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BIOLOGICAL AND LANDSCAPE DIVERSITY CONSERVATION AS A KEY TO SUSTAINABLE AGRICULTURAL DEVELOPMENT OF BELARUSIAN POLESYE

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Introduction

Polesskaya lowland is situated on the territory of Belarus, Ukraine and Poland with total area of 13,2 million ha. It is a unique natural region with rich biological and landscape diversity. There are large forest and bog complexes preserved in natural conditions, vast floodplains which have not merely regional, but European ecological importance.

Rural landscapes of Polesye represent an outstanding combination of ecological, economic, historical and cultural values.

Traditionally close connection of rural inhabitants to natural environment of the region reveals itself both in the transformation of economic activity and in the historically formed values (traditional ways of living, peculiarities of labor, ethnic differences, self-awareness of people). This way conservation of biological and landscape diversity in Polesye contributes to the preservation of historical and cultural heritage, to the sustainable development of the region's material and spiritual culture.

Natural Ecosystems

Belarusian Polesye occupies the northern part of the Polesye lowland with an area of 6,1 mln. ha, which is almost 32,0 % of the territory of the Republic of Belarus (Fig. 1). The core of the region is the Prypyat' river basin, the landscape of which is characterized by exclusive diversity and spatial heterogenity. There 35 regional kinds of landscapes with various genetic features of relief, soil composition, moisturizing conditions, vegetation cover. Wetland ecosystems which occupy more than 44 % of Belarusian Polesye have got both regional and European importance. Their main part is situated in the floodplains of the Prypyat' river and its tributaries. The total area of the Prypyat' river floodplain within the Belarusian Polesye is more then 320,000 ha. The floodplain in some of the upper parts is as wide as 20 to 25 km, while the central part and the river mouth is near about 3 – 8 km wide [1, 1].

Belarusian Polesye is the largest region in Central and Eastern Europe were natural wetland ecosystems are spread with total area over 680,000 ha.

Complexity and special character of geological and paleogeographical development, uniqueness of geomorphological, hydrological, climatic and edaphic conditions, in combination with zonal and geographical location of the region, favored formation here of a regional solitary plant cover.

Flora of Belarusian Polesye includes a number of rare species. Over 1,400 species of higher vascular plants are found in the region, representing 96 % of the whole flora assemblage of the country. More then 60 rare species are included into the Red Data Book of Belarus [2, 1].

The regional isolation of Polesye flora can be traced by its chorological peculiarities: about 15 % of species are geographically formed, i.e. grow at natural boundaries of continuous or insular range. This includes specific regional and zonal species. So, the area of Polesye is a peculiar Polesye chorological disjunction in the natural habitats of many species of different geographical components of flora.

Historical causality of natural conditions in Polesye predetermined the regional peculiarities of its flora and vegetation development. The present plant cover in Belarusian Polesye, amounting to 69,3 % of its total area, consists of forest (42,1 %), meadow and mire (23,3 %) vegetation types.

Forest vegetation includes the following groups of formations: coniferous (61,1 %), broad-leaved (7,9 %), small-leaved (12,4 %) and Larch native forests on bogs (18,6 %). The

most important forest formations among them are: *Pine* (58,7 %), *Birch* (15,3 %), *Black Alder* (13,5 %), *Oak* (7,2 %), *Spruce* (2,4 %) and *Aspen* (1,2 %) forests with their own geobotanical structure and regional features. They are primarily forest formations of West European type among which broad-leaved (*Oak, Hornbeam, Ash*) and broad-leaved/coniferous forests are noticeable.

Geo-botanical zonality in Polesye manifests itself not only in substitution of East-European forests of south-taiga type by West-European forests but in the change in phytocoenosis structure of the latter. This appears as a change in woody and low-layered vegetation. A complete edapho-phytocoenotic series of pine-oak phytocenosis, absent in more northern regions of the country, is characteristic of Polesye. Reduction in the amount of spruce forests and their ecosystem diversity in Polesye is also accompanied by saturation of their phytocoemosis by West-European immoral components. Here mohodominant phytocoenoses occur to an insignificant extent and primarily biodominant spruce-oak, spruce-alder and other phytocoenoses with immoral component of broad-leaved forests prevail. Extensive areas are occupied by Black Alder forests typical for fen mires.

The distinctive feature of meadow vegetation in Belarusian Polesye is wide development and prevalence of lowland meadows as opposed to dry ones. Closeness to the forest-steppe zone and peculiar climatic conditions in Polesye defined the development of a particular syntaxonomic category of steppe meadow vegetation in floodplains of large rivers. These meadows are characterized by the existence of phytocoenosis with a great number of meadow-steppe species (*Agrostis vinealis, Festuca trachyphylla, Koeleria delavignei, Phleum phleoides*).

Peculiarities of the relief, specific bedrock developments and hydrographic net functioning defined broad development of fen and transition mires in Polesye. Raised bogs occur rarely and do not grow there and *Sphagnum* mosses have a different species ratio than in the northern raised bogs. *Sphagnum fuscum* concedes its phytocenotic role to *Sph. magellanicum, Sph. rubellum, Sph. cuspidatum* and *Sph. apiculatum*. Such raised bogs are attributed to a particular Polesye type with a distinctive vegetation complex.

Mires in Polesye, though being slightly different from their analogues in the floristic structure in the rest of the country, also display a specific character. They are represented by large wide tracts and are occupied mainly by reed, large sedge, *Hypnum*-sedge, and grass-sedge communities. Belarusian Polesye, as a whole, has its own floristic characteristics: zonal distribution, regional specific character, typical and regionally attributed species. These features were taken into account when performing floristic zonation of Belarus and the area became known as Polesye region. The boundaries of the floristic Polesye largely coincide with the borders of the hydrological Polesye [3, 2].

Presence of huge wetland areas defined international importance of the region for fauna diversity. All Belarusian amphibians and reptiles, about 80 % of Belarusian birds, and 55 % of mammals are found on this territory. About 100 species of animals are included into the Red Data Book of Belarus as unique and requiring protection.

Social-Economic And Cultural Potential

Belarusian Polesye takes an essential role in social and economic development of Belarus as a large region of economical activity.

All assured resources of potassium ores (2,8 bln.), oil, construction stone both like a dominated part of brown coal, turf, construction and silicon sands and other kinds of raw materials are concentrated here.

There are near 30 % of population of the country live in the region. There 5 cities from 14 with the number of population over then 100 000 are situated here. These are Gomel (475,5 thous.), Brest (286,4 thous.), Pinsk (129,9 thous.), Mozyr' (109,8 thous.), Soligorsk (100,9 thous.). They are large diversified industrial centers. Another medium and small towns are specialized on extraction of domestic natural resources and their processing, especially agricultural production (meat, milk and fruit processing industry).

The share of Belarusian Polesye in the total amount of output industrial products of the country is over then 25 %. The importance of the region in the economy of Belarus will be increased due to its strategically significant nature resources potential, high industrial and demographic potential, both like favorable geographical situation and relatively developed transport infrastructure of the region. So there are all necessary prerequisites for increasing of its transition role for the trade between countries both Western, Central Europe and Russia and other CIS countries. Railway and highway Warszawa – Brest – Pinsk – Kalinkovichi – Gomel, "Druzhba" oil pipeline, naval river system Western Bug – Dnieper-Bug channel – Prypyat' – Dnieper have got a transeuropean importance and passing through the territory of Belarusian Polesye. All these transport communications have got large railway junctions (Brest, Luninets, Kainkovichi, Gomel') which have got a good accessibility to the Baltic and Black Sea ports.

Belarussian Polesye is a large agricultural and forestry region. More then 1/2 of gross output of agriculture of the Republic of Belarus is produced here, including 40 % of grain, near 50 % of potato and vegetables, almost 75 % of sugar-beet, 45 % of milk and meat production. Agrarian development of Belarusian Polesye will continue to dominate in the future defined by the still large availability of significant agricultural lands. Polesye covers about 24 % of total country land resources. Availability of land, the warmest climate in Belarus, and the remaining rural population – these three factors can ensure leadership of this region in the agricultural sector of national economy [4, 3].

Anthropogenic Transformation Of Habitats And Lands

Wide prevalence of wetlands and large floods historically defined low population numbers and density, as well as uneven distribution. Only during the past 80-100 years the human impact on natural ecosystems of this region has increased. The first decades of 20th century were characterized by the gradual rise of human impact on forest ecosystems, manifested by timber felling and hunting. As a result, Brown Bear *Ursus arctos,* Beaver *Castor fiber* and Lunx *Lunx lunx* as well as hunting ungulates such as Red Deer *Cervus elaphus,* Elk *Alces alces,* Wild Boad *Sus scrofa* became almost extinct. However, the change in Polesye ecosystems at that time was reversible, and the numbers of Beaver and ungulate species were successfully restored by 1950-60s.

However, during the second half of 20^{1} century, especially during 1966-90, more than 2,6 million ha of wetlands were drained in Polesye. Later repair of old drainage systems was carried out on more than 500,000 ha and 1,1 million ha were converted to agricultural use through amelioration projects undertaken in the past decades. Large-scale drainage activities led to an ecological catastrophe for plant and animal communities in this region. Fatal changes in different types of wetlands were observed in huge areas of Polesye (Table 1). Around 20 % of the Pripyat catchment area was drained and most of the small rivers were canalized. Dam construction along the Pripyat disturbed natural development of floodplain ecosystems depending on annual spring floods. The flow discharge in the Pripyat channel has increased as a result of canalisation of small rivers. Thus many floodplain areas become exceedingly inundated and wet because of large water supply. This caused degradation and destruction of forest vegetation in some places. Natural ecosystems were destroyed by the fatal consequences of drainage on significant parts of this unique region.

One of the main reasons for the catastrophic impact of drainage in Belarus was the disregard of scientific demands for conservation of undisturbed natural ecosystems maintaining biodiversity among vast tracts of ameliorated areas. In total it caused a significant decrease in the number of different animal species, especially waterfowl and led to their redistribution.

The main characteristic features of Polesye are predominant sandy loam soils and also high occurrence of mires and peat soils. Low-yield peat soils with thin peat layer (less than 1 m) spread by sands and sandy loams are widespread. As a result of the Program of Land Reclamation about 1,8 million ha have been drained. Main areas of drained peat soils (about 700 thousand ha) are concentrated in this region. At first such collective farms had some ad-

vantages, since drained arable lands ensured bigger crops in comparison with low productive mineral soils. However, it shortly became evident that drained lands were ecologically unstable. Now the state of drained peat soils and the areas with predominance of such soils causes particular anxiety.

Wetland area changes during 1960-2004

Table 1

Habitat types	1960	2004	% of change
	Lakes		
Small forest lakes, km^2	23	23	0
Low productive lakes, km^2	1117	1117	0
High productive lakes, km^2	162	204	+21
	Artificial waterbodies		
Fish-farm ponds, km^2	24	192	+800
Water reservoirs, km^2	65	416	+640
Channels, km^2	5000	32157	+85
	Rivers		
Highly waterlogged floodplains, km^2	3700	688	-82
Moderately waterlogged floodplains, km^2	3000	2715	-10
Riverbeds, km^2	12000	12000	0
Small rivers, km^2	77270	62160	-20
	Mires		
Open fen mires, km^2	10765	3800	-65
	Wet mineral lands		
Wetlands with mineral soils, km^2	26800	12750	-52

It was estimated that the total loss of organic matter in 1986-2000 was 43 million tons. As a result of the loss of organic matter, the peat layer on the drained lands will decrease by 20 – 40 cm and drastic changes in vegetation structure can be expected. Specifically, over 220,000 ha of peat-clay soils will be transformed to organic-mineral soils. Organic-mineral soils formed earlier will become closer to sandy, sandy-loam and podzol soils [4, 4].

Hence, in the near future, agriculture in some administrative regions of Polesye will turn out get new soil conditions, under which continued effective economic activities would require additional funding, changes in specialization and other measures.

Land degradation in Polesye has recently been exacerbated by negative climate changes, including more frequent and powerful droughts and other extreme natural phenomena (early frosts, disruption in the hydrological regime, organic matter, peat mineralization, etc.). Only for the last 50-year period the amount of droughts in the region increased 2,5 times. Especially critical is the situation on more than 40 % wetlands which were drained during 1960 – 1990.

The Chernobyl nuclear accident influenced and is still largely influencing the agriculture of Polesye. More than 1,8 million ha of agricultural lands are polluted by Cs-137 with density over 1 *Ci/km*^{2}. 265,400 ha of fields were excluded from agricultural use. Direct annual loss for plant-growing only is estimated at about 70 million $ US. The cost of buildings and equipment remaining in abandoned Chernobyl accident zone is several times higher [5, 4].

During the implementation of the Program on Dealing with the Consequences of the Chernobyl Nuclear Accident the main attention was directed to radionuclide polluted areas with human population. Agricultural activities were maintained on 1,36 million ha contaminated by radioactive cesium and almost 0,5 million ha contaminated by Sr-90. The production of agricultural products with safe level of radionuclide content is the main aim of the contaminated area development. In this respect, a new agricultural system is being formed, based

on extensive knowledge of radionuclide migration in soil and the accumulation in different plants, as well as further migration through the food chain to humans. This system includes regulation of soil water regime, use of appropriate crops, fertilizers and means for plant protection.

Utilization And Preservation Of The Reclaimed Agricultural Landscapes

In connection with a widescale land-reclamation and agricultural development of the worked out peat deposits many bog landscapes became anthropogenicly disturbed. Attempts at their return back into agriculture were made. There are many examples of unsuccessful leveling of such new agricultural landscapes because of the overestimated coefficient 0,9 and more of the ground utilization. There are no conditions for conservation of biological diversity; degraded peat soils and chemicals introduced to improve agriculture are also main pollutants of ground and surface waters. Reclaimed agricultural landscapes with such high coefficients of ground utilization are ecologically nonresistant and degrade quickly.

The conception of formation and utilization of the reclaimed agricultural landscapes consists of the targeted regulation of factors of life of cultivated plants along with the provision of not only high biological efficiency of the reclaimed terrains, but also of ecological stability of ingredients of agricultural landscapes during the agricultural utilization. This can be achieved observing the following five principles of construction, formation and utilization of the reclaimed agricultural landscapes.

The principle of maximal territorially differentiated distribution of reclamation systems and grounds, based on utilization of the existing natural diversification and structure of wetland landscapes, obligates land-users to apply scientifically proved territorial distribution of arable and meadow lands, forest areas and forest belts, water basins, ponds, buffer, soil-saving and water-security zones, coordinated with the characteristics of the natural constitution of landscapes and reclamation systems [6, 5]. The interrelations between reclaimed and not reclaimed lands, the areas under various agricultural crops, and also distribution of various reclamation constructions – large canals, reservoirs and water receivers - should be optimized in the agricultural landscapes (table 2) [7, 5].

Present and proposed optimal land use proportion of rural landscapes of Belarusian Polesye

Table 2

Land use	Present proportion, %	Optimal proportion, %	% changes
Forests and shrubs	7	10	+3
Arable lands	48	31	-17
Meadows	37	45	+8
Mires	8	14	+6

The principle of natural anthropogenic compatibility obligates land-users to place anthropogenic ingredients of landscapes (canals, reservoirs, fields, roads etc.) so, that they were harmoniously entered in a natural habitat, and conformed to the dwelling places. It is necessary to take into account, preserve and sustain their microzonal distribution during the designing, formation and agricultural utilization of the reclaimed agricultural landscapes [8, 5]. Maintenance of diversification of elements of landscapes is an obligatory and necessary condition for conservation of biodiversity. In the reclaimed agricultural landscapes the processes of self-purification and self-regeneration of natural habitats should be organized by means of creation of transitive zones from agricultural grounds to natural biocenoses - forests, bushes, bogs, river valleys etc. The increase in the number of species and hence – in the level of biodiversity – is observed in such zones following variety of ecological conditions.

The principle of preventive measures in the formation and utilization of agricultural landscapes is based on the priority of the measures preventing negative consequences over the melioration measures. It is necessary for the reclamation systems to render the nature protec-

tion effect, preventing dropping of the ground-water table in the adjacent terrains, precluding contamination of waters through drainage systems, conserving biodiversity by means of inclusion of small landscape forms into the reclamation systems: environmental niches, hibernated pits, rifts, artificial niduses for muskrats, otters etc.

The integral part of the principle of preventive measures covers measures directed on the maintenance of a high level of fertility of the reclaimed soils and conservation of their organogenic stratum. It can be achieved both by the immediate impact of the reclamation systems on the air regime of soils, and correct system of crop rotations, optimization of the structure of areas under crops, doses of fertilizers, efficient application of agricultural technologies.

Environment And Sustainable Rural Development

Successful development of the region should be accompanied by reforms of agriculture, creation of multistructural character of economy, the breakup of the monopoly of large state agricultural enterprises. Such economic forms as joint stock companies, cooperative farms, individual farms, share companies, associations, agro firms, holdings etc. should be developed. A crucial problem of agrarian transformation is land relations reform, formation of a new land use structure based on private ownership principles, land market creation, land rental system, land hypothecation, hypothecation credit, etc. There should be a more rational approach to decision making on land use for the agricultural purposes. With more integrated thinking, it may be expected that approximately 30 % of the now agricultural lands are going to be excluded from agriculture for their low productivity, far distance from large settlements, high economic expenses for ameliorative system management. That's why it is important to discuss their subsequent use, a perspective of assigning such lands to a different land use category, expansion of protected area network, etc. [9, 6].

The most realistic way for sustainable development of Belarussian Polesye is ecologization and intensification of economic activity on the basis of nature protection technologies, complex nature resource use, introduction of new forms and methods of economy organization and management. In Belarusian Polesye the reforms could go hand in hand with landscape restoration, protected nature territories extension and ecological network creation. This task solution is dependent in many respects on the outside investments, in the form of long-term loans, joint international environmental projects.

The problem of ecological and socio-economic rehabilitation of territories contaminated by radionuclides as a result of catastrophe on the Chernobyl power plant is high on the agenda for the development of Belarusian Polesye. About 70 % of overall radioactive contamination is found in the Polesie region, 88 % of population resides here (1,4 mln ha).

A promising way to resolve the problems of biological and landscape diversity conservation in Belarussian Polesye together with rational use of natural complexes is establishment of nature protected areas. Polesian protected areas have to become an important element of the European ecological network. A uniform network will be a continuous and interconnected system, linking similar territories of neighboring countries (Poland, Ukraine, Russia). Natural protected areas of Belarussian Polesye amount to 484,500 ha, which is over 11 % of the region's area. Prypyatski national park (82,2 thous. ha), Polesski radiation-and-ecological reserve (215,5 thous. ha), 28 national reserves including 7 landscape reserves, 1 hydrological and 20 biological reserves. Middle-Pripyat (90,4 thous. ha), Olmany mires (94,2 thous. ha), Zvanets (10,4 thous. ha) are largest zakazniks of the region. Belarussian Polesye is region where problems of nature use and creation of ecologically sustainable environment have are combined and have to be resolved in an integrated way.

Exclusion of ineffectively used lands from crop rotation is extremely important to restore traditional kinds of nature use. These were once widely developed in Belarusian Polesye before the total collectivization and wide-scaled drainage. This issue should be tackled alongside with development of agrarian and ecological tourism, folk crafts, hunting, fishery, apiculture etc.

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Сохранение биологического и ландшафтного разнообразия – ключ к устойчивому сельскохозяйственному развитию Белорусского Полесья

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Белорусское Полесье представляет собой крупное региональное природно-территориальное образование с присущими ему специфическими геоморфологическими, гидрологическими, климатическими, почвенно-географическими, геоботаническими и фитохорологическими особенностями. Это дало основание выделить Белорусское Полесье в качестве самостоятельной таксономической единицы физико-географической классификации – подзоны суббореальных широколиственных (полесских) ландшафтов. Подобное его своеобразие и уникальность отражены практически во всех существующих схемах покомпонентного природного районирования. В настоящее время Белорусское Полесье играет не только ключевую роль в обеспечении экологического равновесия, но в существенной мере влияет на устойчивое социально-экономическое, в т.ч. агрохозяйственное развитие Беларуси в целом. Достижение последнего возможно при условии решения задач, направленных на максимальное сохранение природных комплексов и интенсификацию хозяйственной деятельности на основе оптимизации территориальной структуры аграрного природопользования и комплексного использования аграрного потенциала региона.