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# THE EVALUATION OF FRESHWATER AND AGRICULTURAL LAND ECOSYSTEM SERVICES AND ITS UTILISATION

Water and soil belong to basic natural resources that are essential for the existence and development of human civilization. These resources represent part of natural capital which provides or can provide ecosystem services - goods and services. Definition of significant ecosystem services related to agricultural land and inland waters is basic precondition to evaluate these systems. While in the case of freshwater ecosystems (rivers, lakes and also groundwater) we are at the start, in the case of ecosystem services of agricultural land (cropland, permanent grasslands) there are already available spatial results of bio-physical and economic evaluation of soil functions in GIS format.

Suitability for water use for a specific purpose (that in fact represents ecosystem service) in Slovak conditions is assessed according to a particular set of water quality parameters and corresponding limit values. Evaluation of freshwater ecosystem services can serve as support for the selection of cost-effective measures, and for the mapping and assessment of ecosystems services as part of the EU Biodiversity Strategy to 2020.

Ecosystem service approach is considered as extension of soil function approach that can be perceived as core of ecosystem services evaluation that integrates soil and biotic aspects. The bio-physical evaluation of soil functions or services serves as basic precondition for it local use with regard to mitigate the anthropogenic pressures and its consequences. At present, the real possible utilisation of soil ecosystem services/functions can be seen at improvement of soil protection especially via modification of soil price at its permanent sealing.

**Key words:** ecosystem services, agricultural land ecosystems, freshwater ecosystems

**Лисняк А., Буйновский Р., Вилчек Й. ОЦЕНКА ЭКОСИСТЕМНЫХ УСЛУГ ПРЕСНОЙ ВОДЫ И СЕЛЬСКОХОЗЯЙСТВЕННОЙ ЗЕМЛИ И ЕЁ ПРИМЕНЕНИЕ**

Вода и почва относятся к основным природным ресурсам, которые необходимы для существования и развития человеческой цивилизации. Эти ресурсы выступают в роли части природного капитала, который предоставляет или может предоставлять экосистемные услуги - товары и сервис. Определение значимых экосистемных услуг, связанных с сельскохозяйственными землями и внутренними водами является основной предпосылкой для оценки этих систем. В то время как в случае пресноводных экосистем (рек, озер, а также грунтовых вод) мы находимся на начальном этапе оценки, то в случае экосистем сельскохозяйственных земель (пашни, постоянные пастбища) уже имеются пространственные результаты биофизической и экономической оценки функций почв в ГИС-формате.

Использование воды для определенной цели (что, по сути, представляет экосистемные услуги) в словацких условиях оценивается по определенному набору параметров качества воды и соответствующих предельных значениях. Оценка экосистемных услуг пресной воды может служить поддержкой для выбора экономически эффективных мер, а также для картирования и оценки экосистемных услуг как часть стратегии ЕС по Биоразнообразию до 2020 года.

Экосистемный подход рассматривается как расширение подхода функции почвы, который может восприниматься в качестве основной оценки экосистемных услуг, который интегрирует почвенный и биотический аспекты. Биофизическая оценка функции почвы, как услуга, служит основной предпосылкой для её изучения в отношении смягчения антропогенного воздействия и его последствий. В настоящее время, реальные возможности использования почвенных экосистемных услуг/функций можно увидеть на примере улучшения охраны почв, в частности, через изменение цены на почву в месте его постоянного уплотнения.

**Ключевые слова:** экосистемные услуги, сельскохозяйственные земли, экосистемы, пресноводные экосистемы

**Лісняк А., Буйновський Р., Вілчек Й. ОЦІНКА ЕКОСИСТЕМНИХ ПОСЛУГ ПРІСНОЇ ВОДИ І СІЛЬСЬКОГОСПОДАРСЬКОЇ ЗЕМЛІ ТА ЇЇ ЗАСТОСУВАННЯ**

Вода і ґрунт відносяться до основних природних ресурсів, які необхідні для існування та розвитку людської цивілізації. Ці ресурси являють собою частину природного капіталу, який надає або може надавати екосистемні послуги – товари та сервіс. Визначення значущих екосистемних послуг, пов'язаних з сільськогосподарськими землями і внутрішніми водами є основною передумовою для оцінки цих систем. У той час як у випадку прісноводних екосистем (річок, озер, а також ґрунтових вод) ми перебуваємо на початковому

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етапі оцінки, то в разі екосистем сільськогосподарських земель (ріллі, постійні пасовища) вже є просторові результати біофізичної та економічної оцінки функцій ґрунтів в ГІС-форматі.

Використання води для певної мети (що, по суті, є екосистемними послугами) в словацьких умовах оцінюється за певним набором параметрів якості води та відповідних граничних значеннях. Оцінка екосистемних послуг прісної води може служити підтримкою для вибору економічно ефективних заходів, а також для картування та оцінки екосистемних послуг як частина стратегії ЄС з Біорізноманіття до 2020 року.

Екосистемний підхід розглядається як розширення підходу функції ґрунту, який може сприйматися в якості основної оцінки екосистемних послуг, який інтегрує ґрунтовий та біотичний аспекти. Біофізична оцінка функції ґрунту, як послуга, служить основною передумовою для її вивчення відносно пом'якшення антропогенного впливу і його наслідків. В даний час, реальні можливості використання ґрунтових екосистемних послуг/функцій можна побачити на прикладі поліпшення охорони ґрунтів, зокрема, через зміну ціни на ґрунт в місці його постійного ущільнення.

**Ключові слова:** екосистемні послуги, сільськогосподарські землі, екосистеми, прісноводні екосистеми

## *Introduction*

Water and soil belong to basic natural resources that are essential for the existence and development of human civilization. These resources represent essential part of natural capital which provides or can provide ecosystem services – goods and services. Ecosystem services are defined as the outputs from natural systems from which people can have benefits (e.g. NRC, 2004; Boyd and Banzhaf, 2007).

A continual deterioration of natural resources recorded in a number of documents (e.g. EEA, 2012; MEA, 2005; UNEP, 2012; Jones et al., 2012) is a general challenge for maintaining the welfare of human civilization on Earth in the future which embraces the reassessing priorities and restructuring of the global economy and more efficient use of natural resources and environment protection (e.g. European Commission, 2010; European Commission 2011; OECD, 2011). Moreover, improvement of management and avoiding the overexploitation of natural resources, together with the finding of the value of ecosystem services, is one of the objectives of the renewed EU Sustainable Development Strategy. Evaluation of ecosystem services is also enshrined in the EU's biodiversity strategy to 2020, which became the main accelerator of the assessment and mapping of ecosystem services in the Europe.

According to typology of ecosystems (Maes et al., 2013), agricultural land is linked to terrestrial ecosystems (cropland, grasslands) and inland water corresponds with fresh water ecosystems (rivers, lakes) and moreover also groundwater, which is not directly mentioned.

## *Material and methods*

This paper is focused to definition of significant ecosystem services related to agricultural land and inland waters for Slovak conditions in accordance to recent knowledge (COWI, 2014; Maes et al., 2014; Robinson et al., 2014) when the Common International Classification of Ecosystem Services (CICES) v. 4.3 (Haines-Young and Potschin, 2013) is used as base. Principles of evaluation of ecosystem services and their practical utilisation are analysed and discussed.

## *Results and discussion*

***Ecosystem services related to freshwater ecosystems*** Significant freshwater ecosystem services in Slovak conditions are introduced in Table 1.

A selection of ecosystem services is affected by the fact that the Water Framework Directive (WFD) is explicitly focused to use values. As can be seen from Table 1, several ecosystem services (in particular the provision of raw water for different types of use, mediation of waste and toxic and recreational activities) directly relate to the provision of major water uses, which are analyzed in the Water Plan of the Slovak Republic (MoE, 2010). Finally, the extent of freshwater ecosystem services assessment is primarily influenced by the availability and quality of bio-physical data.

Evaluation of freshwater ecosystem services is to some extent linked with implementation of Water Framework Directive. Considering the list of ecosystem services it can be noted that utilisation of many ecosystem services create the pressures on the water bodies. It is namely the case of provisioning and some regulation ecosystem services. Providing of ground- and/or surface water for industrial, drinking and irrigation purposes as well as pollutants dilution after wastewater discharge may put considerable pressure on the water bodies and increase the

**Table 1**

**Significant freshwater ecosystem services**

| Services | Division/group | Class |
|---|---|---|
| Provision | Provision of biomass | Aquatic animals - aquaculture |
| | Provision of materials | Water for different use – drinking water, crop irrigation, industrial use as raw material and cooling medium, Sands, gravels, riverbed sediments |
| | Provision of energy | Electricity production |
| Regulation and maintenance | Mediation of waste, toxics | Decomposition and removal of pollutants |
| | | Dilution of pollutants |
| | Transport of objects and substances | Waterways transport |
| | Maintenance of physical, chemical, and biological conditions | Habitat and gene pool protection |
| Cultural | Physical and intellectual interactions | Recreation - swimming, angling, boating |
| | | Scientific and educational use |
| | | Heritage, cultural aspects |

risks of not achieving WFD objectives. Moreover evaluation of benefits arising out of the freshwater ecosystem services or the deficits, when necessary measures are not realized, is one of the ways of evaluating the external costs of environmental damage (Brouwer, 2004). So it has link to Article 9 on cost recovery and water pricing.

Suitability of water use for a specific purpose (that represents ecosystem services) is assessed according to a particular set of water quality parameters and corresponding limit values. Economic evaluation of freshwater services are mostly based in the non-preferential methods (in particular the methods of market valuation, cost methods) that are applicable in the case of evaluation of production and regulatory services. As stated Chee (2004), identifying preferences of people and their willingness to pay for ecosystem services is in many cases burdened with insufficient awareness of (real meaning) functions and consequently the services that the ecosystem provides.

It is necessary to mention, that the results of ecosystem services evaluation are significantly influenced by the used method and corresponding parameters entering the evaluation. For example, in the case of water for crop irrigation the result is influenced by the consumption of irrigation water in relation to the weather course and also inter-annual dynamics of commodity prices, used to express the effect of irrigation. In the case of recreational swimming in natural waters, the economic effect of the ecosystem service is derived from the number of visitors, which is directly influenced by course of the weather in the bathing season.

As the link between good ecological status/potential defined by the WFD and the ecosystem services is not always clear (COWI, 2014), suitability for water use for a specific purpose in Slovak conditions is assessed according to a particular set of water quality parameters and corresponding limit values. With regard to the differences in spectral classification schemes for assessing the quality of individual water uses on the one hand, and good chemical and ecological status of waters on the other hand, the evaluation of the benefits or deficits arising from achieving or non-achieving of good status of water becomes problematic (Kijovská et al., 2014). Of course, ecosystem with improved ecological status will often be able to provide a higher variety of ecosystem services, but on the evaluation of actually used waters has often small effect as many of ecosystem services have fixed locations (e.g. hydropower plants, natural bathing waters or watercourses for the abstraction of water for drinking purposes).

According to COWI (2014), by incorporating ecosystem service considerations into the implementation of the WFD and the Flood Directive, it is possible to capture and describe better the benefits and possible co-benefits of achieving the objectives of the directives. Evaluation of freshwater ecosystem services can serve

mainly as support for the selection of cost-effective measures by considering co-benefits delivered by measures and the mapping and assessment of ecosystems services as part of the EU Biodiversity Strategy to 2020.

The specific objectives of the WFD – such as «good status» and «no deterioration» – are not directly describing the benefits which the EU citizens will experience. Hence, translating these objectives into the ecosystem services that benefits the population could significantly improve the whole stakeholder involvement throughout the implementation process (COWI, 2014). Public engagement represents an essential aspect of WFD implementation. But, as states Everard (2012), support for WFD implementation may be often regarded as an altruistic task, as the public may not be able to appreciate the benefits of delivering its aims and how this affects their quality of life.

***Ecosystem services related to agricultural land*** The significant ecosystem services relevant to agricultural land or agro-ecosystems in Slovak conditions are introduced in Table 2.

Most of defined ecosystem services of agricultural land are corresponding with previous definition of soil functions (e.g. Bujnovský et al., 2009).

**Table 2**

**Significant ES relevant to agricultural land**

| Services | Division/group | Class |
|---|---|---|
| Provision | Provision of biomass | Biomass of cultivated crops for food production, raw material and bio-energy |
| | | Reared animals |
| | Provision of materials | Peat |
| | | Sand, gravel, clays |
| | Space for human activities | Physical support to present and future human activities |
| Regulation and maintenance | Mediation of waste, toxics | Bio-remediation |
| | | Bio-chemical detoxification |
| | | Bio-physicochemical filtration of pollutants |
| | Mediation of flows | Water infiltration and accumulation |
| | | Soil erosion control |
| | | Flood protection |
| | Maintenance of physical, chemical, and biological conditions | Organic matter decomposition, nutrients turnover |
| | | Carbon storage - climate change regulation |
| | | Buffering the pH changes |
| | | Habitat and gene pool protection |
| Cultural | Physical and intellectual interactions | Recreation - agro tourism |
| | | Preservation of artefacts |
| | | Scientific and educational use |
| | | Heritage, cultural aspects |

Some authors make difference between functions and services (e.g. NRC, 2004; Potschin and Haines-Young, 2011), some not (Creamer and Stone, 2014). By our opinion the decisive is rather character of service/function - if it is transitional or final. Till now, the evaluation the benefits of human from soils and their use was based on soil functions. The aim to define these functions was to highlight their importance to society and the necessity to protect this natural resource (e.g. Blum, 1990; European Commission, 2006). It was also stressed that the sustainability of societal development requires maintenance of soil quality and soil functions – especially the regulation ones (Bujnovský et al., 2009).

It seems that the ecosystem service approach masks the significance of the soil as such. So, from the side of soil scientists there is effort to modify this reality. To stress the importance of soil resources Dominati et al. (2010) define the ecosystem services as the beneficial flows arising from natural capital stocks and fulfilling human needs.

As fundamental limitation at soil valuation is that it is valued as a component of land, which

is insufficient for capturing changes in the value of soil associated with alteration of soil quality or functionality, Robinson et al. (2014) propose the development of indicators that can be used to assess the state of «soil function», if a soil «quality» aspect is to be incorporated into approaches such as the SEEA (System of Environmental and Economic Accounts).

We consider the ecosystem service approach as extension of soil function approach that can be perceived as core of ecosystem services evaluation that integrates soil and vegetation aspects. Evaluation of ecosystem services, predominantly based by soil and relief parameters, does not allow to assess all significant services/functions as some services are markedly influenced also by management practices and site factor. For example, the increase of soil organic matter content belongs to the targets associated with mitigation of climatic change. The rate of carbon sequestration depends rather on soil use than on the soil itself. Another example is the use of agricultural land as space for recreational purposes and tourism which till now has the marginal importance. Development of agro-tourism alone is relatively low dependent on soil parameters (and if yes so rather in inverse way) as for these activities are usually attractive pre-hilly and hilly areas.

Principles of bio-physical evaluation of several regulation ecosystem services/functions in the Slovak Republic were/are based on key soil and relief parameters (Bujnovský et al., 2009; Vilček, Bujnovský, 2014). Within whole agricultural land in Slovakia, till now there were evaluated (bio-physically and economically) the following soil functions/services: biomass production, filtration of inorganic pollutants, filtration of inorganic pollutants and transformation/detoxification of organic pollutants with spatial delineation of individual categories of each function on relative high level of resolution (1:10 000). Each soil function is available in GIS-layer.

Economic valuation of selected soil functions was/is based on use of cost methods (saved or avoided costs and replacement costs). In the case of provision of biomass was applied the expert approach based on pricing of production and cost parameters that are obtained from economic evaluation of homogenous fields within typical set of land evaluated unit. Distribution of the economic value of individual soil function within agricultural land is available in GIS-format.

Meaningful assessment of soil ecological functions is conditioned by relation of society to them and the possibility of pricing that will be part of pricing tool used with regard to soil protection and use. Within agricultural soil use production function dominates. Ecological soil functions were/are used automatically without regard to society awareness. The value of the potential of soil ecological functions proves when their use is reflected into economic costs or benefits.

The bio-physical evaluation of soil functions or services if often considered as basic precondition for it local use with regard to mitigate the anthropogenic pressures and its consequences (degradation processes). Often contemplated payment for some ecosystem services - PES (e.g. Robinson et al., 2014) seems problematic as assessment of effect through change of soil parameters relevant to given ES is significantly affected by spatial and temporal effects.

The agri-environmental payments within Rural Development Programme belong to PES category. Theoretically, the evaluation and valuation of the environmental effects of the implementation of Agri-environmental measures may be considered in two ways. The direct method is based on the quantification of changes in natural farm or its services and their valuation. This group ranks and awards decrease in crop yield (the change of productivity approach) due to soil degradation and also compare costs and benefits of soil protection measures (cost-benefit analysis) (Yesuf et al., 2005). It should be emphasized that the environmental effects or benefits of preventive measures are generally reasonably evident in the future. Indirect method based on the assessment of damage or risk reduction options for improving the components of the natural environment due to the implementation of specific measures. It can be said that agri-environmental measures typically reduce the risk of damaging natural resources or create opportunities to improve their quality. From that point of view it is therefore more appropriate to draw the line efficiency of the funds due to meet environmental effect, which is against the needs of society acceptable. As results from the Napier's work (Naper, 2012), issues relating to the use and protection of environmental media are not exclusively the matter of financial supports for preventive measures, and environmental awareness of farmers. As states Blandford (2010) many contemporary economic problems has essentially ethical origin. Neo-liberal or neo regulatory approach is not able to address urgent issues that affect agriculture and natural resources, such as the deteriorating quality of the

environment and the problem of climate change. To find a solution, we need to take into account more realistic behavioural model compared to that one commonly used in the economic assessment, and acknowledge the key role of values in the individual and collective decision-making.

So, according to Bujnovský et al. (2009) real possible utilisation of soil ecosystem services/functions can be seen at improvement of soil protection especially via modification of soil price at its permanent sealing.

### *Concluding remarks*

Economic valuation of water and soil resources through ecosystem services offers the broader view on real importance and subsequently they value for the society. Despite of the fact, soil is considered as supporting medium to above ground ecosystems (MEA, 2005), the capacity of soil to provide functions/services (mainly provision and regulation ones) often determine the provision of ecosystem services of agricultural land although soil use and management this capacity can alter (in positive as well as in negative way).

In contrast to the freshwater, the soil natural capital (consisting of mineral stock, nutrient stock, carbon stock, organisms, soil water) is less important as soil within this agricultural use is not consumed and crucial soil parameters enter into evaluation of soil functions (especially the regulation ones). Direct use of soil capital is often associated with permanent (development of industry, settlements, peat extraction) or temporal land consumption (extraction of sand, gravel, clays) resulting in destroying or significant change of original soil or ecosystems.

Evaluation of ecosystem services with aspect of space and time. Site specific evaluation is considered as better than extrapolation of results across space. Projection of state of ecosystems in to the future seems very actual problem (e.g. Fisher et al., 2011), but can introduce significant errors with regard to outcome (especially in the case of freshwater ecosystems). This problem can be avoided by cyclic assessment based on actual data.

As assessment of freshwater ecosystem services is not or may not be in direct relation to the achievement of the environmental objectives of the WFD, providing more capacity ecosystem services often depend on factors other than water quality. This means that improving water status by achieving good ecological and chemical status can occur only at increasing the capacity of some ecological functions.

Economic valuation of soil services/functions serve as base for estimation of more realistic price of soil that is through industrial and urban development irrecoverably lost. The aim of evaluation and pricing of the fresh water ecosystems encompasses also the aspect of awareness raising. Of course, the price of environmental service or given ecosystem does not reflect its societal importance because the economy is focused to the prices (usually market oriented) and not to the values or significance of these services for the society. It is especially true for the soil. So, in accordance with Sciama (2007), economic valuation should not be used as a basis for ethical values forming imminently connected to the human approach towards soil and its degradation, and which are essentially needed by global society.

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### *References*

1. Blandford D. Presidential address: The visible or invisible hand? The balance between markets and regulation in agricultural policy./ D. Blandford. // J. Agric. Economics. – 2010. –V. 61. – P. 459-479.

2. Blum W.E.H. The challenge of soil protection in Europe. / W.E.H. Blum.//Environmental Conservation.– 17.– 1990. – P. 72-74.

3. Boyd J. What are ecosystem services? The need for standardized environmental accounting units./ J. Boyd, S. Banzhaf .//Ecological Economics. – 2007. –V. 63. – No 2-3. – P. 616-626.

4. Brouwer R. The concept of environmental and resource costs. Lessons learned from ECO2. /In Brouwer, R., Strosser, P. (eds.), Environmental and resource costs and the Water Framework Directive. An overview of European practices./Workshop Proc. Lelystad : RIZA. – 2004. – P. 3-12.

5. Bujnovský R. Soil degradation and soil value in Slovakia - two problems with common denominator / R.

Bujnovský, J. Vilček. //Agriculturae Conspectus Scientificus. –2011. –V. 76. –No 1. – P. 9-14.

6. Bujnovský R., Balkovič, J., Barančíková G., Makovníková J., Vilček J. Assessment and economic valuation of ecological functions in agricultural land of Slovakia. VÚPOP, Bratislava, 2009. – 72 p. (in Slovak with extended summary) ISBN 978-80-89128-56-3.

7. Chee Y.E. An Ecological perspective on the valuation of ecosystem services./ Y.E. Chee. // Biological Conservation. – 2004.– 120. – P. 549-565.

8. COWI 2014. Support Policy Development for integration of an ecosystem services approach with WFD and FD implementation. Towards practical guidelines to support River Basin Planners. Kongens Lyngby: COWI A/S, 119 p.

9. Creamer R., Stone D. Functional soil planning: managing soil ecosystem services for sustainable food production. / R. Creamer, D. Stone //Abstract. In Soil's Role in Restoring Ecosystem Services. SSSA meeting supported by Bouyoucos Conferences, March 6-9, 2014, Sacramento, CA https://scisoc.confex.com/scisoc/2014SES/webprogram/Paper84576.html

10. Dominati E. framework for classifying and quantifying the natural capital and ecosystem services of soils./ E. Dominati, M. Patterson, A. A. Mackay. // Ecological Economics.– 2010. – 69. – P. 1858-1868.

11. European waters – assessment of status and pressures. EEA Report No. 8/2012. Copenhagen: EEA. –2012. – 96 p. ISBN 978-92-9213-339-9.

12. European Commission 2010. Communication from the Commission 2010. EUROPE 2020. A strategy for smart, sustainable and inclusive growth. COM(2010) 2020. Brussels : European Commission, 32 p.

13. European Commission 2006. Proposal for a directive of the European Parliament and of the Council establishing a framework for the protection of soil and amending Directive 2004/35/EC. COM(2006) 232 final. Brussels : European Commission. – 30 p.

14. European Commission 2011. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of Regions. A resource-efficient Europe - Flagship initiative under the Europe 2020 Strategy. COM(2011) 21. Brussels : European Commission. – 16 p.

15. Everard M. Why does «good ecological status» matter? / M. Everard //Water and Environmental Journal– 2012. – 26. – P. 165-174.

16. Fisher B. Valuing ecosystems: benefits, values, space and time. / B. Fisher, I. Bateman, R.K. Turner //Ecosystem Services Economics Working paper series – 2011.– No 3. – 11 p.

17. Haines-Young R., Potschin M. CICES V4.3 - Revised report prepared following consultation on CICES Version 4. EEA Framework Contract No EEA/IEA/09/003. Centre for Environmental Management, University of Nottingham. 2013. – 32 p.

18. Jones A., Paganos P., Barcelo S., Bouraoui F., Bosco C., Dewitte O., Gradi C., Erhard M., Hervás J., Hiederer R., Jeffery S., Lükewille A., Marmo, L., Montanarella, L., Olazábal, C., Petersen, J.E., Penizek, V., Strassburger, T., Tóth, G., Van den Eeckhaut, M., Van Liedekerke, M., Verheijen, F., Viestova, E., Yigini, Y. The state of soil in Europe. A contribution of JRC to the European Environment Agency´s Environment State and Outlook Report – SOER 2010. Luxembourg : Publications Office of the European Union. 2012. – 76 p. ISBN 978-92-79-22806-3.

19. Kijovská L. Historical-scial development in the assessment and protection of water quality./ L. Kijovská, M. Valúchová, R. Bujnovský, A. Kurecová, K. Kučárová // Water management Journal (Vodohospodársky spravodajca) 57, special issue, 2014.. –P. 27-36.

20. Maes J. Mapping and assessment of ecosystems and their services. / J. Maes, A. Teller, M. Erhard and other /An analytical framework for ecosystem assessments under action 5 of the EU biodiversity strategy to 2020. Luxembourg : Publications office of the European Union.– 2013. – 57 p. ISBN 978-92-79-29369-6.

21. Maes J. Mapping and assessment of ecosystems and their services. / J. Maes, A. Teller, M. Erhard. And other//Indicators for ecosystem assessments under Action 5 of the EU Biodiversity Strategy to 2020. Technical report. Luxembourg : Publications office of the European Union. 2014. – 80 p. ISBN 978-92-79-36161-6.

22. MEA (Millenium Ecosystem Assessment) Ecosystems and human well-being: Synthesis. Washington, DC: Island Press. 2005. – 137 p. ISBN 1-59726-040-1.

23. MoE (Ministry of Environment of SR) MŽP SR 2009. Water Plan of the Slovak Republic. Abbreviated version. Bratislava : Ministry of Environment.– 2010. – 124 p. ISBN 978-80-89503-15-5.

24. Napier T. L. US conservation achievements threatened by future prosperity of the agricultural sector./ T. L. Napier // ECCS Newsletter – 2012. – No. 1. – P. 3-10.

25. NRC (National Research Council) Valuing ecosystem services: toward better environmental decision-making. Washington, DC : National Academy Press. – 2004. – 290 p. ISBN: 978-0-309-09318-7.

26. A green growth strategy for food and agriculture. Ver. 01-Feb-2011. Paris : OECD – JWP on Agriculture and the Environment– 2011. – 61 p.

27. Robinson D. A. On the value of soil resources in the context of natural capital and ecosystem service delivery./ D. A. Robinson, I. Fraser, E.J. Dominati and other. //Soil Science Society of America Journal – 2014.– 78, No 3. – P. 685-700.

28. Sciama,Y. Towards a planet-wide ethic. A talk with Dominique Bourg. Research EU– 2007. – No. 52. – P.16-17.

29. UNEP : Global environmental outlook 5. Nairobi : United Nations Environmental Programme**.** 2012. **–** 528 p. ISBN 978-92-807-3177-4.

30. Vilček, J., Bujnovský, R. 2014. Soil environmental index for Slovak agricultural land. Pedosphere 24, No 1. – P. 137-144.

31. Yesuf M., Mekonnen A.l., Kassie M., Pender J. Cost of land degradation in Ethiopia. A critical review of past studies. Environmental Economics Policy Forum in Ethiopia - International Food Policy Research Institute, 2005. – 82 p.

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