Optimization variations of valley-river landscape-technical systems of the Right Bank zone of Ukraine

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Abstract. The aim of the research was to develop areas for optimization of valley-river landscape-technical systems (LTchS) on the example of the model region – the Right Bank of Ukraine. The research was based on the materials of the long-term field observations which were carried out in the context of the studies of F.M. Milkov about anthropogenic landscapes. The use of expeditionary and stationary research techniques made it possible to receive the required material for the development of the optimization options of valley-river LTchS. Six options/practices for the optimization of valley-river LTchS on the example of the Right Bank zone of Ukraine are suggested. Option A does not envisage a control regained over landscape-technogenic systems (LTS); it can be used locally. Option B₁ is directed towards a partial restoration of the previous functions of the system and an episodic/occasional control over a technical block of LTS. Option B₂ implies a total change of the economic purpose of LTchS with the aim of recreation. Option B₃ consists in making a nature reserve of some landscape technogenic systems, in perspective the range/habitat of unique species of flora and fauna can be saved or restored on these territories. The restoration of a landscape-techno-genic system to the «operation» stage with previous functions is achieved when option C₁ is used. Option C₂ requires substantial capital investments, as it implies the creation of an absolutely new landscape-engineering system. For this option, projects have been developed to restore sections in the valleys of the Sob River (Gaisyn city, Vinnytsia region) and the Hirskyi Tikych River (Buky town, Cherkasy region). A layout of the optimized valley-river LTchS on the territory of the Right Bank of Ukraine was suggested. The conclusion has been made that the use of one of the suggested options will not help improve the condition of all valley-river landscape-technogenic systems of the model region. Each river valley requires an individual approach in which the combination of all the above-mentioned directions will be used. The valley-river landscapes optimized with help of the presented scheme will form the image of nature of a present-day European state which will favour the establishment of the concept of well-balanced development.

Key words: anthropogenic landscape, landscape-technical system, valley-river landscapes, river valley, optimization of landscapes.

Варіації оптимізації долинно-річкових ландшафтно-технічних систем Правобережної України

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Анотація. Кризовий стан багатьох долинно-річкових ландшафтно-технічних систем (ЛТчС) в Україні зумовлює потребу оптимізації таких ландшафтів. У більшості попередніх досліджень суть оптимізації долинно-річкових ландшафтів полягала у їх охороні та заповіданні, озелененні, рекультивації або використанні як рекреаційно-турісних об’єктів. З позиції
інженерного ландшафтознавства покращення стану ЛТчС не обмежується лише зазначеними напрямами. Зазначено, що в умовах дестабілізованого середовища варто звернутися увагу на ландшафтно-техногенні системи (ЛТС), які перебувають на стадії «руйнування» і становлять певну небезпеку для суміжних ландшафтів. Грунтуючись на попередніх дослідженнях, запропоновано шість варіантів оптимізації долинно-річкових ЛТчС на прикладі модельного регіону – Правобережної України. Варіант А не передбачає відновлення контроль над ландшафтно-техногенною системами його можна використовувати локально. Варіант Б, спрямований на часткове відновлення попередніх функцій системи і епізодичний контроль технічного блоку ЛТС. Варіант В змінює господарський спрямування ЛТчС і з метою рекреації. Варіант В3 полягає у наданні статусу об’єктів природно-заповідного фонду окремим ландшафтно-техногенним системам, на території яких у перспективі можна зберегти або відновити ареали унікальних видів флори і фауни. Відновлення ландшафтно-техногенної системи до стадії «функціонування» з попередніми функціями здійснюється при виборі варіанта С.

Ключові слова: антропогенний ландшафт, ландшафтно-технічна система, долинно-річкові ландшафти, річкова долина, оптимізація ландшафтів.

Introduction.

During many centuries river valleys were the places of «birth» for many civilizations (Egypt, Mesopotamia, India, China). Ukraine is no exception; ancient Rus settlements were built on «the rivers». The building of the engineering facilities (ETF) in the channels, floods, floodplain terraces and slopes led to a radical transformation of valley-river landscapes and to the formation of the complicated combinations of nature and engineering – landscape-technical systems (LTчS). In the process of scientific-technical progress valley-river landscape-technical systems improved, became useful for society and at the same time they damaged the environment. At present the dimensional organization and functioning of valley-river LTчS in most cases are controlled by man; however the unstable social-economic situation resulted in their self-destruction, some of them were included in the category of landscape-technogenic systems (LTS) and into the highly anthropogenic landscapes (VAL) (Denysyk, 1998; Lavryk, 2019). The intensification of the anthropogenic load in river valleys is determined by a high concentration of population and industrial facilities. Destructive actions on head waters cause negative geo-ecological consequences at the bottoms of the river valleys (Shevtsova, 2005). The critical condition of numerous valley-river LTчS in Ukraine determines the need to optimize such landscapes and emphasizes the relevance of this research.

A great number of scientific publications are devoted to the issue of working out the ways to rational use natural resources and to optimize landscapes. In most previous researches the optimization of valley-river landscapes consisted in their protection and turning them into nature reserves (Gudzevych, 2012; Denysyk, 1998; Milkov, Mikhno, 1987; Denysyk, Kanska, Kansky, 2016; Hayetsky, 2006; Sheiyag-Sosonko, Grodzinsky, Romanenko, 2004; Sarapatka, Mekotova, Sterba, 2005), planting (Yatsentiuk, 2004; Yatsentiuk, 2015), recultivation (Denysyk, Zadorozhnya, 2013; Denysyk, Kozymska, 2015) or use as recreation-tourist facilities (Volovyk, 2013; Volovyk, 2015), etc. Mainly geographers concentrate their attention on one of those directions for a certain class of landscape. And yet, valley-river landscapes are intra-zonal and cover extensive areas. It is not possible to apply only one way of optimization for a certain river valley. Nowadays insufficient attention is paid to the identification of the optimization options for valley-river landscape-technical systems and their combination within a river valley.

Materials and methods.

The research was based on the materials of the long-term field observations on the territory of the Right Bank zone of Ukraine which were carried out in the context of the studies conducted by F.M. Milkov on anthropogenic landscapes. The concept of geo-technical systems is at the center of the research on LTчS. Its main statements reveal the essence of the concept «a landscape-technical system» in the most optimal way. The working out of the ways to optimize existing and to form new ecologically safe LTчS, aimed at satisfying the needs of the generations to come, supplements the three-task concept of the well-balanced development. The use of expeditionary and stationary research techniques made it possible to receive the required material for the development of the optimization options of valley-river landscape-technical systems within the model region – the Right Bank zone of Ukraine.
Results and their analysis.

From the point of view of engineering landscape studies, the improvement of the LTS condition is not limited to the above-mentioned directions of optimization. Each landscape-technical system by its properties is a unique complex which performed or performs a certain economic function. If man creates an anthropogenic landscape, it has to be of use. The major task of a landscape-engineer is to find the ways of optimal use of LTchS in various spheres of the life of contemporary society. An ecological aspect is of importance as well: under certain conditions of the functioning, LTchS can optimally coexist with adjacent landscape complexes.

Landscape-engineering systems (LES) do not require an essential optimization as their condition is maintained on a stable level. The availability of a management block ensures the functioning of such systems, which makes them valuable for the national economy. In the current conditions of the destabilized environment it is expedient to pay attention to landscape-technogenic systems, where the management block is either lost or works occasionally. They are at the «destruction» stage (or they are in the transition from the stage of functioning to the stage of «destruction») and present a certain threat for adjacent landscapes. When this becomes evident, a specialist has to make the right decision (Fig. 1) concerning a further development of LTS.

Despite the fact that option A does not envisage a control regain over LTS, it can be used locally. In the forest-field zone (basins of the Dnipro, Dniestr and Pivdennyi Bug (Southern Bug) rivers) a great deal of mining LTS are concentrated in river valleys. These are abandoned quarries and dumps of waste rock where woody plants and shrubs grow intensively. Very frequently they turn into lakes flooded with underground waters. Locals (local residents) use them as recreation zones, pastures or scrap yards. To prevent a total degradation of landscape-technogenic systems, local self-government bodies should carry out explanatory work among the population on their rational use. Such activities can be carried out with the participation of landscape engineers – specialists who combine engineering and geography.

The application efficiency of option A is low and it can be a case for LTS, the use of which is planned in future.

Option B, is aimed at a partial restoration of the previous functions of the system and the occasional control over a technical LTS block for recreational purposes. The use of this option is the most optimal for residential LTS – historical-geographical centers of cities and towns. Within valley-river landscapes, they are the most numerous in the forest-pasture and forest-field zones. As a rule they were peculiar to some parts of river valleys, «convenient» for construction – channel islands, river meanders, high and steep slopes, etc. (Denysyk, 1998). The formation of such systems resulted from an architectural-cultural impact of the countries of Western Europe which used to occupy the territory of the Right Bank zone of Ukraine. In fact, in Kyiv city or in regional centers (Lviv, Lutsk, Rivne, Ternopil, Zhytomyr, Khmelnytskyi, Vinnytsia) the condition of these LTchS is under control, whereas in towns and district settlements a technical block...
keeps collapsing due to their suffering lack of finance as architectural monuments.

Rare monumental structures (fortresses and castles, Catholic churches and synagogues, tunnels and catacombs, monuments, gardens and parks), narrow streets paved with cobblestones, residential buildings with atlantes and caryatids – up till now they all «convey the atmosphere» of the epoch of XVI–XVIII centuries and create a cultural image of the present-day town LTchS. These systems include such towns as Halych, Zalischchyky, Khotyn, Mohyliv-Podilskyi, Yampil, Bilhorod-Dnistrovskyi in the valley of the Dniestr River; Chortkiv – Seret; Sataniv, Skala-Podilska – the Zbruch River; Kamianets-Podilskyi – the Smotrych River; Sharhorod – the Murasha River; Busk, Kaminanka-Buzka, Chervonohrad, Sokal – the Western Buh River; Izmali – the Danube River; Black Island, Medzhybizh, Letychiv, Khmilyusk, Bratslav – the Southern Buh River; Bar – the Riv River; Nemyriv – the Ustia River; Tulchyn – the Silnytsia River; Uman – the Umanka River; Volodymyr-Volynskyi – the Luha River, Beresteche – the Styr River; Iziaslav, Slavuta, Ostroh, Dubovytsia – the Horyn River; Starokostiantyniv, Novohet-Volynskyi – the Sluch River; Korosten – the Uzh River; Chudniv, Korostystysh, Radomyshl – the Teteriv River; Volodarka, Bila Tserkva, Rohytne, Bohuslav, Korun-Shevchenkivskyi, Stebliv – the Ros River; Chyhyryn – the Tiasmyn. The principles of the application of these LTchS consist in the need to control both their condition (as objects of architecture) and the adjacent areas where they are built. Not only the departments of the Ministry of Culture of Ukraine and city administrations but also all conscious residents of these settlements have to bear the responsibility for their preservation.

Option В₁ consists in changing some landscape-technogenic systems into nature reserves, and in future it will be possible to preserve or restore habitat of rare species of flora and fauna on these territories. It is advisable to apply this approach to dried peat bogs of the forest-pasture and the north of forest-field zones (the basins of the rivers Dnipro and Western Buh). This optimization implies a repeated waterlogging of degraded peat-hags. This technique was borrowed from Belarus, 70 % of its territory was dried in the second half of XX century. Since 2016 the processes of repeated water-logging of degraded peat-hags have been carried out. In recent years these measures have been taken on 15 territories, the total area of which is over 28 th. ha. (Otchet…, 2010). This work was done to prevent fires on previous peat bogs. Statistical data confirm that after repeated water-logging only one case of fire was recorded, whereas before it there were 5-15 fires per year (PS…, 2018).

Biological studies (Grichik, 2013) prove the efficiency of repeated water-logging which leads to the restoration of the population of numerous water-swamp species. In Ukraine the first attempts of repeated water-logging have already been made. In the framework of EU Project «ClimaEast: Preservation and stable use of peat bogs» (2013–2017), on the territory of Chernihiv region 2,800 ha of swamps of the ameliorative system «Smolianka» were restored and a regional landscape park «Nizhynskyi» covering an area of 6,100 ha was created (Kuprienko, 2017). The principles of such nature use are based on a minimal presence of a management block. However, its activity is exercised in the control over the preservation of
the peat bogs from outside effects rather than in the control over its restoration.

The restoration of a landscape-technogenic system to the «functioning» stage with previous functions is implemented when option \( C_1 \) is chosen. The condition of a technogenic cover is to be taken into account. It is not expedient economically to reconstruct LTS if the majority of technical elements do not meet the requirements of safety regulations. From the point of view of the national economy, drained ponds, waterlogged water bodies and small hydro-electric stations are the best for this optimization option. Their reconstruction and maintenance in a stable condition are aimed at fish farming and electricity production. On the territory of the Right Bank zone of Ukraine these LTS are mostly concentrated within the forest-field zone. Almost in every village ponds are at a transformational stage – from «functioning» to «destruction». Local renters bear all responsibility for the preservation of hydro-facilities but they do not always use pond LTchS rationally. Hence, engineers-landscape experts in team with the representatives of local authorities can coordinate the optimization work. In the conditions of the overregulation of a river flow, it is not advisable to use option \( C_1 \) for all ponds and water body LTS. Within continuous pond cascades it is necessary to create «interspaces», i.e., to remove some non-functioning LTchS (next option \( C_2 \)). This will partially increase the flow of rivers, improve the self-cleaning capacity of their waters and create conditions for the formation of new habitats of hydrophilic plants and animals.

Small hydroelectric stations, which were actively built on the rivers of Ukraine in the second half of XX century, must get the right for «a new life». Their reconstruction and updated equipment will provide several adjacent settlements with cheap electric power. The experience of such countries as Germany, China, France and Japan proves the efficiency of the use of small scale electric power. One of the ways of its restoration is the combination of energy equipment as was done in 2011-2012 on the territory of Slobo-do-Bushanska HES. An above-ground solar electric station was installed in the channel of the Murafa River (on the island which was formed as a result of laying a derivation channel). Total power of electric energy produced by the electric station is 1.875 Mwt (Sonachna…., 2018). The following hydroelectric stations have a very good potential for the reconstruction and introduction into operation: Medzhybizhskaya HES, Tytrivska HES, Sokiletska HES in the valley of the Southern Buh River; Pavlivska HES – the Sob River; Butska HES – the Hirskyi Tikych River; Horodysh-

chenska HES – the Zhar River; Bereizivska HES – the Murasha River; Volodivska HES, Sainska HES – the Murafa River; Klembtivska, Pysarivska HES – the Rusava River; Zadarivska HES – the Zolota Lypa; Plotytska HES – the Strypa River; Chervonohradskaya HES – the Dzhuryn River; Rozsohivska HES – the Uzh River; Shvaikivska HES – the Hnylopiat River.

The consideration of the principles of a landscape design in the process of the restoration of hydro-energy LTchS will enable their polyfunctional use. The constructions in the form of interesting images (geoglyphs) (Fig. 2) and planted ornamental plants on the slopes of terraced areas will help create a cultural landscape. This will prevent the development of negative slope processes and the siltation of water reservoirs with deluvial deposits. In addition to energy, fish farming and recreation purposes, hydro-energy LTchS will have an aesthetic function. During a spring-autumn season the tourists, who are fond of open air routes, will have a chance to watch the change of images and a colour scheme within LTchS. On the basis of such optimization it is expedient to form cultural landscapes in river valleys.

Option \( C_2 \) requires serious capital investments, as it envisages the creation of an absolutely new landscape-engineering system. This can be done on the basis of both highly anthropogenic landscapes and the landscape-technogenic systems in all areas of the Right Bank zone of Ukraine. River valleys which are not used rationally in the national economy have to be rearranged for other needs. They will play a role of a «foundation» for the construction of LTchS, the functions of which will become more efficient for nature and the population of a corresponding region. The project of the restoration of the valley of the Sob River in Haisyn city, Vinnytsia region under the name «Solar flood» was suggested as one of the ways of optimizing agricultural landscapes (Berchak, Lavryk, 2018).

Some landscape-technogenic systems require a purposeful transformation into anthropogenic landscapes. There is no need to wait until a block system passes the stage «destruction» and starts functioning as a geo-component system. Waterlogged channels and ponds, ruined dams and hurdles, remains of the walls of former ETS, which cannot be saved, have to be dismantled. Former quarries and dumps of waste rock will be re-cultivated and this will optimize a transformed relief to a great extent. To a certain degree this is the re-naturalization of a valley-river landscape, when an anthropogenic landscape obtains some features of a natural one through a thorough restoration of the condition of separate geo-components.
In the USA, Canada and Australia the term «river recreation» has a long life (Wollmuth, Schomaker, Merriam, 1985) – this is a river valley, in the riverbed of which landscape complexes aimed at the creation of a recreation-tourist culture were designed. A relief of flood is leveled, grasses are sown, lawns are mowed, bushes and trees are pruned, beach areas are cleaned. There are analogues of footpath-camp meadows – encampment lawns and recreation areas. For a river valley to bring profit, it has to be used for water tourism, amateur fishing and walking. In practice this idea can be implemented in the valleys of transformed small rivers. In future «a recreation river», rather than cascades of waterlogged ponds and water reservoirs, is to become a connecting link between residential LTchS of the Right Bank zone of Ukraine.

To use just one of the suggested options will not assist in improving the condition of all valley-river landscape-techno-genic systems of a model region. Each river valley requires an individual approach which will combine all the described options (Table 1). Conclusions.
Table 1. Combination of the options of LTchS development and its optimization within one river valley

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Explanation to Table 1: Correlation of the variations of LTchS development and its optimization

- optimal
- admissible
- not recommended

Fig. 3. Layout of optimized valley-river LTchS of the Right bank zone of Ukraine

Natural landscapes. I. Mixed conifer-deciduous forest landscapes: 1 – sandy terraces, hilly-wavy, with sod-light-opodzolic sandy soils, mostly in pine forests; 2 – sandy terraces, flat-wavy and hilly, with sod-slight-and-medium opodzolic sandy soils, under island pine forests and sub-pine forests, with low swamps. II. Deciduous forest landscapes: 3 – high Dnister terraces with opodzolic chernozem and dark-grey forest soils, island oak woods; 4 – high Dnister terraces, divided by valleys, cut into palaeozoic deposits, with grey and dark-grey opodzolic forest soils, deep chernozem, hornbeam woods. III. Forest-steppe landscapes: 5 – high Dnister terraces, divided by valleys, cut into crystalline rocks, with grey and dark-grey opodzolic soils, island oak-hornbeam woods; 6 – sandy terraces with sod-opodzolic soils, with hornbeam sub-pine forests. IV. Steppe landscapes: 7 – sandy terraces with sod soils in combination with meadow saline soils, with meadow-like pine woods and sub-pine forests; 8 – loess terraces, with southern low-humus chernozem together with saline soils, under fescue-feather-grass vegetation in the past. River landscapes of the plains: 9 – channels, formed by aqua plots of overflows and deep places; 10 – forest and meadow-swamp floods; 11 – forest, meadow-steppe saline floods; 12 – flood-plains, meadow-steppe saline floods.

Anthropogenic zones: 13 – forest-pasture; 14 – forest-field; 15 – field.

Optimization options of valley-river LTchS. Option A: 16 – non-operational quarries and dumps of waste rocks; 17 – unique underground adits; 18 – military-fortification complexes (defensive bulwark, trenches); 19 – drained ponds; 20 – waterlogged chan-
The valley-river landscapes optimized by this scheme will create the image of the nature of a modern European country which in turn will favour the establishment of the concept of the well-balanced development. Based on the ideas of this paper (Berchak, Lavryk, 2018; Lavryk, 2019; Lavryk, Tsymbaliuk, 2018), we suggest the following implementation of the options of a rational use of valley-river landscape-technogenic systems, taking a model region – the Right Bank of Ukraine as an example (Fig. 3).

The experience of such work is the basis for conducting similar studies in river valleys of other regions of Ukraine. Maps of valley-river landscape-technical systems can be used by public authorities in the field of environmental protection and implementation of the provisions of the Association Agreement between Ukraine and the European Union.

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