

THE DNIEPER RIVER CASCADE OF RESERVOIRS AS A MAIN REASON OF BIODIVERSITY LOSS

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Abstract: The article considers the problem of floodplain's ecosystems destruction as a result of the creation of six cascading reservoirs on the Dnieper River. Analysis of the reservoirs impact on ecosystems and biodiversity conditions was not held. In this regard, an actual task is the justification of biodiversity loss causes on the territory of the Dnieper River floodplain. The reservoirs cascade construction on the Dnieper river has led to the actual destruction of the whole biome of long-term flooded ecosystems: forests, meadows and marshes. Thirty four plant communities from the Ukrainian Green Book have disappeared from the floodplain territory. The plant kingdom lost 14 species from the IUCN Red List of threatened species, 27 species from The European Red List, 14 species of the Bern Convention and 84 species from the Ukrainian Red List. The study shows that secondary ecosystems are formed in condition of adventive plant species complete dominance (Desert False Indigo - *Amorpha fruticosa*, Water Soldier - *Stratiotes aloides*) with actual displacement of the indigenous vegetable biodiversity. The problem of the Dnieper river floodplain biodiversity loss can be solved by dismantling the Dnieper river reservoirs' cascade. Thus it is necessary to expand the territorial system of the natural reserve fund and ecological network for enhancing the biodiversity, involving lands disturbed by mining.

Keywords: biodiversity, cascading reservoirs, Dnieper river, ecosystem, floodplain

Introduction:

The noospheric stage of human development added to biosphere both the human mind as a "new geological power" and the ecological problem, that nowadays are transferred to global rank (Shennikov 1941). Biodiversity loss has become one of the significant problems, which has been especially acutely introduced in Ukraine. Land plowing has led

to the actual destruction of the whole steppe biome. Not only did hydraulic building influenced biodiversity, but also land plowing. The creation of six cascading reservoirs on the Dnieper River – the main water artery of the territory – has led to flooding of no less then 700,000 ha and destruction of floodplain ecosystems. Reservoirs creation has led to flooding million hectares of adjacent areas, loss of thousands hectares of coastal land as a result of coastal abrasion, changes in the moisture regime of small river valley and resulted in ecosystems' degradation on large areas.

Geobotanical and floristic studies of the Dnieper River floodplain biodiversity were carried out, mainly, at the beginning of the 20th century, before total flooding (Elenevskii and Elenevskaia 1927;

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Shennikov 1941; Afanasiev 1950; Belgard 1971; Kleopov 1990).

Modern researches are dedicated mostly to secondary vegetation (Senchilo 2010) and on the reservoir territory primarily to aquatic vegetation (Baranovskii 2000). Analysis of the reservoirs' impact on the ecosystems and biodiversity conditions was not held. In this regard, the task of justifying biodiversity loss causes on the territory of the Dnieper River floodplain has current concern for more than 50 years.

Materials and methods:

The research objects were wetlands of modern Dnieper River valley, prevailing in the steppe zone. The research subject focused on abiotic and phytodiversity changes that had occurred under the reservoirs influence. Standard geobotanic, floral and zoological methods were applied to identify biological phenomena. Comparative, historical, ecosystemological (Starodubcev and Sahackij 2009) methods and dimensions on landscape maps were used to analyze the consequences of the reservoirs creation.

Results and discussion:

Retrospective analysis of the ecosystems' biodiversity flooded by reservoirs

Archival materials and the literature analysis (Elenevskii and Elenevskaia 1927; Shennikov 1941; Afanasiev 1950; Belgard 1971; Kleopov 1990) of studying similar objects (such as Dniepr-Orelii Nature Reserve, tract Dievskie plavni) indicate the loss of long-term floodplain ecosystem's biome. Flooding and further elimination of the floodplain moisture regime have led to the disappearance of the following phytocenoses:

- forest with domination of White Willow (*Salix alba*), Crack Willow (*Salix fragilis*), Almond Willow

(*Salix triandra*), Purple Willow (*Salix purpurea*), Long-leaved Violet Willow (*Salix acutifolia*), Grey Willow (*Salix cinerea*), Black Poplar (*Populus nigra*), Silver Poplar (*Populus alba*), Black Alder (*Alnus glutinosa*), Pedunculate Oak (*Quercus robur*), with unique ephemeral and ephemeroïd plants, most of which today are included in the National and Regional Red Lists;

- tulip (*Tulipa quercetorum*), Siberian Squill (*Scilla sibirica*), Two-leaf Squill (*Scilla bifolia*), Yellow Anemone (*Anemona ranunculoides*), Wood Anemone (*Anemona nemorosa*), Hollow-Root (*Corydalis cava*), Corydalis Marshalliana (*Corydalis marshalliana*) and others;
- meadows with extra moistening with domination of Water Meadow Grass (*Glyceria maxima*), Acute Sedge (*Carex acuta*), Reed Canarygrass (*Phalaroides arundinacea*); meadows with extra normal moistening with domination of Red Fescue (*Festuca rubra*), Meadow Fescue (*Festuca pratensis*), Bentgrass (*Agrostis tenuis*); meadows with insufficient moistening with domination of Wood Small-Reed (*Calamagrostis epigeios*); meadows with salinization with dominance of Tall Fescue (*Festuca orientalis*), Weeping Alkali Grass (*Puccinellia distans*);
- marshes with dominance of Common Reed (*Phragmites australis*), Lesser Pond Sedge (*Carex acutiformis*).

Bayou ecosystems with plant communities of the Ukrainian Green Book were lost: White Lilies communities (*Nymphaeeta albae*, no. 119), Dwarf White Water Lily (*Nymphaeeta candidae*, no. 120), Yellow Water-Lily (*Nuphareta luteae*, no. 121).

According to our estimates, 34 plant communities of the Ukrainian Green Book

have disappeared from the flooded floodplain territory, the plant kingdom lost 14 species from the IUCN Red List of threatened species, 27 species from The European Red List, 14 species of the Bern Convention and 84 species from the Ukrainian Red List.

Adventive species spreading as a threat to the natural biodiversity of the territory

Changes in ecological conditions have led to transformation of vegetation with acute reinforcement of adventive species. Dnieper Islands and waterlogged coastal territory fell under capture of Desert False Indigo (*Amorpha fruticosa*), which formed monodominant shrub communities and massive undergrowth of secondary poplar and willow communities. Aboriginal shrub species is in competition with it for light and nutrients.

The same situation can be noticed in water of bays' ecosystems and secondary reservoir lakes, where the Water Soldier (*Stratiotes aloides*) took a dominant position and its communities' development led to ponds' overgrowth and loss of natural biodiversity in interspecific competition.

Biodiversity of secondary islands

The bottomset beds accumulation leads to fast growth aquatic level thickness and consequent outbreak on the daylight surface. The spread of secondary landscapes, which are formed in the upper part of reservoirs where the hydrotechnogenic internal delta is formed, was reflected in numerous papers by Starodubcev and Sahackij (2009).

Similar processes occur in small and middle river estuaries. Research of landscape creation at the river mouth of the left Dnieper River tributary – the Samara River, testifies that there formed secondary soils in the area over 190 ha during the period of 1983–2006 (according to the sailing directions, maps, space images) (Fig. 1).

Secondary delta islands were formed on the site of the Dnieper reservoirs on an area of over 150 ha in the river mouth of the Orel Channel and on an area over 46 ha at the mouth of the Kilchen River.

Secondary islands' vegetation is found in very severe terraqueous conditions with significant fluctuations of water level at hydropower dumping, when amplitude can reach 3.0 m. In such conditions only pure Common Reed (*Phragmites australis*) communities can survive.

Ecological network developing as a measure of overcoming biodiversity loss under the reservoirs' influence

Within the green corridor system the core areas occupy the main position, especially the natural reserve fund areas. Shortening distance between such objects promotes closer interaction and therefore integrity of the network. The area and the number of core areas increasing is one of the main tasks of Dnieper ecological corridor forming.

Today within the site of the Dnieper reservoirs there is formally justified the existence of 5 objects of the nature reserve fund (Shennikov 1941) (Tab. 1).

The Dnieper-Orelii nature reserve has in its composition a sand pit, and metallurgical slag heaps on the island. In the sand pit there developed a population of Marsh Helleborine (*Epipactis palustris* [L.] Crantz), which is included in rare and endangered species list of the Dnepropetrovsk region (Shennikov 1941). This fact suggests the possibility of turning disturbed land areas into usage for biodiversity conservation.

Yatsevo tract represents a typical natural ravine forest complex. It can be used as a model for the restoration of Predneprovsk arroyos ecosystems.

Today on the program of ecological network formation of Dnepropetrovsk region there are planned significant expanding objects of the nature reserve fund (Tab. 2).

Figure no. 1 Secondary soil forming on the delta islands at the mouth of the Dnieper river left tributary - the Samara River: a - topographic map M 1:100 000, based on survey materials from 1952-1954, 1958 and updated in 1990; b - space image Google-Earth of the survey of 06.05.2012 (the arrow indicates the area of secondary soil growth)

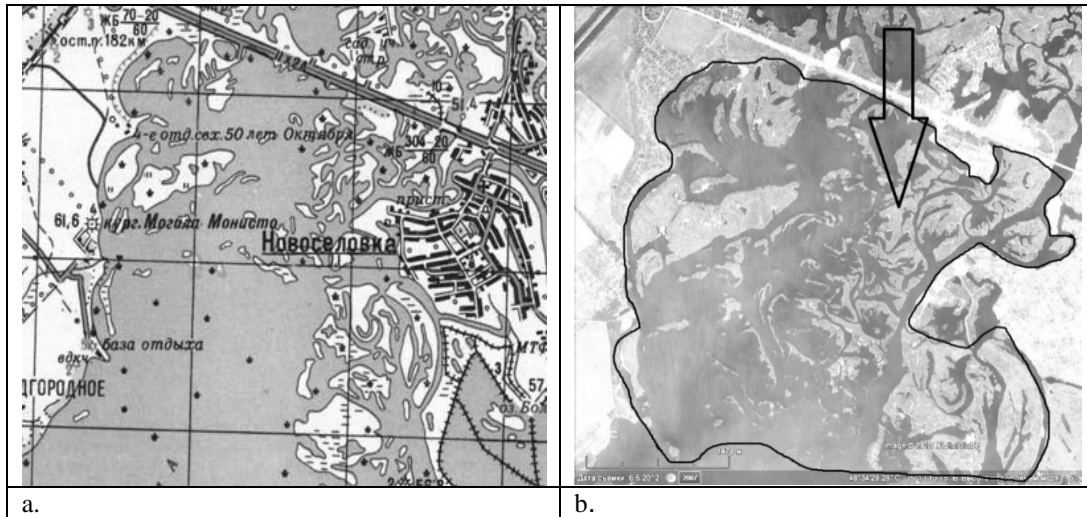


Table no. 1 Existing core areas on the Dnieper reservoirs territory

Name	Protected regime	Vegetation	ha
Dnieper-Orelskii nature reserve	Scientific nature reserve	Moderate flood-plain and arena forests, meadows, marshes	3766
Yatsevo tract	Refuge	Ravine forest	175
Granitnye skaly	Natural monument	Petrophytic steppe	4
Dneprovskie Lesa	Regional landscape park	Ravine forest	4438
Pridneprovskii	Regional landscape park	Petrophytic, steppe and forest ecosystems	4918
Total			13301

Table no. 2 Core territories which are planned to be created on the Dnieper reservoir territory

Name	Protected regime	Vegetation	ha
Lyubimovskie Beams	Refuge	Ravine forest	1000
Goryanovskie Lakes	Refuge	Meadow, solonets, wetland complexes	1000
Partizanskiy forest	Refuge	Pine forest, alkali-saline complexes	2500
Total			4 500

The abandoned granite quarries (Taromskii, Karnauhovskii, Rybatskii, Lyubimovskii, Starokodatskii and Kodachekskii), which are located on the

Dnieper River banks can be used to ensure the integrity of the Dnieper ecological corridor on the site of Dnieper reservoirs.

Their holding area can reach 450 ha (Skrypnyk et al. 2004).

The creation of the technological landscape reserve on the Starokodatskii mine territory has a particular interest (Belgard 1971; Kleopov 1990). Quarry goaf and overburden dumps require ecosystems' restoration.

Artificial nature of technogenic territory allows creating separate areas natural ecosystem restoration, agroecosystems, natural forests, steppes, exotic vegetation. Quarries provide great opportunities for vertical layout. Artificial landscapes may look like unique lowland areas.

In accordance with the growth conditions there can be implemented the reintroduction of rare species listed in the Red Book of Ukraine, rare and endangered plant list of Dnepropetrovsk region, which are common in the neighboring areas or at the border area.

In this way, significant possibilities for the core territories' development enjoy protection on the Zaporogskoe reservoir site, being spread throughout the neighbouring territory or situated on the areal border.

A radical solution to the problem of Dnepr-river floodplain biodiversity loss is the dismantling of the Dnepr-river cascade of reservoirs.

Conclusions:

To summarize it all we find it necessary to mention that:

- the building of the Dnieper river cascade of reservoirs has led to the actual destruction of the whole biome of long-term flooded ecosystems: forests, meadows and marshes. Thirty four plant communities from the Ukrainian Green Book have disappeared from the floodplain territory, the plant kingdom lost 14 species from the IUCN Red List of threatened species, 27 species from The European Red List, 14 species of the

Bern Convention and 84 species from Ukrainian Red List;

- secondary ecosystems are formed in condition under the adventives plant species complete dominance (Desert False Indigo - *Amorpha fruticosa*, Water Soldier - *Stratiotes aloides*) with actual displacement of the indigenous vegetable biodiversity;
- the community of secondary islands existed in the stringed amphibian conditions with evident dominance of Common Reed (*Phragmites australis*) and do not contribute to the increase of biodiversity;
- a radical solution to the problem of Dnepr-river floodplain biodiversity loss is the dismantling of the Dnepr-river cascade of reservoirs. Under the current conditions, it is necessary to expand the territorial system of the natural reserve fund and the ecological network for the biodiversity increase, involving lands disturbed by mining.

Rezumat:

BAZINELE ÎN CASCADĂ DE PE RÂUL NIPRU CA PRINCIPAL ARGUMENT PENTRU SCĂDEREA BIODIVERSITĂȚII

Articolul analizează problema distrugerii ecosistemelor din lunca inundabilă a Niprului ca urmare a creării a șase bazine în cascadă de-a lungul râului. Studii privind impactul acestor bazine asupra ecosistemelor și a biodiversității nu au fost realizate până în prezent. În acest sens, un scop real ar fi găsirea cauzelor care au provocat scăderea biodiversității pe teritoriul luncii inundabile a râului Nipru. Construirea bazinelor în cascadă pe râul Nipru a condus la actuala stare de distrugere pe termen lung a întregului biom al ecosistemelor inundabile: păduri, pajiști și bălți. 34 comunități de plante din Cartea Verde a Ucrainei au dispărut din lunca inundabilă. Din regnul

vegetal au dispărut 14 specii înscrise în Lista Roșie a speciilor amenințate IUCN, 27 de specii din Lista Roșie Europeană, 14 specii din Convenția de la Berna și 84 de specii din Lista Roșie a Ucrainei. Studiul indică faptul că ecosistemele secundare s-au format pe baza unor specii de plante adventive dominante (amorfa - *Amorpha fruticosa*, foarfeca-bălții - *Stratiotes aloides*), prin eliminarea biodiversității vegetale autohtone. Problema biodiversității din fosta luncă inundabilă a râului Nipru poate fi soluționată prin renunțarea la bazinele în cascadă. Astfel, este necesar să se extindă teritoriul rezervației naturale și rețeaua ecologică pentru creșterea biodiversității, implicând și terenurile deranjate prin minerit.

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