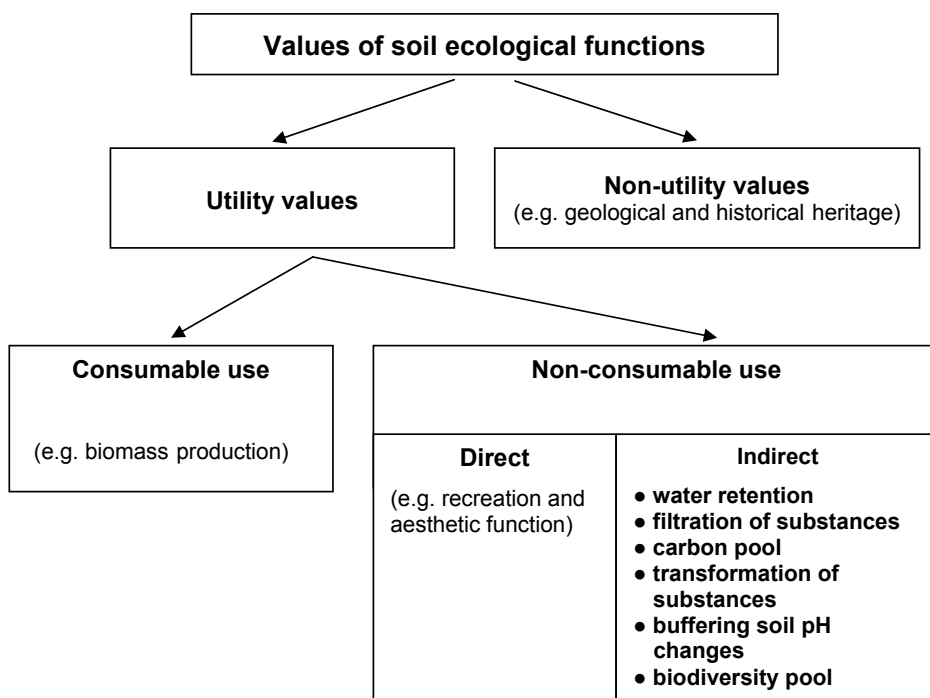
It is necessary to mention that in given system usually dominate economically oriented societal interests despite of fact that society claim for many ecological and social values of soil and landscape. Preference to economic interests together with reluctance to search compromise solutions is often manifesting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

Living conditions and subsequently quality of human life directly or indirectly depends on the accessibility environmental goods and services that usually have non-monetary value (de Groot et al., 2002). As introduce Scott et al. (1998), services represent properties of ecological, soil functions from that human derives the benefits. While production function (biomass production) brings utility values, many soil ecological functions can be ranked into regulation functions of environment (e.g., Daily, 1997; de Groot et al., 2002; Hawkins, 2003) - see Fig. 1.

Economic valuation of selected soil functions - in analogy to ecosystem services (e.g. deGroot et al., 2002; Faber et al., 2002; Daily, 1997; Hawkins, 2003; Hackett, 2006) – represents indirect market economic valuation of selected regulation soil services (expressed by ecological functions) can be based on estimation of *i*) saved or avoided costs due to provision of given soil function or *ii*) replacement costs relating with returning of damaged soil into original state or quality. So the values of most soil ecological functions are classified as use values of indirect non-consumptive use.

Economic valuation of selected soil functions is based on assumptions introduced in Tab. 2.

Fig. 1: *Ranking of services resulting from soil ecological functions into value categories*



Source: authors

Preliminary average value of selected ecological functions of agricultural soils in Slovakia represents 4943 € per hectare for water retention, 4720 € per hectare for filtration of organic pollutants (including practically inorganic pollutants) and 4336 € per hectare for transformation of organic pollutants, respectively. Buday et al. (2006) estimated the replacement costs resulting from positive externality of agricultural landscape (protection against floods, prevention against water erosion, absorption of SO₂ and NO₂ and disarming of organic wastes) at 465 to 597 € per hectare. Linkeš et al. (1996) introduce the non-production soil functions of Slovakia at 830 € per hectare. Presented estimation of values of ecological soil functions significantly exceeds existing estimations.

Tab. 2: *Frame for economic valuation of selected soil ecological functions*

Soil function	Benefit or remediation saved costs
Water accumulation retention water capacity in soil (up to 1 m)	Soil is regarded as reservoir Average costs of artificial basin are considered to be 2 € per 1 m ³ .
Filtration and immobilisation of inorganic pollutants sorption of organic pollutants on SOM and clay expressed through evaluation of significant soil parameters (Cox, SOM quality Q4/6, topsoil depth) with regard to average sum of rainfall Filtration and immobilisation of organic pollutants sorption of organic pollutants on SOM and clay expressed through evaluation of significant soil parameters (Cox, SOM quality Q4/6, topsoil depth) with regard to average sum of rainfall	Soil is regarded as water treatment plan and price of waste water collection approximately 0.75 € per 1 m ³ is taken as price for the soils category with very high capacity for substances filtration. Of course this economic valuation embraces filtration inorganic and organic pollutants. So the above introduced price is divides by half for each category of pollutants but spatial distribution of soil capacity to provide filtration remains spatially different – according to original separate index evaluation of soil capacity to filtrate inorganic and organic pollutants
Transformation of organic pollutants biotic and abiotic transformation of organic pollutants expressed through evaluation of selected parameters (SOM quality – Q4/6, Cox, clay content, pH) with regard to average annual air temperature	It is assumed that very high ability of soil to transform the organic pollutants can be identical to costs for soil decontamination (over 1000 µg.kg ⁻¹ PAU). Average PAU content in Soils of Slovakia is around 200 µg.kg ⁻¹ PAU. The assumed costs for decontamination are 30 USD per tonne and 0.1 m soil layer is assumed.

Source: authors

Valuation of soil and its ecological functions seems as possible way for improvement of soil protection especially in modification of soil price at its permanent sealing. In spite of that, in harmony with Sciama (2007) financial values should not to be used as a ground for forming ethical values, which are imminently connected with human approach towards soil and its degradation, and which are essentially needed by global society.

CONCLUSIONS

Economic valuation of soil ecological functions offers the broader view on real importance and subsequently the value of the soil for the society. Estimated economic value of selected soil ecological functions is considered as contribution to the improvement of soil protection especially in modification of soil price at its permanent sealing.

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VÝZNAM A HODNOTA EKOLOGICKÝCH FUNKCIÍ PÔDY

Zhrnutie

Pôda obdobne ako ekosystém zabezpečuje viacero služieb a poskytuje statky ktoré sa v pôdoznaleckej terminológii nazývajú funkcie pôdy. Okrem produkcie biomasy rastlín, ktorú je možno ekonomicky hodnotiť, pôda zabezpečuje ekologické funkcie ktoré sú pre spoločnosť k nezaplateniu. Udržiateľný rozvoj spoločnosti predpokladá udržiavanie kvality pôdy a jej funkcií – predovšetkým ekologických. Príspevok prezentuje ekonomické hodnotenie prínosov vybraných ekologických funkcií poľnohospodárskej pôdy pre spoločnosť. Priemerná ekonomická hodnota vybraných ekologických funkcií v rámci poľnohospodárskych pôd je nasledovná: schopnosti pôdy akumulovať vodu 4943 €·ha⁻¹, filtrácia organických a anorganických polutantov 4720 €·ha⁻¹ a 4336 €·ha⁻¹ transformácia organických polutantov. Hodnotenie pôdy a jej ekologických funkcií sa ukazuje ako možná cesta pre zlepšenie ochrany pôdy predovšetkým pri modifikácii ceny pôdy pri jej trvalých záberoch. Napriek tomu, oceňovanie nemôže byť použité ako základ pre formovanie etických hodnôt bezprostredne spojených s postojom človeka k pôde a jej degradácii, ktoré globálna spoločnosť tak naliehavo potrebuje.

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