Chapter 1

Agriculture and Its Impact on Land-Use, Environment, and Ecosystem Services

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Additional information is available at the end of the chapter

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Abstract

Human expansion throughout the world caused that agriculture is a dominant form of land management globally. Human influence on the land is accelerating because of rapid population growth and increasing food requirements. To stress the interactions between society and the environment, the driving forces (D), pressures (P), states (S), impacts (I), and response (R) (DPSIR) framework approach was used for analyzing and assessing the influence of agriculture on land use, environment, and ecosystem services. The DPSIR model was used to identify a series of core indicators and to establish the nature of interactions between different driving forces, pressures, states, impacts, and responses. We assessed selected indicators at global, national, and local levels. Driving force indicators describe growing population trend and linking land-use patterns. The driving forces exert pressure on the environment assessed by indicators describing development in fertilizer and pesticides consumption, by number of livestock, and by intensification joined growing release of ammonia and greenhouse gas (GHG) emissions from agriculture, and water abstraction. The pressure reflects in the state of environment, mainly expressed by soil and water quality indicators. Negative changes in the state then have negative impacts on landscape, e.g., traditional landscape disappearance, biodiversity, climate, and ecosystem services. As a response, technological, economic, policy, or legislation measures are adopted.

Keywords: Agriculture, land use, environment, ecosystem service, DPSIR model

1. Introduction

Land cover and land-use patterns on Earth reflect the interaction of human activities and the natural environment [1]. Human population growth together with competitive land use causes land scarcity, conversion of wild lands to agriculture and other uses. As we can see, the anthropogenic factor has an important impact on land use and land cover changes. Given this human influence, especially during the past 100 years, the recent period has been called the Anthropocene Age [2]. Human influence on the land and other natural resources is accelerating because of rapid population growth and increasing food requirements. The increasing agricultural intensity generates pressure not only on land resources but also across the whole environment. These factors make agriculture a top-priority sector for both economic and environmental policy.

Comprehensive assessment of the agriculture is a challenging task. There are different possibilities and methods for such assessment. To stress the interactions between society and the environment, the DPSIR framework approach is used for analyzing and assessing the influence of agriculture on land use and environment with emphasis on Slovakia.

2. Methodology

Within integrated environmental assessment a framework is used, which distinguish driving forces (D), pressures (P), states (S), impacts (I), and response (R). This is known as the DPSIR model. As the model can capture the cause–effect relationships between the economic, social, and environmental sectors, it has been widely applied to analyze the interacting processes of human-environmental systems [3]. The DPSIR model originated from the pressure–state–response (PSR) framework, which was developed by the Organisation for Economic Cooperation and Development [4]. Later it was elaborated by European Environment Agency [5]. Environmental indicators should reflect all elements of the chain between human activities, their environmental impacts, and the societal responses to these impacts [6].

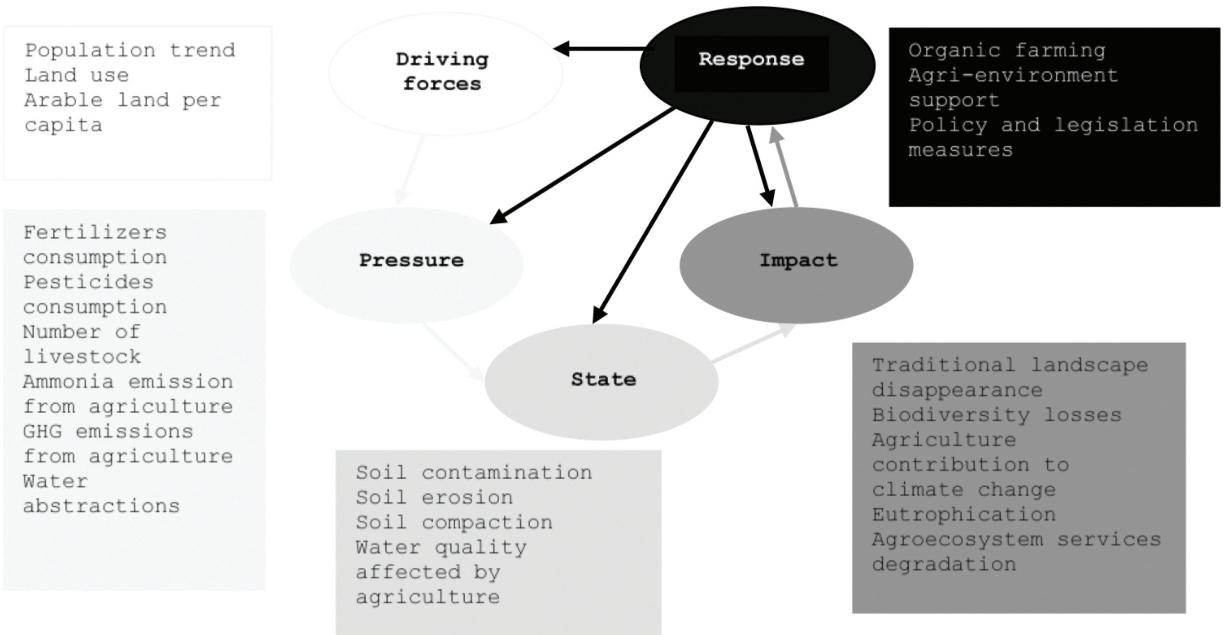

Figure 1. DPSIR model for agriculture and environment.

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The DPSIR model was used to identify a series of core indicators and to establish the nature of interactions between the different driving forces, pressures, states, impacts, and responses, and thus to assess the agriculture and its impact on land use, environment, and ecosystem services (**Figure 1**). More attention was paid to Slovakia. We assessed selected indicators at global, national (country Slovakia), and local (cadastre Liptovská Teplička (LT)) level. Slovakia is located in central Europe and covers an area of 49,035 km^2. It is largely located in the mountain territory of the western Carpathian arch. The climate is temperate. Despite the mountain character of the majority of the Slovak territory, there were suitable conditions for agricultural development. The Slovak rural territory represents 87% of the total land area and the Slovak rural population represents 43.7% of the total population. Liptovská Teplička (LT) cadastre is located in the northern part of Slovakia where Low Tatras is adjacent to the Liptov basin with elevation over 900 m above sea level. Mean annual temperature is 5°C, and mean annual precipitation is 900 mm.

3. Results and discussion

3.1. Driving forces

With the growing world population the requirements are grown to cover the food demand. Human expansion throughout the world caused that agriculture is a dominant form of land management globally, and agricultural ecosystems cover nearly 40% of the terrestrial surface of the Earth. Agricultural ecosystems are interlinked with rural areas where more than 3 billion people live, almost half of the world's population. Roughly 2.5 billion of these rural people derive their livelihoods from agriculture. Thus, population and land-use trends are considered to be the main driving forces for agriculture. Besides these driving forces, EEA [7] further distinguished the so-called external and internal driving forces originating from market trends, technological and social changes, as well as the policy framework.

For many economies, especially those of developing countries, agriculture can be an important engine—driving force—of economic growth. Approximately three-quarters of the world's agricultural value added is generated in developing countries where agriculture constitutes the backbone of the economy. But not only in the developing countries but also in the developed countries agriculture has always been the precursor to the rise of industry and services [8].

3.1.1. Population trend

In the twentieth century, the world population grew four times [9]. Although demographic growth rates have been slowing since the late 1970s, the world's population has doubled since then, to approximately 7 billion people currently and is projected to increase to over 9 billion by 2050. But already millions people are still suffering from hunger and malnutrition. The latest available estimates indicate that about 795 million people in the world (just over one in nine) were undernourished in 2014–2016. Since 1990–1992, the number of undernourished people has declined by 216 million globally, a reduction of 21.4%. The vast majority of the hungry people live in the developing regions. The overall hunger reduction trends in the developing countries since 1990–1992 are connected with changes in large populous countries (China, India) [10]. Paradoxically, most of people suffering from hunger and malnutrition are in rural areas and only 20% are in city slums. According to FAO, 50% of them are small peasants, 20% are landless, 10% are nomadic herdsmen or small fishermen, and 20% live in city slums. In the developing countries, this rural social class is, above all, often a victim of marginalization and exclusion from its governing classes (political, economic, and financial) as well as from the urban milieu where there is a concentration of power and knowledge, and therefore money, including funds for development. Often the urban and rural worlds are separated. Whereas in the EU the farming population constitutes only 5% of the total population, it is about 50% in China, 60% in India, and between 60 and 80% in sub-Saharan Africa [11].

In past, Slovakia was typical agrarian country. Even during the nineteenth century the vast majority of the population worked in agriculture, but with the beginning of the twentieth century the decreasing trend began and continued to the present. In 1921, 60.4% of the working population was engaged in agriculture, after 1945, it was 48.1%. In 2012, 50,400 people worked in agriculture [12] which represented 2.2% of the working population, and 2.76 workers worked per 100 ha of agricultural land which was less than EU-27 average (8.81 workers per 100 ha of agricultural land) [13].

3.1.2. Land use

The global land area is 13.2 billion ha. Of this, 12% (1.6 billion ha) is currently in use for cultivation of agricultural crops, 28% (3.7 billion ha) is under forest, and 35% (4.6 billion ha) comprises grasslands and woodland ecosystems. The world's cultivated area has grown by 12% over the past 50 years. Globally, about 0.23 ha of land is cultivated per head of the world's population [14]. In 1960, it was 0.5 ha of cropland per capita worldwide. In Europe, about one-half of land is farmed and arable land is the most common form of agricultural land. Twenty-five percent of Europe's land is covered by arable land and permanent crops, 17% by pastures and mixed mosaics, and 35% by forests. The average amount of cropland and pasture land per capita in 1970 was 0.4 and 0.8 ha and by 2010 this had decreased to 0.2 and 0.5 ha per capita, respectively [15].

Such a state is a result of dynamic land-use and land-cover changes. Humans have altered land cover for centuries, but recent rates of change are higher than ever [16].

Land-use change reflected in land-cover change and land-cover change is a main component of global environmental change [17], affecting climate, biodiversity, and ecosystem services, which in turn affect land-use decision. Land-use change is always caused by multiple interacting factors. The mix of driving forces of land-use change varies in time and space. Highly variable ecosystem conditions driven by climatic variations amplify the pressure arising from high demands on land resources. Economic factors define a range of variables that have a direct impact on the decision making by land managers. Technology can affect labor market and operational processes on land. Demographic factors, such as increase and decrease of population, and migration patterns have a large impact on land use. Life-cycle features arise and affect rural as well as urban environments. They shape the trajectory of land-use change, which itself affects the household's economic status.

The development of the present ecosystems in the postglacial period (Holocene) depended on significant changes in climate. Warming in the postglacial period, about 10,000 years ago, created conditions of back migration of individuals species from their refuges, where they were protected during the glacial periods. After the neolitic revolution, human society began to influence more noticeably the development of natural ecosystems. About half of the ice-free land surface has been converted or substantially modified by human activities. Forest covered about 50% of the Earth's land area 8000 years ago, as opposed to 30% today. Agriculture has expanded into forests, savannas, and steppes in all parts of the world to meet the demand for food and fiber.

The central and north Europe were almost completely naturally covered by forests. Only high mountain and alpine rocky localities were without forest cover. Nowadays Europe is a mosaic of landscapes, reflecting the evolutionary pattern of changes that land use has undergone in the past. The greatest concentration of farmland is found in Eastern Europe, where also Slovakia lies, with more than half of its land area in crop cover [18]. Europe is one of the most intensively used continents on the globe. Despite the long tradition of human impact investigation on the environment and vegetation in Europe, there are few comparable studies in North America. This difference is often attributed to the shorter duration of intensive human impact in most of North America versus Europe. As a result, prior studies in the United States have generally been restricted to local investigations [19].

During the past three centuries, in many developing countries and countries with transition economies, growing demand for food due to an increasing population has caused substantial expansion of cropland, accompanied by shrinking primary forests and grassland areas [20]. Based on many studies, in China between 1700 and 1950, cropland area increased and forest coverage decreased. Similarly in India, between 1880 and 2010, cropland area has increased (from 92 to 140.1 million ha), and forest land decreased (from 89 to 63 million ha) [21]. But in the past 50 years, over world rapid urbanization has been evident [22]. Migration in its various forms is the most important demographic factor causing land-use change at timescales of a couple of decades [23]. Rapid economic growth is accompanied by a shift of land from agriculture to industry, infrastructure, road network, and residential use. Countries in East Asia, North America, and Europe have all lost cultivated land during their periods of economic development [18]. The dramatic growth and globalization of China's economy and market since economy reforms in 1978 have brought about a massive loss of croplands, most of which were converted to urban areas and transportation routes during 1978–1995 [24].

In Slovakia land-use trends are in many aspects similar to EU development. In 2013, of the total area of Slovakia agricultural land covered 48.9% (2,397,041 ha) and forest land 41.1% (2,017,105 ha). The highest share of used agricultural land was represented by arable land (58.9%) followed by permanent grasslands (36.1%). The average amount of agricultural land per capita was 0.44 ha [25]. Cereals are the main growing crops. Since 1990, decrease in agricultural land was recorded, often in favor of built-up area. Analysis of historical land-use changes at Liptovská Teplička cadastre showed that the landscape has undergone changes in land-use and cover during the 224 years. From the long-term point of view, gradual afforestation and permanent grassland conversion to forest land was observed where forest land increased from 67.7% in 1782 to 83.7% in 2006 [26].

3.2. Pressure

Agriculture in the last century has evolved from self-sufficiency to surplus in some parts of the world. Thus, transformation was connected with intensification and specialization of production as main trends in European or North American agriculture accompanied by negative impact on the environment. Agricultural intensification is defined as higher levels of inputs and increased output of cultivated or reared products per unit area and time [27]. Over the past 50 years, agricultural production has grown between 2.5 and 3 times, thanks to significant increase in the yield of major crops [14]. Changing land-use practices have enabled world grain harvests to double from 1.2 to 2.5 billion tonnes per year between 1970 and 2010. Globally, since 1970, there has been a 1.4-fold increase in the numbers of cattle and buffalo, sheep and goats, and increases of 1.6- and 3.7-fold for pigs and poultry, respectively [28].

The mix of cropland expansion and agricultural intensification has varied geographically. Tropical Asia increased its food production mainly by increasing fertilizer use and irrigation. Most of Africa and Latin America increased their food production through both agricultural intensification and extensification. In western Africa cropland expansion was accompanied by a decrease in fertilizer use and a slight increase in irrigation [18]. Agriculture is the single largest user of freshwater resources, using a global average of 70% of all surface water supplies.

3.2.1. Intensification and specialization of agriculture

Intensification and specialization have been predominant trends in EU countries including Slovakia for several decades. Between 1965 and 2000 there was a 6.87-fold increase in nitrogen fertilization, a 3.48-fold increase in phosphorous fertilization while irrigated land area expanded 1.68 times, contributing to a 10% net increase in land in cultivation [29]. Strong intensification in Europe in contrast to other countries is obvious if we compare selected indicators, e.g., fertilizer consumption or livestock density (**Figures 2** and **3**). In Slovakia, the maximum intensification level was reached during the socialistic era in 80th. However, since 1990, there are signs of a trend toward a more efficient use of agricultural inputs as a result of not very favorable economic situation of farms but also as a consequence of different environmental measures implementation. During 1980–2010 in Slovakia, indicators concerning to agricultural intensification dropped, in case of fertilizer consumption by 73% (**Figure 4**), the pesticides consumption by 77%. This period is typical in livestock number reduction, in case of cattle by 71, pigs 73, and sheep 37% (**Figure 5**).

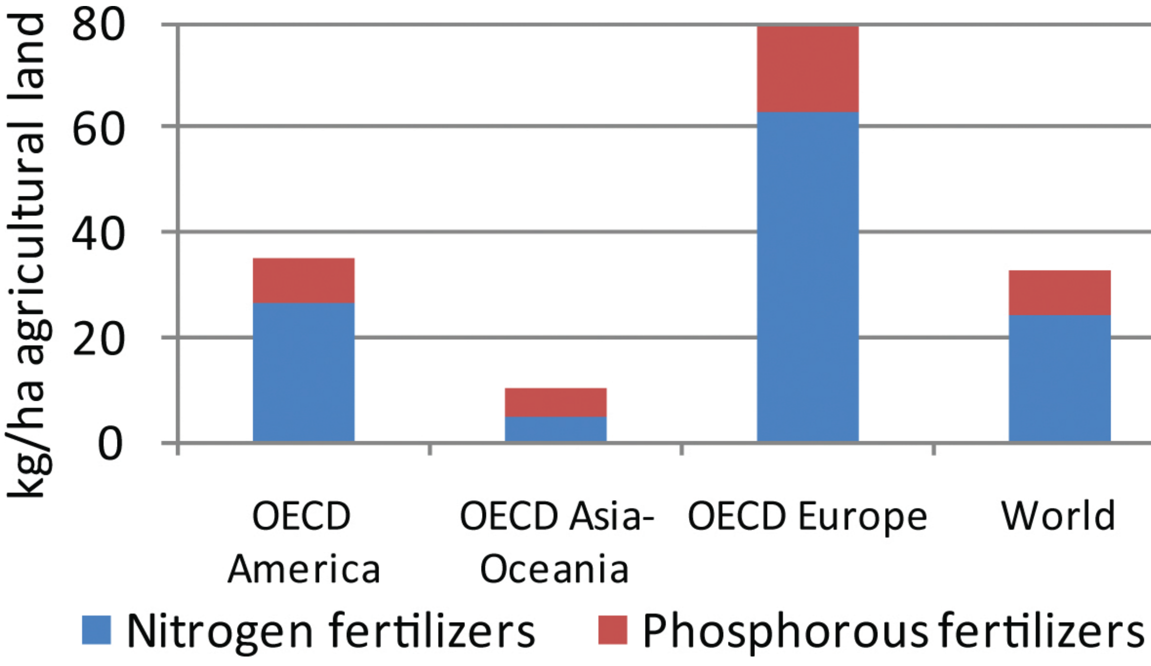

Figure 2. Fertilizer consumption in 2012 (kg/ha of agricultural land) (based on data from OECD [30]).

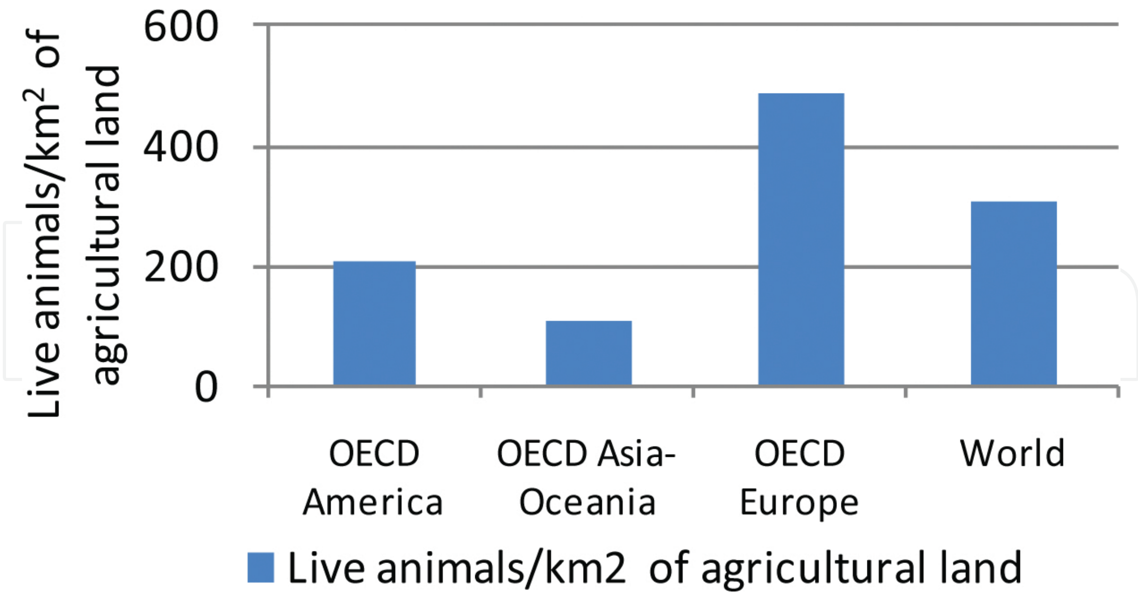

Figure 3. Livestock density in 2012 (live animals/km^2 of agricultural land) (based on data from OECD [30]).

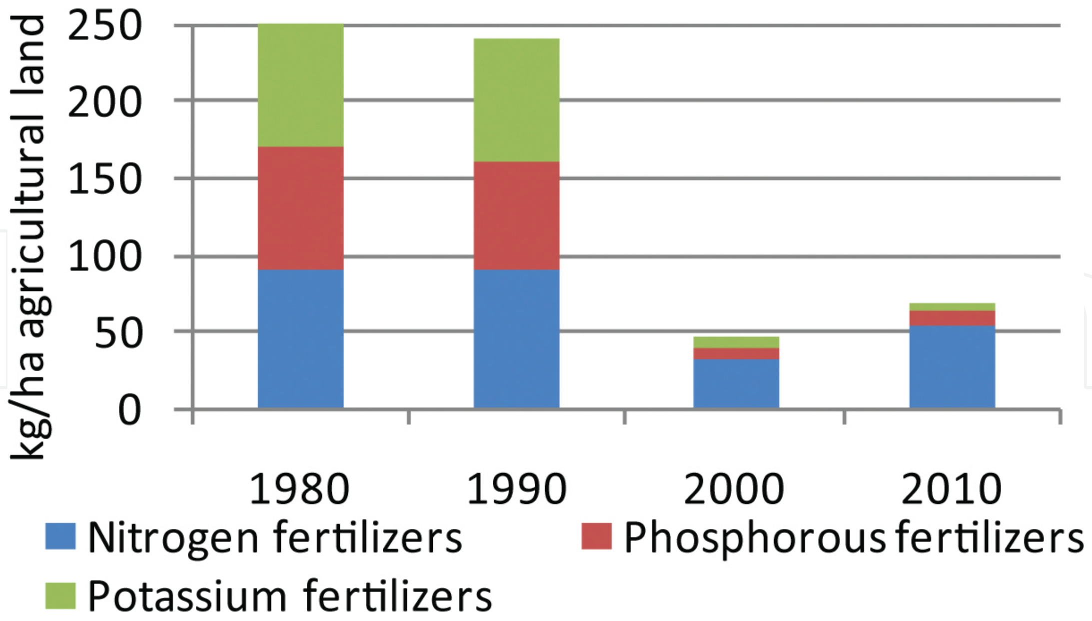

Figure 4. Development in fertilizer consumption in Slovakia (kg pure nutrient/ha) (based on data from CCTIA [31]).

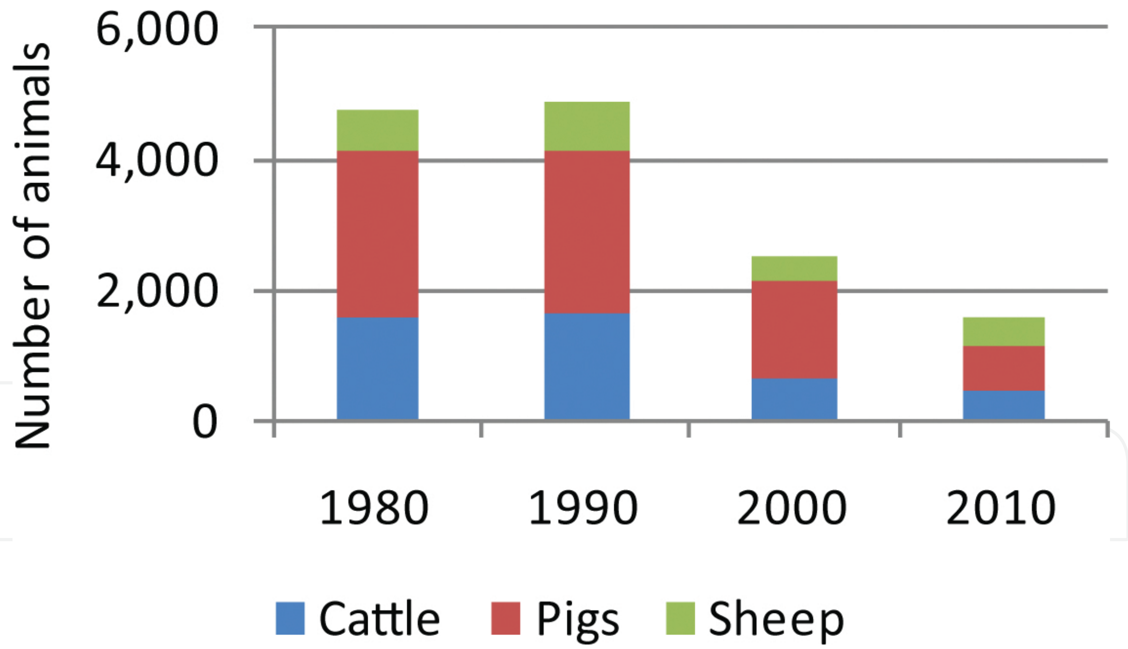

Figure 5. Development in number of livestock in Slovakia (live animals/ha of agricultural land) (based on data from SOSR [32]).

Intensification is connected with increasing release of atmospheric emissions through management of land and livestock, and thus agriculture release to the atmosphere significant amounts of greenhouse gases emissions of CO_2, CH_4, and N_2O [33] and ammonia emissions. The agricultural sector is currently responsible for the vast majority of ammonia emissions in

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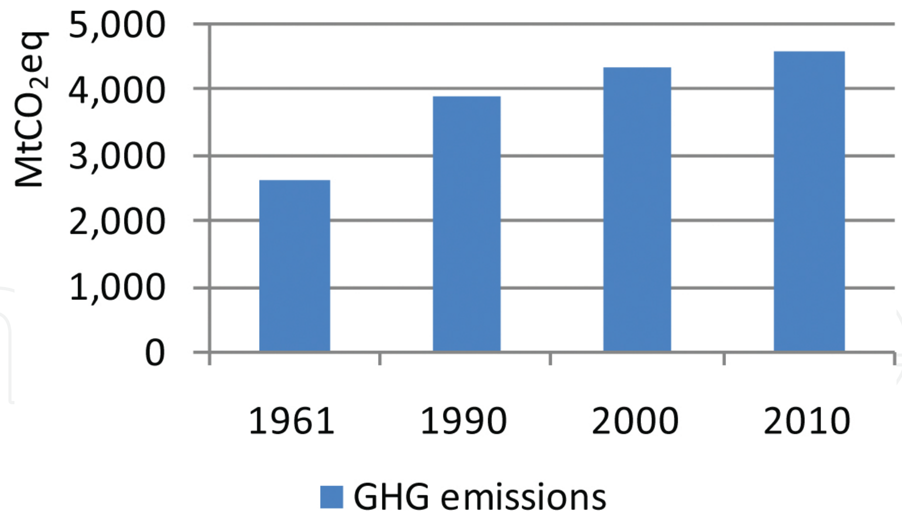

Figure 6. Global GHG annual agriculture emissions (MtCO2eq) (based on data from Tubiello et al. [35]).

the European Union. Agriculture contributes to about 47 and 58% of total anthropogenic emissions of CH_4 and N_2O, respectively. Annual GHG emissions from agricultural production in 2000–2010 were estimated at 5.0–5.8 $GtCO_2eq$/year while annual GHG flux from land use and land-use change activities accounted for approximately 4.3–5.5 $GtCO_2eq$/year. The enteric fermentation and agricultural soils represent together about 70% of total emissions, followed by paddy rice cultivation (9–11%), biomass burning (6–12%), and manure management (7–8%) [34]. Development of the global GHG annual agriculture emissions from 1961 to 2010 based on FAOSTAT data shows **Figure 6**. Annual GHG emissions from agriculture are expected to increase in coming decades due to escalating demands for food and shift in diet. However improved management practices and emerging technologies may permit a reduction in emissions per unit of food produced. In Slovakia, due to decrease number of livestock also decreasing trend in GHG and ammonia emissions were observed since 1990 (**Figure 7**).

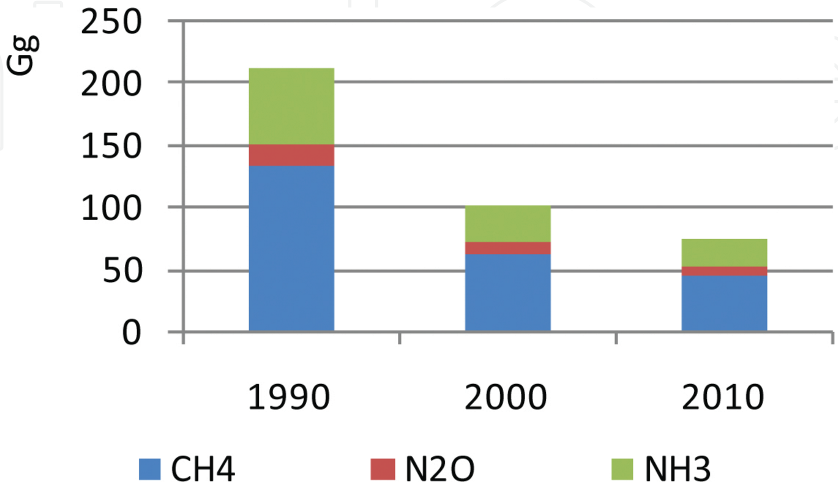

Figure 7. Emissions from agriculture in Slovakia (Gg) (based on data from MESR, SEA [36]).

3.3. State

Intensive management practices in agriculture escalating rates of land degradation threatens most crop and pasture land throughout the world. Worldwide, more than 12 million hectares of productive arable land are severely degraded and abandoned annually. Increased pressure is connected with deterioration of the state of environment, mainly soil and water.

3.3.1. Soil

Soil is the most fundamental asset on farms. Its quality that directly affects provisioning ecosystem services is strongly affected by management practices. The state of soils can be assessed by the help of indicators on soil contamination, erosion, and compaction.

Soil contamination implies that the concentration of a substance in soil is higher than would naturally occur. Agricultural activities contribute to soil contamination by introducing pollutants or toxic substances such as cadmium by application of mineral phosphate fertilizers or organic pollutants by pesticide application. Comprehensive inventories and databases on local and diffuse soil contamination are lacking on the global or regional extent. Estimates show that about 15% of land in the EU-27 exhibits a surplus in excess of 40 kg N/ha [37]. In Slovakia, data from the soil monitoring showed that only 0.4% of the total soil cover is contaminated by heavy metals [38].

The loss of soil from land surfaces by soil erosion has been significantly increased by human activities. Each year about 10 million ha of cropland are lost due to soil erosion [39]. In Slovakia, 32% of agricultural land is threatened by water and 5% by wind erosion, respectively [36].

Since the 1950s, pressure on agricultural land has increased considerably also owing to agricultural modernization and mechanization what caused next serious environmental problem—soil compaction. Overuse of machinery, intensive cropping, short crop rotations, intensive grazing, and inappropriate soil management leads to compaction [40]. Soil compaction problems, in various degrees, are found in virtually all cropping systems throughout the world. They are of particular significance where intensive mechanization has been adopted on soils subject to high rainfall or irrigation [41]. According to estimation approximately 600,000 ha of agricultural land is compacted in Slovakia [42].

The effect of farming on soil causing soil compaction expressed as soil penetrometric resistance (PR measured to 20 cm depth in MPa) was investigated in May 2014 at Liptovská Teplička cadastre, on soil type Rendzina with four different land-use (AL, arable land; M, meadow; AG, abandoned grasslands; FL, forest land) (**Figure 8a–d**). The different land use and practices reflected in different PR values (**Figure 9a–d**). The highest mean PR value was measured in AL (1.52 MPa), followed by M and FL (same value of 1.08 MPa), and abandoned grasslands (0.90 MPa) [43]. Measured values show at compaction in arable land. But there is necessary to take into account possibility that PR value in AL could be also the lowest among observed different land-use sites. Such situation can be observed when the measurement is done immediately after some technological operation, e.g., ploughing, contributing to turning the soil over, and diminishing higher soil horizons compaction.

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Figure 8. (a) Arable land in cadastre Liptovská Teplička, Law Tatras Mountain.

Figure 8. (b) Meadow in cadastre Liptovská Teplička, Law Tatras Mountain.

Figure 8. (c) Abandoned grasslands in cadastre Liptovská Teplička, Law Tatras Mountain.

Figure 8. (d) Forest land in cadastre Liptovská Teplička, Law Tatras Mountain.

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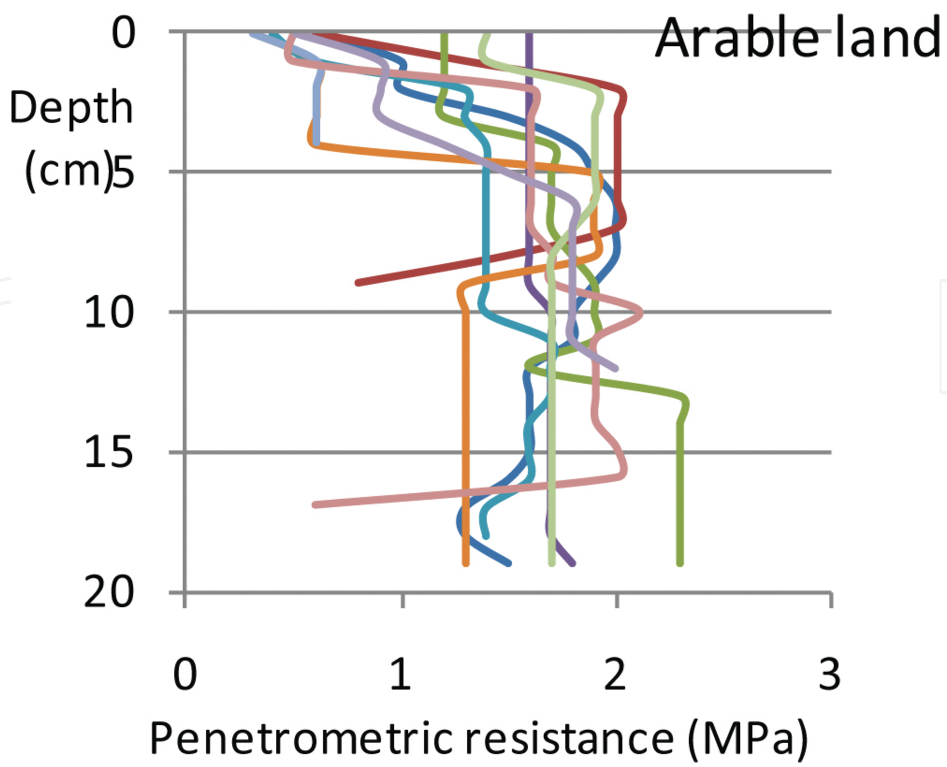

Figure 9. (a) Penetrometric resistance at arable land in cadastre Liptovská Teplička.

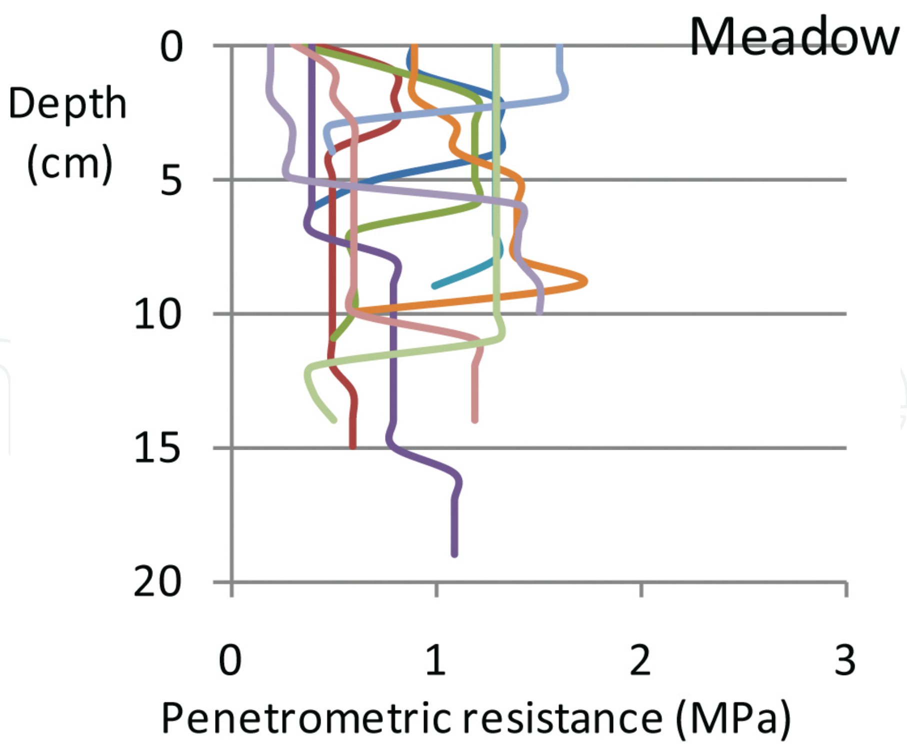

Figure 9. (b) Penetrometric resistance at meadow in cadastre Liptovská Teplička.

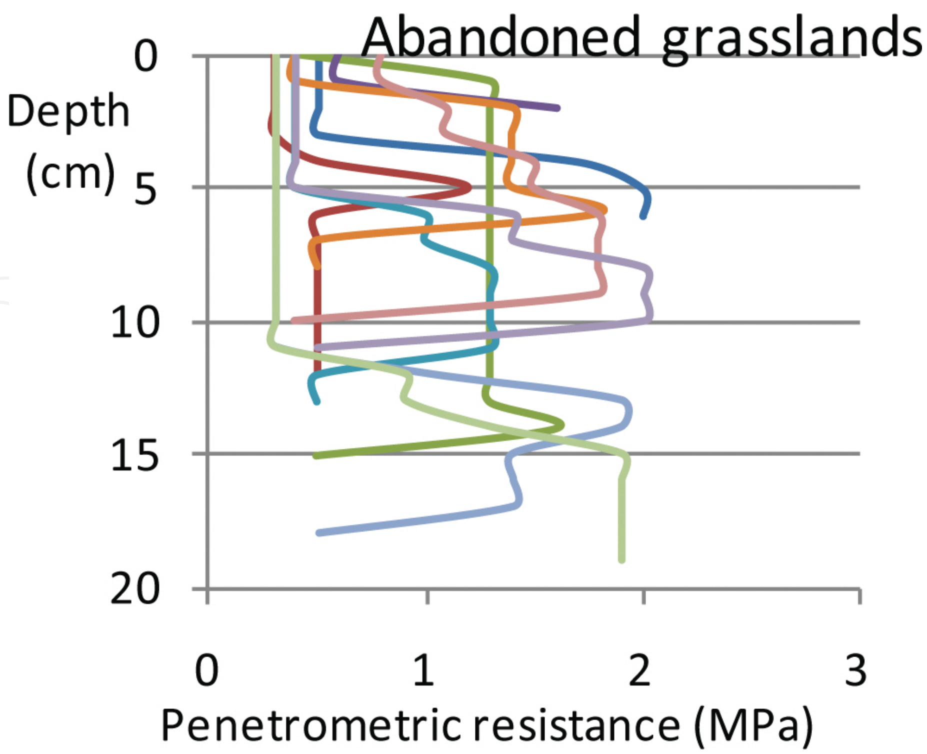

Figure 9. (c) Penetrometric resistance at abandoned grasslands in cadastre Liptovská Teplička.

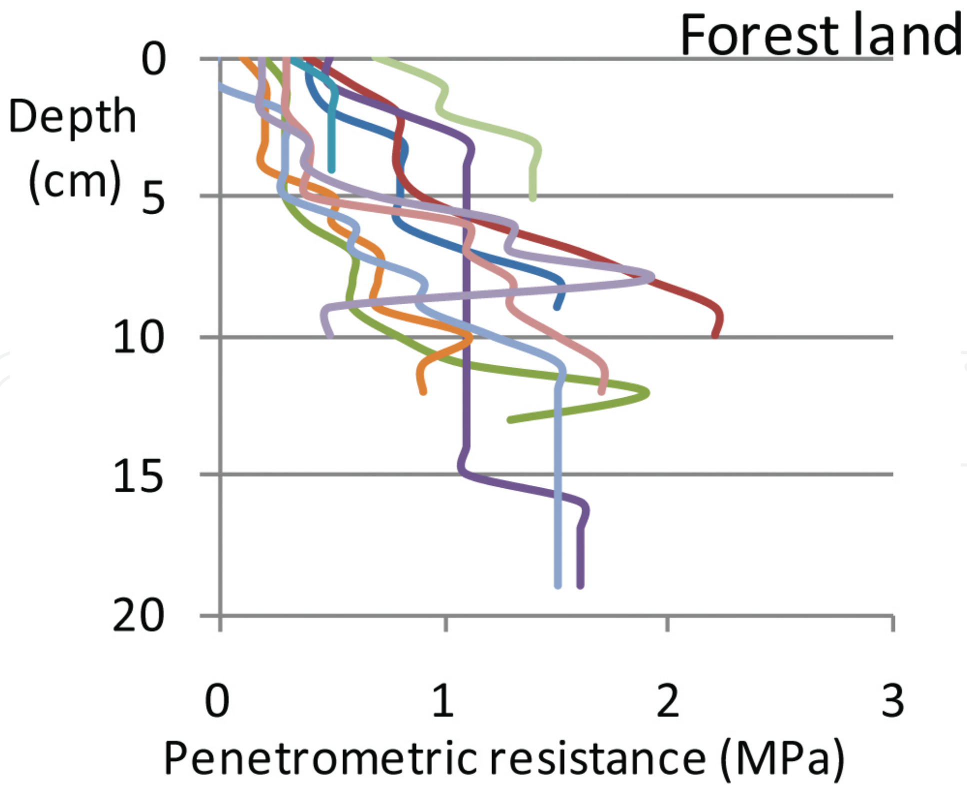

Figure 9. (d) Penetrometric resistance at forest land in cadastre Liptovská Teplička.

3.3.2. Water

Agriculture is both cause and victim of water pollution. Evidence for elevated nitrate and phosphate contents on farm, in drains, streams and rivers, and lakes is partial and tends to be specific to a given location and circumstance. Global phosphorus flux to the ocean increased 3-fold to about 22 Tg per year by the end of the twentieth century.

Nitrate is the most common chemical contaminant in the world's aquifers. An estimate for continental USA in the 1990s indicates that returns to water are close to 20% of total applied agricultural nitrogen, with up to 25% lost in gaseous form. Mean nitrate levels have increased by about 36% in global waterways since 1990 [44].

Pesticides contaminate surface water and groundwater. They can reach surface water through runoff from treated plants and soil. Contamination of water by pesticides is widespread, and groundwater pollution due to pesticides is a worldwide problem [45].

3.4. Impact

Impacts are commonly the result of multiple stressors. Agriculture exerts pressure on the environment that is both beneficial and harmful and can result in both positive and negative environmental impacts. The wide variation in farming systems and practices throughout the world, and differing environmental characteristics mean that the effects of agriculture on the environment arise at site-specific level but can have impacts at local to global level.

3.4.1. Traditional landscape disappearance

The disappearance of traditional agricultural landscape is an ongoing process, accompanying the general trend of agricultural abandonment in Europe [46]. In Slovakia, traditional agricultural landscape is described as agricultural ecosystems that consist of mosaics of small-scale arable fields or permanents agricultural cultivations such as grasslands, vineyards, and high-trunk orchards or early abandoned plots with a low succession degree [47]. Important parts of such landscape are linear landscape elements (hedges, tree lines, stone walls).

In Slovakia, traditional extensive farming with individual farmer attitude to landscape was transformed to collectivization with overall interest in land exploitation [48]. Collectivization caused small-scale parcels managed by individual farmers to be consolidated into large blocks (polygons) managed by large co-operative farms and resulted in a decrease of the mosaic of arable land and grasslands. At Liptovská Teplička cadastre during 1956–1990, number of polygons decreased from 15 to 2 at arable land, and from 82 to 29 at permanent grasslands [26]. In addition, the management of traditional agricultural landscapes structures decreased rapidly after collectivization. Nowadays the main barriers in ideal management are unfavorable subsidies in agriculture and the financial inaccessibility of modern tools and machinery together with inadequate market and the weak support of local government [49].

3.4.2. Contribution to climate change

Anthropogenic land-use activities and changes in land use/cover caused changes superimposed on the natural fluxes. Land-cover changes are responsible for surface and vegetation modifications what reflects in surface albedo and thus surface-atmosphere energy exchanges, which have an impact on regional climate. Terrestrial ecosystems are important sources and sinks of carbon and thus land-use changes reflect also in the carbon cycle. The important contribution of local evapotranspiration to the water cycle—that is precipitation recycling—as a function of land cover highlighted yet another considerable impact of land-use/cover change on climate, at a local to regional scale [50].

The influence of land use/cover on soil temperature was investigated at Liptovská Teplička cadastre study site in May 2014 where 10 measurements in depth of 5 and 25 cm at four different land-use plots (AL, arable land; M, meadow; AG, abandoned grasslands; FL, forest land) were done by insert soil thermometer (**Table 1**). The highest mean soil temperature was recorded in AL in 5 cm depth (4.6°C), the lowest in FL in 5 cm depth (3.5°C). Measured values show how plant cover and its microclimate functions are important and can affect soil temperature.

Depth (cm)	**Land use**			
	Arable land	**Meadow**	**Abandoned grasslands**	**Forest land**
5	4.6	4.3	4.2	3.5
25	4.3	4.4	4.6	3.8

Table 1. Actual soil temperature in cadastre Liptovská Teplička in May 2014 (°C).

Agriculture is unique among economic sectors releasing GHG emissions and thus contributing to climate change. Agricultural activities lead, in fact, not only to sources but also to important sinks of CO_2. Agricultural contribution to greenhouse gases accounts for 13.5% of global greenhouse gas emissions [51]. At the same time, agricultural production is fully climate and several further natural conditions dependent. Every change in climate has not only short-term but also long-term consequences. Climate change brings an increase in risk and unpredictability for farmers—from warming and related aridity, from shifts in rainfall patterns, and from the growing incidence of extreme weather events.

On the other hand, agriculture can also positively contribute to climate change mitigation. The utilization of agricultural residues as raw materials in a biorefinery is a promising alternative to fossil resources for production of energy carriers and chemicals, thus mitigating climate change and enhancing energy security [52].

3.4.3. Biodiversity losses

Land use, specifically in agriculture, has great impact on biodiversity. Another aspect contributing to biodiversity decline is that humans today depend for survival on tiny fraction of wild species that has been domesticated. Yet only 14 of 148 species weighing 45 kg or more were actually domesticated. Similarly, worldwide there are about 200,000 wild species of higher plants, of which only about 100 yielded valuable domesticates [53].

All long-term historical land-use changes responsible for natural ecosystems conversion to seminatural ecosystems or artificial systems contributed to the extensive changes in biodiversity composition and ecological processes. Agriculture plays an important role in these processes and is responsible for biodiversity decline. Over the past 50 years, ecosystems have changed more rapidly than at any other period of human history [62]. This period is connected with high agricultural intensification in many parts of the world. Land-use changes have been shown to be one of the leading causes of biodiversity loss in terrestrial ecosystems [54, 55]. To demonstrate the impact of land use and land management on soil biota quantitative analysis of earthworm was done at Liptovská Teplička cadastre in May 2014 when earthworms were hand sorted, weighted, and numbered from seven soil monoliths (35 cm × 35 cm × 20 cm) placed in line in 3 m distance in four different land-use plots (AL, arable land; M, meadow; AG, abandoned grasslands; FL, forest land). The earthworms may be used as bioindicator because they are very sensitive to both chemical and physical soil parameters. Earthworm biomass or abundance can offer a valuable tool to assess different environmental impacts such as tillage operations, soil pollution, different agricultural input, trampling, and industrial plant pollution [56]. The highest mean number (87.5 individuals m^{-2}) and earthworm body biomass (40.3 g m^{-2}) was recorded in M, the lowest in AG (5.8 individuals m^{-2} and 5.9 g m^{-2} body biomass) (**Table 2**) [49]. Relatively high number and earthworm biomass in AL at Liptovská Teplička cadastre is consequence of organic farming.

Depth (cm)	Land use			
	Arable land	Meadow	Abandoned grasslands	Forest land
Number	33.8	87.5	5.8	8.2
Body biomass	16.2	40.3	5.9	6.6

Table 2. Number of earthworm individuals and earthworm body biomass in cadastre Liptovská Teplička in May 2014 (individuals m^{-2}, g m^{-2}) [43]

Though intensified land use is undeniably the main cause of biodiversity loss. There is an increasing expectation that productive agricultural landscapes should be managed to preserve or enhance biodiversity [57].

3.4.4. Eutrophication

Eutrophication is a process of pollution that occurs when a lake or stream becomes overrich in plant nutrients as a consequence it becomes overgrown in algae and other aquatic plants. The major impacts of eutrophication due to overloading with nitrogen and phosphorus nutrients are changes in the structure and functioning of marine ecosystems, reduced biodiversity, and reduced income from fishery, mariculture, and tourism. The main source of nitrogen run-off from agricultural land brought to the sea via rivers. Atmospheric deposition of nitrogen may also contribute significantly to the nitrogen load. This nitrogen originates partly from ammonia evaporation from animal husbandry. Most of the phosphorus comes from households and industries discharging treated or untreated wastewater to freshwater directly to the sea, and from soil erosion.

Human activity has increased N fluxes. In 1970s, an explosive increase in coastal eutrophication in many parts of the world correlates well with the increased production of reactive N for agriculture and industry [45]. Eutrophication is a global environmental problem. In EU, there is marked variation in groundwater nitrate concentration between different geographical regions with high concentration in Western Europe and very low concentrations in Northern Europe. The lack of a general decrease is due to continued high emissions from agriculture [58].

3.4.5. Agroecosystem services degradation

Agroecosystems both provide and rely on ecosystem services to sustain production food, fiber, and other harvestable goods. Increases in food and fiber production have often been achieved at the cost of other critical services.

Services that help to support production of harvestable goods can be considered as services to agriculture. These services include soil structure and fertility enhancement, nutrient cycling, water provision, erosion control, pollination, and pest control, among others. Ecological processes that detract from agricultural production can be considered disservices to agriculture and include pest damage, competition for water, and competition for pollination. Management of agricultural ecosystems also affects flows of ecosystem services and disservices (or diminution of naturally occurring services) from production landscape to surrounding areas. Disservices from agriculture can include degradation or loss of habitat, soil, water quality, and other off-site, negative impacts [59].

Provision of ecosystem services in farmlands is directly determined by their design and management [60] and strongly influenced by the function and diversity of the surrounding landscape [61]. The Millenium Ecosystem Assessment [62] reported that approximately 60% (15 out of 24) of services measured in the assessment were being degraded or unsustainably used as a consequence of agricultural management and other human activities.

3.5. Response

In recent decades, increasing concern for the environment and sustainability has compelled many governments to continuously adjust their land-use policies to balance multiple uses of land resources. These policies have caused changes in cropland and its spatial distribution. There are different environmental objectives incorporated into agrienvironment measures, training programs, support for investments in agricultural holdings, protection of the environment in connection with agriculture and landscape conservation, support to improving the processing and marketing of agricultural products. Organic farming or low-input farming systems are examples where support for the processing or marketing of their products can help in achieving environmental objectives. In 2013, there were 43.1 million hectares of organic agricultural land, including conversion areas. The regions with the largest areas of organic agricultural land are Oceania and Europe [63]. In Slovakia, organic farming area covered 8.4% of the total agricultural land [36].

4. Conclusion

Agriculture is a dominant form of land management globally. Rapid population growth as primary driving force connected with increasing food requirements generate great pressure on future land use, environment, natural resources, and ecosystem services. The DPSIR framework approach helped us to analyze selected indicators having the cause–effect relationships between the economic, social, and environmental sectors.

Recent rates of land-use and cover changes are higher than ever. In many developing countries and countries with transition economies, growing demand for food has caused expansion of cropland. Extensive agricultural systems are slowly intensified. In developed countries, economic growth has been recently accompanied by a shift of land from agriculture to industry, road network, and residential use. Extensive forms of agriculture used in past mainly in Europe and North America were transformed into industrial-style agriculture accompanied by intensification and specialization. The large inputs of fertilizers, pesticides, fossil fuels have large, complex effects on the environment. Agriculture releases significant amounts of greenhouse gases and ammonia emission to the atmosphere. It is the single largest user of freshwater resources. Intensive management practices escalating rates of land degradation, soil and water deterioration. The effects on the environment arise at site-specific level but can have impact at local to global levels. Land-cover changes cause the disappearance of traditional agricultural landscape and are responsible for vegetation modifications which have an impact on regional climate, carbon sequestration, and biodiversity losses. Agriculture also has impact on the natural systems and ecosystem services on which humans depend.

Future challenges relating to greater pressure on environment, natural resources, and climate change imply that a "business as usual" model in agriculture is not a viable option. Green growth is a new method that places strong emphasis on the complementarities between the economic, social, and environmental dimensions of sustainable development. Thus, the main role of future agriculture is its transformation into good productive but a sustainable system that can be effective for centuries without adverse effect on natural resources on which agricultural productivity depends.

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