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AN APPROACH TO THE ASSESSMENT OF REGULATING AGROECOSYSTEM SERVICES

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Abstract. Two different approaches to assess and map the potential of regulating agroecosystem services have been used, the assessment of the potential of regulating agroecosystem services based on a composite index and the assessment of the potential of individual regulating agroecosystem services were used in the Krupina study area. The overall composite index indicates a general overview of the performance of an agrosystem in terms of providing ecocosystem services. Result from our study showed that the composite index accumulates information on soil condition and its ability to perform regulating agroecosystem services, mainly the potential of water regime regulation and cleaning potential of ecosystem. The modeling and evaluation of individual regulating services allows more detailed assessment of regulating agroecosystem services and defining the sources of variability and spatial differences. Moreover, the methodology developed in this paper is replicable and can be applied by planners if they are proficient in geographic information systems (GIS).

Keywords: agrecosystem services, composite index, regulating services, agroecosystem services mapping

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INTRODUCTION

Ecosystem services are defined by inherent interaction between ecological and social systems as only those ecosystem processes that contribute to the fulfilment of human needs (Dominati *et al*. 2010, Burkhard *et al*. 2014). An approach based on ecosystem offers the opportunity to explore the influence of land use and cultivation practices on natural capital stocks, on the processes that build and degrade these stocks, and on the flow of ecosystem services from the use of these stocks (Dominati *et al*. 2010). Traditionally, agroecosystems, as the largest ecosystems in the anthropocene (Daniel *et al*. 2012), have been considered as primary sources of provisioning services, but more recently their contributions to other types of ecosystem services have been recognized (Burkhard *et al*. 2014, MEA 2005), mainly as regulating and cultural services (Dominati *et al*. 2010, Burkhard *et al*. 2012). In the past, some ecosystem services, e.g. climate regulation and stabilization, water flow and nutrient movement have been underestimated to the point when natural ecosystem resilience has deteriorated due to climate change, land-contaminated production, soil erosion or eutrophication (Krkoška Lorencová *et al*. 2016, Makovníková *et al*. 2017). Regulating services were the most frequently mapped services, followed by provisioning, cultural, and supporting services (Forouzangohar *et al*. 2014). Models of ecosystem services can vary from simple expert scoring systems to complex ecological models cycles of carbon, nitrogen and water (Burkhard and Maes 2017).

Regulating services are benefits created by the self-sustaining capabilities of ecosystems, the regulation of ecosystem processes. All these services are not directly consumed by man as goods but regulating services bring many direct benefits by keeping safe and habitable environment, supporting food production systems or processing and removing waste and pollution (Burghard and Maes 2017). In ecosystems of the agricultural land, regulation of water regime (water storage), control of soil erosion (erosion control), climate regulation (C stocks in the soil) and filtration of pollutants are main regulating services (Dominati *et al*. 2014). The availability of water in agroecosystems depends not only on infiltration and flow but also on its accumulation in the soil (Power 2010). Soils act as filtering agents, too (Yong *et al*. 1992, Makovníková *et al*. 2007). The filtering capacity of soil (cleaning potential) refers to its ability to retain nutrients and contaminants bonding them with varying intensity (from weak to strong) to organic or mineral soil constituents, and thereby preventing their release into water passing through the soil profile (Burghard and Maes 2017). Soils have natural content of risk elements released from parent rock in the process of pedogenesis, which can be increased by inputs of risk elements by anthropogenic deposition. High potential for contamination reduces the potential of soil regulating service because the sorption sites are occupied and thus the free sorption capacity, which can contribute to the immobilization of risk elements is reduced (Makovniková *et al*. 2007, Makovníková and Barančíková 2009, Ryzhenko and Kavetsky 2015). Erosion regulation (erosion control) is the role of ecosystems and vegetation in maintaining soil or avoiding soil being eroded as a result of wind or run-off water (Burghard and Maes 2017). Carbon stored in ecosystems is an important indicator of regulation services potential (Honigová *et al*. 2012) whose values depend on land use and land management practices (Krkoška Lorencová *et al*. 2016). In ecosystems of agricultural land, soil organic matter represents the largest share of the total organic carbon stock in the soil. Agroecosystems contribute to climate regulation by sequestration of organic carbon in the soil. Content of soil organic carbon can be used to represent the carbon sequestration, further it can be used as an indicator in climate regulation potential service (Forouzangohar *et al*. 2014). Stocks of soil organic matter in agroecosystems are influenced by soil type and subtype genesis, soil utilisation (arable land, permanent grasslands) as well as by soil management (ploughing, mineral or organic fertilization, crop rotation and others) (Kheir *et al*. 2010). Currently, it is a priority to integrate regulatory ecosystem services together with the other categories of ecosystem services into a comprehensive ecosystem assessment. Regulating services are functionally linked not only to each other but are also closely linked to the other categories of services provided by a particular ecosystem.

Recent conceptual works have used the ecosystem services approach to highlight the importance of pedosphere for the human well-being and prosperity (Forouzangohar *et al*. 2014, Costanza *et al*. 2017). To determine how soils provide ecosystem services, the soil properties (natural capital stocks) and processes that support each soil service need to be investigated in detail (Burghard and Maes 2017). Soil plays a fundamental role in terrestrial ecosystems as a three-dimensional body that performs a wide range of ecological functions as part of services provided by ecosystems (Montanarella 2015). Soil natural capital (Costanza *et al*. 2017), represented by soil properties, contributes to the ecosystem services through its multiple functions, as demonstrated in the cascade model developed by Haines-Young and Potschin (2009). Agroecosystem based on soil is multifunctional in all conditions, both in terms of processes, functions and services (Coyle *et al*. 2016) and, therefore, the index of the healthy soil (Laishram *et al*. 2012, Abbott and Manning 2015) may by used for acumulative assessment of regulating services. The soil health index created from soil indicators needs to respect knowledge of their critical limits (Arshad and Martin 2002). Kibblewhite *et al*. (2008) defined a healthy agricultural soil as one that is capable of supporting the production of food together with continued delivery of other ecosystem services that are essential for maintenance of the quality of life for humans and the conservation of biodiversity. Available and derived soil data selection is determined by the goal of ecosystem services assessment. Alam *et al*. (2016) describe the composite indicator combining multi-dimensional concepts and variables into a single value used for urban ecosystem services.

The aim of this study was to assess and map the cumulative index for regulating agroecosystem services and to compare this with an assessment of individual regulating agroecosystem services. The paper aims to describe the use of GIS techniques to create uniform spatial units for the inventory of agroecosystem services.

MATERIALS AND METHODS

In agricultural land ecosystems, regulation of water regime (water storage), control of soil erosion (erosion control), climate regulation (carbon reserves in the soil) and filtration of pollutants (cleaning potential) are main regulation services (Dominati *et al*. 2014). We used two different approaches to assess and map the potential of regulating agroecosystem services; the assessment of regulating agroecosystem services potential on the basis of the composite index and the assessment of the potential of individual regulating agroecosystem services were presented.

Composite index for regulating agroecosystem services (CIR)

In Slovakia, authors like Bujnovský *et al.* (2011), Makovníková *et al*. (2007), Barančíková *et al*. (2010), Vilček and Koco (2018) define a minimum set of soil indicators needed for sufficient assessment of soil functions. These indicators were used as a basis for composite index (CIR) of regulating agroecosystem services assessment. The CIR index was created using a minimum data set of physical and chemical soil indicators (direct indicators) combined with environmental parameters, land use and climatic region (proxy indicators) that have a direct or indirect impact on the assessed regulating agroecosystem services (Makovniková *et al*. 2007, Kibblewhite *et al*. 2008, Alam *et al*. 2016, Costanza *et al*. 2017). These soil indicators are included in the soil monitoring system in Slovakia (Kobza *et al*. 2014) according to the recommendation of the European Commission (EC) for comprehensive soil monitoring system in Europe (van Camp *et al*. 2004). All indicators are quantifiable. Each observed value was converted into a score (from -1 to 2) with respect to the knowledge concerning their critical limits (Table 1) (Bujnovský *et al*. 2011, Makovníková *et al*. 2007, Barančíková *et al*. 2010, Vilček and Koco 2018). Indicators scores were incorporated into a composite index CIR which quantified the potential of regulating agroecosystem services.

Table 1. Indicators and indicators' scores for CIR evaluation

Indicator	Value of indicator	Score of indicator (SI_i)
Slope	< 5°	1
	> = 5°	0
Soil bulk density	< 1.5 $g \cdot cm^{-3}$	1
	> 1.5 $g \cdot cm^{-3}$	0
Soil texture (soil particles < 0.01 mm)	< 20%	0
	20–45%	1
	> 45%	0
Depth of humus horizon	< 30 cm	0
	> 30 cm	1
pH value	< 4.5	-1
	4.51–6.00	0
	6.01–7.50	1
	7.51–8.00	0.8
	> 8.00	0
Total organic carbon content	< 1%	0
	1–5%	1
	> 5%	2
Quality of organic carbon content (Q^4_6)	< 4.5	2
	4.5–6.0	1
	> 6.0	0
Soil contamination (Cd, Pb, Cu, Zn, Cr, Ni, Co, Se, As, Hg) evaluated by hygienic limit for Slovakia (MP SR, 2004, MPRV SR)	< hygienic limit value	0
	> hygienic limit value	-1

The CIR ($CIR = \sum SI_i$) was evaluated in five categories: 1 – very low potential of CIR (lower than 1.50 points), 2 – low potential of CIR (1.50–3.50 points), 3 – medium potential of CIR (3.51–5.50 points), 4 – high potential of CIR (5.51–7.50 points), 5 – very high potential of CIR (more than 7.50 points).

The evaluation of individual regulating services

Potential of water regime regulation of agroecosystem

Potential of water regime regulation (soil water storage) was obtained from maps and databases (Bujnovský *et al*. 2009). Its values are given in mm and are determined on the basis of the value of retention water capacity recalculated to soil water storage in context with the soil depth. Values were divided into five categories as follows: 1 – very low potential (< 135 mm), 2 – low potential (135–175 mm), 3 – medium potential (175–215 mm), 4 – high potential (216–275 mm), 5 – very high potential (> 275 mm).

Potential of regulation of soil erosion, regulation of water erosion of ecosystem of agricultural land

Regulation of water erosion was derived from maps and databases based on empirical model of the universal soil loss equation (USLE) (Wischmeier and Smith 1978). The relative ratio of calculated values of soil loss and acceptable erosion expresses the degree of soil erosion endangerment. Values were divided into five categories: 1 – very low potential (more than 2.60), 2 – low potential (2.21–2.60), 3 – medium potential (1.81–2.20), 4 – high potential (1.40–1.80), 5 – very high potential (less than 1.40).

Cleaning potential (immobilisation of soil pollutants) of agricultural land ecosystem

Cleaning potential (immobilisation of soil pollutants) of agricultural land ecosystem depends on the actual soil contamination and potential of soil sorbents that are sensitive to the sorption of risk elements. Higher amount of potential risk elements in the soils takes up the potential sorbent places and consequently reduces the overall soil potential for the sorption of risk elements. Because of considerable differences of soil sorbents on arable soils and grassland, as well as differences in the limit values of pollutants in the produced biomass, score evaluation was determined separately for different cultivation. The method is described in detail in the article by Makovníková *et al*. (2007). Values were divided into five categories: 1 – very low potential (more than 6.50 points), 2 – low potential (5.51–6.50 points), 3 – medium potential (4.51–5.50 points), 4 – high potential (3.50–4.50 points), 5 – very high potential (lower than 3.50 points).

Climate regulation of agricultural land agroecosystem

In agroecosystems of agricultural land, soil organic matter represents the largest share of total organic carbon found in the soil. Agroecosystems contribute to climate regulation by sequestration of organic carbon in the soil (Barančíková *et al*. 2011). Soil organic carbon stock (SOCS) was calculated as a function of soil bulk density (BD, $g \cdot cm^{-3}$) and soil organic matter content (SOC, %) according to the equation (Makovníková *et al*. 2017):

SOCS (depth 0–0.30 m) in $t \cdot ha^{-1}$ = 10 · (BD (0–0.10 m) · SOC (0–10 cm) + BD (0.10–0.20 m) · SOC (0.10–0.20 m) + BD (0.20–0.30 m) · SOC (0.20–0.30 cm) eq. 1

The categories are as follows: 1 – very low potential (lower than 58.00 t C·ha^{-1}), 2 – low potential (58.00–62.00 t C·ha^{-1}), 3 – medium potential (62.01–67.00 t C·ha^{-1}), 4 – high potential (67.01–72.00 t SOC·ha^{-1}), 5 – very high potential (more than 72.00 t SOC·ha^{-1}).

Mapping units

For spatial quantifying of regulating agroecosystem services of agricultural land in Slovakia, we have created a mapping unit by combination of four input layers: 1. climatic region (categories: moderately cold, moderately warm, warm and very warm according to Kizekova *et al*. (2017), 2. slope topography (categories: 0–2º, 2.1º–5º, 5.1º–12º and more than 12º), 3. soil texture (categories: soil particles < 0.01 mm less than 20%, 20–45%, more than 45%), and 4. land use (arable land, grassland and other cultures like sets, vineyards, hops). Each mapping unit represents one cell of 100 m resolution in regular grid derived from EEA reference grid. Mapping units are compatible with the spatial units in international database (Corine Land Cover). We calculated a weighted average of the CIR within each unit as well as a weighted average of the potential of each regulating agroecosystem service. Software package of the geographic information system ArcGIS® was used for processing the input geo-referenced digital data and the resulting maps.

Study area

The region Krupina (Fig. 1),which has been chosen as a study area of our mapping, covers the Štiavnica Mountains from the north-west, the Krupinská planina (plain) from the north-east and the Ipeľ upland from the south. 96% of the area is located at the altitude of 600 m above sea level. Most of the area is located in very warm (58.9%) and moderately warm (36.6%) climatic region. The region Krupina includes 21,845 ha of registered and classified agricultural soils, of which 15,123 ha represent arable land and grassland covers 6,722 ha (as of 2016). Study area was divided into regular spatial mapping units. In the monitored area we have created 31 different combinations of mapping units, of which 17 represent arable land and 14 – grasslands. The CIR and the potential of each regulating service for mapping unit was calculated as a weighted average of CIR or potential of each regulating agroecosystems service which are located in the selected grid (cell of 100 m resolution regular grid derived from EEA reference grid).

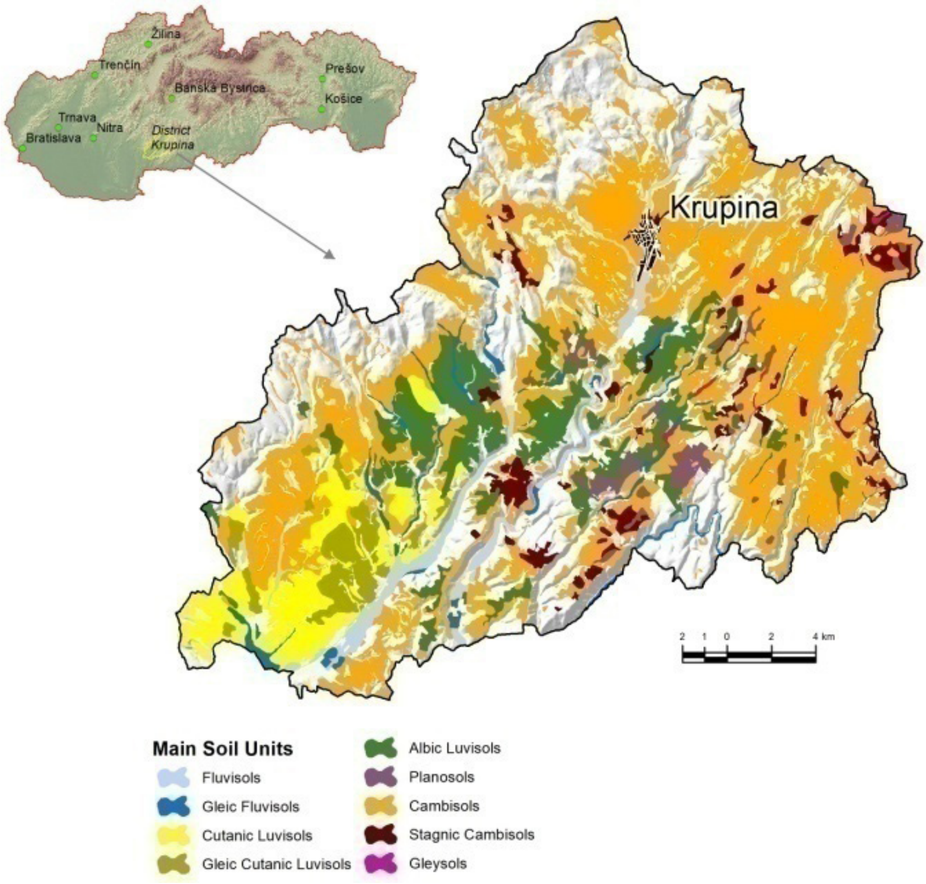

Fig. 1. Study area – Krupina region

RESULTS AND DISCUSSION

The potential of regulating ecosystem services is the stock of natural capital and ensures current and future flows of ecosystem services (Costanza 2008). The potential of the regulating service of agricultural land is determined by its location in the landscape with climatic conditions (temperature and precipitation), and it is a combination of abiotic, biotic, morphological and socio-economic factors (management of arable land and grassland). Specific combination of soil functional characteristics that can be found at a specific location depends on the local conditions for soil formation and development, including parent material (i.e. geology), climate, topography, vegetation and land use (Vogel *et al*. 2018).

The potential of agroecosystem for regulating agroecosystem services assessed by CIR

The potential of agroecosystem for regulating agroecosystem services evaluated by CIR is shown in Table 2 and Figure 2. In the study, 75.30% of the area of agricultural ecosystems (when assessing arable land and grassland together) has high potential for regulating agroecosystem services. They are mostly ecosystems of arable land (92.03%) located in very warm to moderately warm parts of Danube hill and Krupinska planina (plain) with loam to clay loam deep soils without skeleton (as arable land are used in the region with soils of high quality). Ecosystems with very low and low potential for regulating ecosystem services occupy 13.08% (when assessing arable land and grassland together) and these are predominantly grasslands (62.99% of grassland area) on the edge of the agricultural land with moderately cold to moderately warm climate, considerable slopiness occuring on shallow to deep soils with low to medium high content of skeleton. Value of CIR is decreased in areas of geochemical anomalia where higher content of risk elements in soil occurs. The lowest capacities of CIR are in the northern part of study area and in higher altitudes. The potential of the agroecosystem to provide regulating services is influenced by land use and agricultural practices that have a significant impact on the assessed indicators. Agricultural practices typically reduce soil carbon content through soil disturbance and mineralization, application of fertilizer can influence the soil pH value, content of risk elements as well as soil carbon content.

Table 2. The categories of CIR in % of total area of agricultural land

CIR categories	% of total area of agricultural land (arable land, grassland)		
	Agricultural land (21,845 ha)	Arable land (15,123 ha)	Grassland (6,722 ha)
1 – very low potential	2.55	0.00	6.83
2 – low potential	10.53	0.76	4.03
3 – medium potential	11.62	7.21	51.47
4 – high potential	75.30	92.03	37.67
5 – very high potential	0.00	0.00	0.00
Total	100	100	100

A high spatial variation of CIR across the study area is due to the big relief segmentation of Krupina region (Fig. 2). The highest percentage of study area has a high relevant capacity to provide regulating services, whereas only 2.55% presents a very low capacity (when assessing arable land and grassland together).

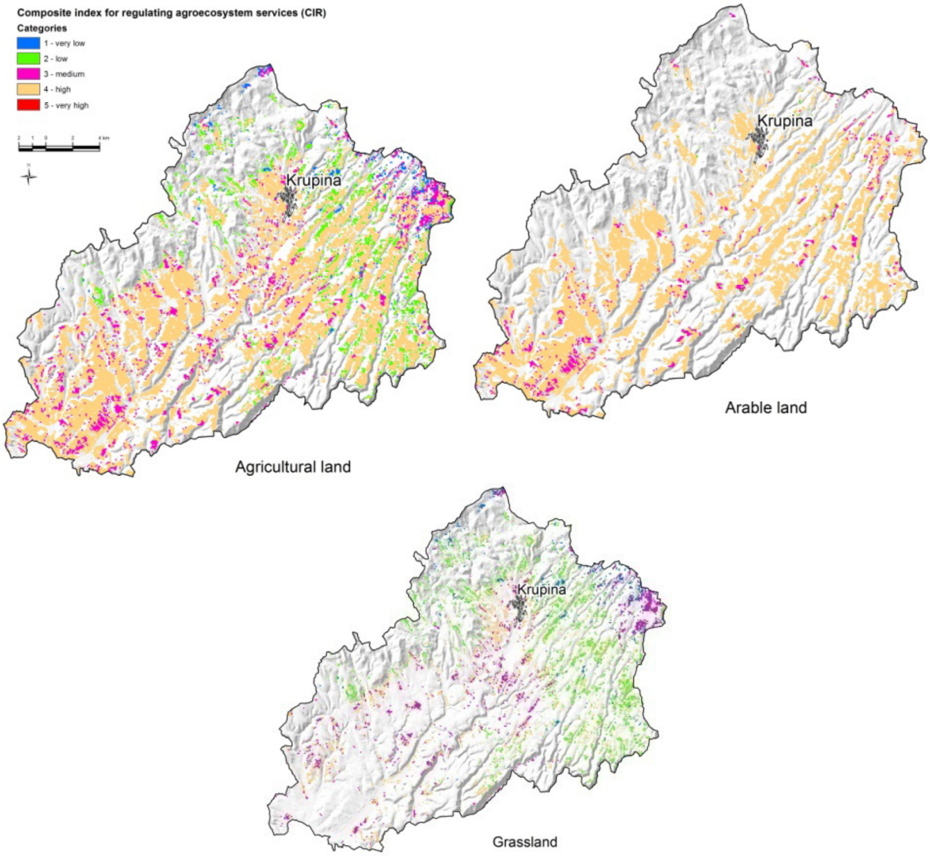

Fig. 2. The categories of CIR in % of total area of agricultural land (agricultural land – arable land and grassland together, separate arable land, separate grassland)

Starting from the pressing need to predict the potential of soil health, we developed a rating system assessing the regulating agroecosystem services. It forms the basis for the use of soil research for evaluating and mapping ecosystem services.

The potential of water regime regulation, potential of erosion regulation, cleaning potential of ecosystems and potential of climate regulation

The availability of water in agroecosystems depends not only on infiltration and flow but also on its accumulation in the soil (Power 2010). We evaluated agricultural land (arable land and grassland overall) and particularly arable land and grassland (current state of land use in 2016). In the study region, 41.59% of the total area of agricultural ecosystems has very high potential for water regime regulation (accumulation of water in soil) (Fig. 3a) and potential for erosion regulation represents 86.61% of this total area. They are mostly ecosystems of arable land located in the Danube hill and Krupinska planina with heavy clay loamy and clayey deep soils without skeleton, mainly on lowland with lower risk of water erosion (Fig. 3b). Another prerequisite for higher potential for water erosion regulation on arable lands is even larger presence of deep soils, and, consequently, higher limit for acceptable level of soil loss. When considering the overall coverage of land by permanent grassland, the potential for soil erosion control achieved very high levels (total area of permanent grasslands is classified to the category with the very high potential). The category with very low potential for water regime regulation are predominantly ecosystems of permanent grasslands developed on shallow and strongly skeletal soils, mostly Cambisols, Rendzic Leptosols and some Fluvisols (Fluvisols located at the upper parts of the river contain a considerable amount of skeleton in Slovakia (Kobza *et al*. 2014) (Table 3). Decreasing the agroecosystems ability to regulate water regime and soil erosion has the effect on reducing the quantity and quality of soil and, thus, its ability to have good yields in the future (Antal and Špánik 2004, Hönigová *et al*. 2012).

Table 3. Categories of the water regime regulation potential and potential of soil erosion regulation in % of total area of agricultural land

Categories	% of total area of agricultural land (arable land, grassland)					
	Potential of water regime regulation			Potential of erosion regulation		
	Agricultural land	Arable land	Grassland	Agricultural land	Arable land	Grassland
1	13.50	1.36	40.81	0.23	0.33	0.00
2	16.26	13.63	22.18	0.85	1.22	0.00
3	17.49	18.40	15.46	7.68	11.09	0.00
4	11.16	7.68	18.98	4.64	6.70	0.00
5	41.59	58.94	2.57	86.61	80.66	100.00
Total	100	100	100	100	100	100

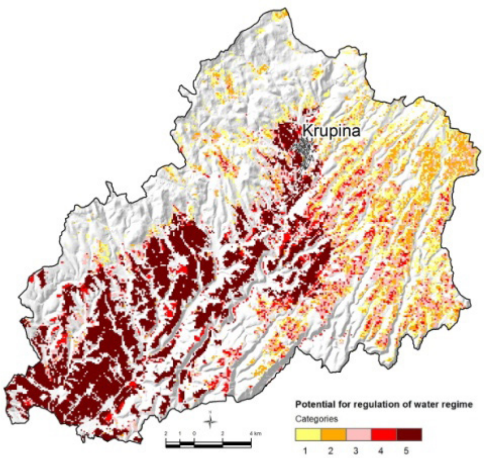

Fig. 3a. Categories of water regime regulation potential in the study area

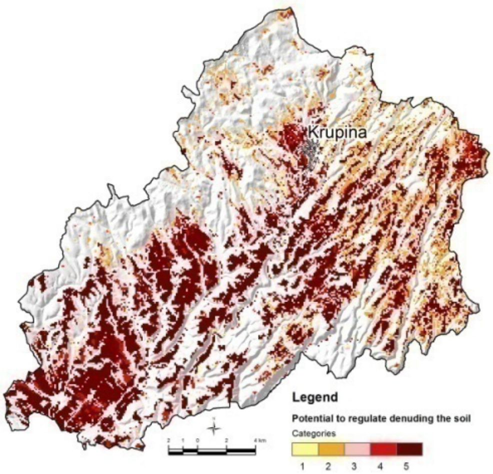

Fig. 3b. Categories of soil erosion regulation potential in the study area

Cleaning potential (immobilisation of pollutants) of ecosystems in agricultural land depends on the potential of contamination and potential of soil sorbents with high affinity to inorganic pollutants. Out of the total study area of agricultural land, 77.79% of ecosystems (when assessing arable land and grassland together) have medium potential for soil cleaning (immobilisation of inorganic pollutants) (Fig. 4a). They are mainly ecosystems of arable land (89.67% of the arable land in the study area) with high content of carbonates without any anthropogenic and geochemical depositions (Table 4). This is based on agrosystems with optimal soil parameters in relation to the ecosystem filtration service (Yong *et al*. 1992, Barančíková and Makovníková 2003, Makovnikova *et al*. 2007, Kobza 2017). Ecosystems of grassland with low potential (48.93% of the total grassland area) are located at higher altitudes, steeper slopes, on soils with lower sorption potential as well as soils developed on substrates with higher content of risk elements. Significant differences in the individual categories of potential (immobilisation of pollutants) between arable land and grassland are influenced by the predominant use of soil of a higher quality than arable (Makovnikova *et al*. 2007).

Soil organic carbon content can be used to represent the carbon sequestration that can serve as an indicator in climate regulation potential service (Forouzangohar *et al*. 2014). Stocks of soil organic matter in agroecosystems limit the use of soil (arable land, permanent grasslands) in addition to soil type and subtype as well as soil management (plowing, application of mineral or organic fertilizers, crop rotation, etc.) (Kheir *et al*. 2010). Results concerning percentage distribution of various categories of climate regulation potential are significantly influenced by arable land ecosystem due to high share of their area in the total agricultural land area. Out of the total area of agroecosystems of agricultural land, up to 83.02% belongs to very low category of climate regulations potential (Fig. 4b). As stated in work of Burkhard *et al*. (2009), arable land ecosystems located in lowlands are characterized by very low potential for climate regulation due to low average stocks of soil organic carbon. In case of higher altitudes, the average organic carbon stocks, and thus the potential of climate regulation, is slightly rising. Carbon sequestration in arable soils is lower compared to grassland (Barančíková *et al*. 2011) within the same soil type, therefore, in agroecosystems of arable soils, categories of medium to very high potential of climate regulation are missing.

Table 4. Categories of cleaning potential (immobilisation of pollutants) and potential of climate regulation of ecosystem in % of the total agricultural land area

Categories	% of total area of agricultural land (arable land, grassland)					
	Cleaning potential of ecosystem			Climate regulation potential of ecosystem		
	Agricultural land	Arable land	Grassland	Agricultural land	Arable land	Grassland
1	0.00	0.00	0.00	83.02	96.94	51.70
2	15.90	1.22	48.93	2.12	3.06	0.00
3	77.79	89.67	51.07	8.46	0.00	27.49
4	6.30	9.11	0.00	6.40	0.00	20.81
5	0.00	0.00	0.00	0.00	0.00	0.00
Total	100	100	100	100	100	100

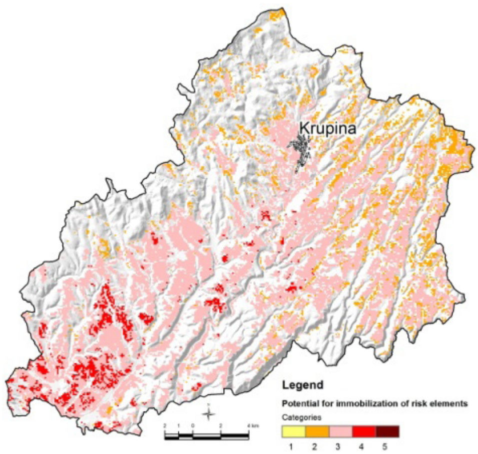

Fig. 4a. Categories of cleaning potential (immobilisation of pollutants) of ecosystem in the study area

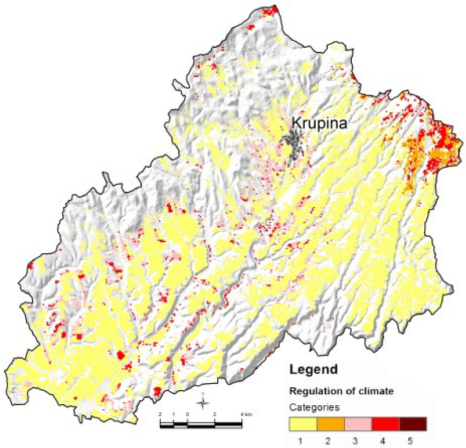

Fig. 4b. Categories of climate regulation potential of ecosystem in the study area

We have established a significant positive correlation between the CIR and the cleaning potential of ecosystem (immobilisation of pollutants) as well as potential of regulation of water regime for agricultural land (when assessing arable land and grassland together) in the study area (Table 5). Similar results have been achieved in case of arable land but have not been confirmed in case of grasslands.

Table 5. Spearmann correlation coefficients (CIR and regulating services)

Spearmann correlation coefficients	Regulating agroecosystem services			
	Potential of water regime regulation	Cleaning potential of ecosystem	Climate regulation potential of ecosystem	Potential of erosion regulation
CIR agricultural land	0.43**	0.56**	-0.12ns	0.16ns
CIR arable land	0.51**	0.57**	0.25ns	0.05ns
CIR grassland	0.39ns	0.29ns	0.25ns	0.35ns

Note: ** $p < 0.01$; ns – non significant

Our results showed that the use of the composite index in evaluation of regulating services is comparable mainly with evaluation of water regime regulation and cleaning potential. Individual models for two regulating services, potential of climate regulation and potential of erosion regulation, with the dominance of only one category are incompatible with the composite index in the evaluation of regulating services.

Table 6. Spearmann correlation coefficients (CIR and climate region, soil texture)

Spearmann correlation coefficients	Climatic region	Soil texture
CIR agricultural land	-0.33*	-0.14
CIR arable land	-0.20ns	-0.53**
CIR grassland	-0.58**	-0.10ns

Note: ** p < 0.01; * p < 0.05; ns – non significant

Our results indicated that the climate has the highest influence on the CIR of grassland and, whereas soil texture has the highest influence on the CIR of arable land (Table 6). These results are consistent with the place of occurence of soil, its properties, processes and functions in the concept of agroecosystem services (Kanianska *et al*. 2016). According to Montoya and Raffaelli (2010), Diehl *et al*. (2013), and Frélichová and Fanta (2015), climate has an important impact on the distribution of agroecosystem services as well as on interactions between them (EEA 2013). This fact has an impact on distribution of these services along climatic regions. In moderate cold region, the majority from the grassland total area has low potential of CIR, in the moderate warm climatic region, there is a high share of categories of low and moderate potential of CIR and majority from the total area of warm climatic region belongs to the categories of moderate to high potential of CIR. On the other hand, soil texture affects mainly arable land in our study area.

CONCLUSIONS

The overall composite index indicates a general overview of the performance of agrosystem in terms of ecosystem services provision. This index linked with mapping units representing the usage of agricultural land (arable land, grassland) and climate region allows a comprehensive assessment of potential of agroecosystem services. Indicators used, that are part of regular soil monitoring system, are a tool for assessing the status and development of this composite index of regulating services. The assessing of regulating agroecosystem services using the linear aggregation of indicators in the composite index does not increase the impact of those indicators, which enter in multiple models in the individual evaluation of each service. Based on the results obtained, we can state that the CIR index accumulates information on soil conditions and its ability to perform regulating agroecosystem services, mainly the potential of water regime regulation and cleaning potential of ecosystem. The results of CIR model belong to the robust models describing the relationship between regulating services potential and explanatory variables. Modeling and evaluation of individual regulatory services allow more detailed assessment of regulating agroecosystem services and defining sources of variability as well as spatial differences.

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