Taking into account regional environmental conditions in the functioning of road landscape-engineering systems

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Abstract. We analyzed the effects of regional and local natural conditions on the process of construction and functioning of road landscape-engineering systems (RLES) – modern actively developing operating roads with the required infrastructure. It has been reported that compared with other anthropogenic landscapes, those of roads do not receive sufficient attention from environmental geographers and landscape scientists, especially regarding the impact of regional and local nature conditions on their functioning. On the example of a region, which is specific according to natural conditions and landscape structure – Podillia, we analyzed three natural factors that significantly affect the functioning of RLES in the region, particularly the manifestation of unfavourable processes in them. These factors include broad distribution (72% of the territory of Podillia) and thick layers of loess rocks (up to 5-7 metres), high differentiation of the surface and cloudburst pattern of atmospheric precipitations. Those factors create preconditions for the development of unfavourable processes in the RLES, especially if this is aggravated by poor planning of their construction and irrational exploitation of RLES of Podillia. In more details, it was analyzed in two natural areas of actively functioning road landscape-engineer systems: Khmelnytsky-Vinnytsia (outskirts of Yakyshyntsi village) and Vinnytsia-Uman (outskirts of Voronovytsia town). We should note that the impact of local peculiarities of the natural conditions and unfavourable processes they had caused often depend on confinement of the RLES to two of the most dynamic types of landscape in Podillia – slopes and floodplains. Manifestation of local peculiarities of natural conditions and landscape complexes was analyzed on the example of Podillia`s commonest slope-type habitats – ravine tracts that intersect the road landscape-engineer systems. The paper demonstrates that regional and local peculiarities of natural conditions of Podillia and their impact on the functioning of road landscape-engineering systems should be considered against the background of expression of zonal natural factors and current conditions of the development of society. Taking into account regional and local natural peculiarities in the process of construction and functioning of RLES is one of the realistic ways to ensure long and safe rational exploitation.

Key words: *automobile road landscapes, Podillia, local, local nature conditions, road microcenters, unfavourable processes, rational functioning*

Врахування регіональних природних умов у функціонуванні дорожніх ландшафтно-інженерних систем

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Анотація. Розглянуто вплив регіональних і локальних природних умов на процес розбудови і функціонування дорожніх ландшафтно-інженерних систем (ДЛІС) – сучасних активно діючих автомобільних доріг з належною їм інфраструктурою. Зазначено, що у порівнянні з іншими антропогенними, дорожнім ландшафтам, географи-природничники й ландшафтознавці не приділяють належної уваги, особливо це стосується впливу регіональних і локальних природних умов на їх функціонування. На прикладі своєрідного за природними умовами і ландшафтною структурою регіону – Поділля, розглянуто три природних чинника, які суттєво впливають на функціонування ДЛІС регіону, зокрема й прояв в них несприятливих процесів. Серед цих чинників – широке розповсюдження (72% території Поділля) і значні товщі лесових порід (до 5-7 м), висотна диференціація поверхні та зливовий характер атмосферних опадів. Ці чинники створюють передумови для розвитку несприятливих процесів у ДЛІС, особливо якщо вони підсилюються необгрунтованою їх розбудовою і нераціональною експлуатацією ДЛІС Поділля. Детальніше це розглянуто на двох натурних ділянках активно функціонуючих дорожніх ландшафтно-інженерних систем:

Хмельницький-Вінниця (околиці с. Якушинці) й Вінниця-Умань (околиці містечка Вороновиця). Зазначено, що вплив локальних особливостей природних умов та зумовлених ними несприятливих процесів часто залежить від приуроченості ДЛІС до двох найдинамічніших типів місцевостей Поділля – схилового і заплавного. Прояв локальних особливостей природних умов і ландшафтних комплексів розглянуто на прикладі найбільш розповсюджених у межах Поділля схилового типу місцевостей – урочищ балок, які перетинають дорожні ландшафтно-інженерні системи. Показано, що як регіональні, так і локальні особливості природних умов Поділля та їх вплив на функціонування дорожніх ландшафтно-інженерних систем необхідно розглядати на фоні прояву зональних природних чинників та сучасних умов розвитку суспільства. Врахування регіональних і локальних природних особливостей у процесі розбудови та функціонування ДЛІС – один із реальних шляхів їх тривалого і безпечного раціонального використання.

Ключові слова: дорожні ландшафти, дорожні ландшафтно-інженерні системи, Поділля, регіональні природні умови, дорожні мікроосередки, несприятливі процеси, раціональне функціонування

Introduction

Together with the residential areas, road landscapes develop a specific carcass of anthropogenic landscapes of any territory. Without roads and proper infrastructure (road landscapes), the development of contemporary economics is impossible: "*…cities plus road network is a carcass, on the basis of which everything stands* " (Baranskyi, 1960). In the early XXI century, the problem of the development and functioning of road landscapes is one of the most relevant.

Road landscapes are complex and dynamic nature-economic systems. In their structure, the essential element is the road landscape-engineering system (RLES). It is a three-block (nature, technology, management) system, in the study of which environmental geographers and landscape scientists are not actively involved. It is especially relevant concerning the effects of regional and local conditions on the process of construction and further rational use of road landscape-engineer systems. It would be practical to survey the local specifics of the development of unfavourable environmental (nature, nature-anthropogenic, anthropogenic) processes in the RLES of Podillia in separate areas of the exploited road system, where they manifest most actively. Taking into account regional and local peculiarities of functioning of the nature block of road landscape-engineering systems allows development of real measures for preventing the manifestation of unfavourable processes and ensuring the rational exploitation of RLES in any region of Ukraine.

Therefore, the ***objective*** of the study was substantiation of the necessity of taking into account the impact of regional and local natural factors that form preconditions for the development of unfavourable environmental (nature, nature-anthropogenic, anthropogenic) processes in the functioning of road landscape-engineering systems.

Materials and methods

While writing the article, we used the materials of our own field landscape surveys conducted during 2017-2020 on 8 natural plots along the Vinnytsia-Khmelnytsky and Vinnytsia-Uman highways. Cartographic models of these two plots are presented in the article. The studies also involved the results of analyses of the projects of construction of these highways in 1998–2001 and 2016–2017 and materials from Vinnytsia Oblast Archive.

The research we carried out is based on the methods of environmental and constructive geography, anthropogenic landscape science, landscape ecology, using the methods of systemic approach, structural analysis and synthesis, comparative-geographic method, cartographic and graph-analytical visualization of the results.

Analysis of previous research

The first to note the road landscapes and distinguish them as a separate class of anthropogenic landscapes was F. M. Mylkov (Mylkov, 1973), though without the analysis of the structural organization of road landscapes. This was carried out later in research on road landscapes (Denysyk, 2005; Voloshyn, 2009; Valchuk-Orkusha; 2010;), particularly in the process of studying the general peculiarities of formation and development of road landscapes, their structure, classification and ecological impact on the environment. More attention to RLES was paid by geochemists and ecologists (Denysyk, 2005; Voloshyn, 2009;Vanchura, 2011; Halahan, 2014). This is due to the fact that geochemical and ecological results of operation of active highways have the greatest impact on adjacent territories and health of the population (Denysyk, 2005; Voloshyn, 2009). Regional and local peculiarities of nature conditions and landscape structure and their role in construction and operation of road landscapes have not been considered in the available researches, though manifestations of unfavourable processes caused by their specifics are mentioned (Denysyk, 2001; Valchuk-Orkusha, 2010; Vanchura, 2011). These processes manifest most actively in currently functioning road landscape-engineering systems, including the ones in Podillia, where one of the densest network of roads (road landscapes) in Ukraine has been developed.

Results and research

To thoroughly research the current road landscapes, it is practical to distinguish three components in their structure: the abovementioned road landscape-engineering system (RLES), road landscape-technogenic systems (RLTS), which are former RLES without a management block, and specifically road landscapes (SRL) – decommissioned RLES and RLTS (Denysyk, 2005). Against the background of zonal landscapes, these structures manifest in different ways (Table).

Table. Structural zonality of road landscapes

Class of anthropogenic landscapes	Structural constituents	Zonality
Road landscapes	Road landscape-engineer systems	Azonal
	Road landscape-technogenic systems	Zonal-azonal
	Specifically road landscapes	Zonal

From the distinguished constituents of road landscapes, the one having the greatest importance in their current functioning and further development is road landscape-engineer systems. The surveys of RLES need to be given a special attention due to active development of social-economic processes in Ukraine, particularly unification of roads (road landscapes) of Ukraine and West Europe and the beginning of construction of the European transport corridors within our country. This will cause significant changes in the structure and specifics of functioning of the existing road landscape-engineering systems, and also notably alter their effects on the adjacent landscapes and health of the population of the regions of construction.

However, geographic and landscape-study analytical review of the literature-cartographic sources concerning the contemporary construction and functioning of landscape-engineering systems over the past 20 years demonstrates that road experts mainly focus on the engineer-construction requirements and safety (Denysyk H.I., 2005, Voloshyn I.M. 2009). At the same time, practically no attention was paid to the regional specifics of the natural conditions and landscape structures of the construction sites and further functioning of the RLEC. For this purpose, to prevent the manifestation and development of negative processes in the road landscape-engineer systems, it is necessary to take into account regional specifics of the environment and the pattern of impact on the further development of the RLEC of each geocomponent and landscape complex. We shall analyze it in more details on the example of Podillia – a region that is distinct in Ukraine for specific environmental conditions and landscape structure (Denysyk, 2001; Denysyk, 2014).

Among the natural factors that stimulated in the past, influence now and will influence in the future the development of negative processes and phenomena in the processes in the operation of the RLEC in Podillia, the main three are:

- *broad distribution of thick layers of loess rocks.* Loess (German, *Löss*) is defined as a continental sedimentary rock with distinct light and pale-yellow colour, high porosity (40-55%), domination of dusty (0.01-0.05 mm) fractions, represented by micro-aggregations, carbonate content, presence of visible vertical capillaries, hidden horizontal lamination, ability to develop columnar jointing in dry condition (cliffs in the conditions of natural bedding). This definition lacks one trait and has one inaccuracy. It does not indicate that loess (loess-like rocks) are easily washed out and driven by the water current, and in general quickly change their properties under the effect of water. The inaccuracy is that in natural condition, neither cliffs nor gullies, develop in loess and other loess-like rocks.

According to the conditions of bedding, completeness of the section and physical-mechanical properties, two zones are distinguished; the zone of beyond-the-glacial loess and zone of loess of the Dnipro glacial current. Most part (94-96 %) of the territory of Podillia is in the zone beyond the glacial. The conditions of bedding of entire loess layer in the interfluves, slopes and high terraces in the region were mainly affected by the neotectonic regime of certain areas and stratification of the terrain. Spatially, loess is distributed in Podillia unevenly; the horizons are characterized by unevenness and varying thickness, dominated by areas with insignificant (5-10 m, rarer 15 cm) covering. Notably, the initial loess layers have developed a subhorizontal slightly wavy terrain surface. Gullies and ravines and their erosive-denudation forms have so far been recorded neither on this surface, nor in the paleolandscapes (Melnychuk, 2004; Kunytsia, 2007).

That is, despite the property of loess and loess-like rocks to be easily washed out by water current in natural conditions, no erosive forms, particularly furrows and gullies have been recorded in the area of loess distribution. The researches by the above-mentioned authors focused on Quaternary deposits, in particular loess and loess-like rocks, paleorelief and paleolandscapes, and include no characteristics of paleo-gullies and paleo-ravines. The impossibility of their development in the natural conditions, and therefore their absence, were confirmed by the results of modeling this process (Denysyk, 2001). Therefore, all ditches, gullies, ravines and upper reaches of the river valleys in loess rocks, which have intersected or will run across the RLES during the construction, have anthropogenic origin. In the conditions of the contemporary Forest-Field of Ukraine, they are mostly unstable, dynamic, and the various processes and phenomena within their boundaries are not always possible to predict. If in the process of construction of the RLES, these anthropogenic forms of terrain are unavoidable or present in the structure of road landscape-engineering systems already, they need to be listed in the cadastre. Thus, in the future, possible scenarios of the development may be composed taking into account the specifics of loess rocks. Measures of prevention or liquidation of deleterious process and phenomena, which may affect the stable functioning of the RLES within Podillia, should be made according to these scenarios;

- *Height of differentiation of the surface*. This needs to be taken into account when calculating the parameters of horizontal and vertical division of the surface the RLEC, steepness of slopes, etc. Around 80% of the Ukraine`s territory has average vertical dimension of the surface ranging 10 to 70 m. In the plains part, the greatest differentiation of the surface is characteristic of the Forest-Field within the Podillia, Cisdniester, Poltava and Central Russian Uplands (Denysyk, 2001). In Podillia, these territories lie in the Dniester Canyon (Middle Prydnistrovie), Podilske low-hill uplands and the Kremenets Mountains, Podilski Tovtry and partially Opillia. Particularly, the height dimension of the canyon-like part of the Dniester basin within Podillia is 100-120 to 200-220 m. This is the so-called Middle Dniester “Low Hill Terrain” (Nuzkohiria). There, and also in the previously mentioned territories, the RLES are characterized by numerous road serpentines, supporting walls, bridges, ditches and embankments, etc. Those dynamic structures and possibility of manifestations of unfavourable processes they cause affecting the early stages of the construction of the RLES are being taken into account partially. However, functioning and development of road landscape-engineering systems of Podillia and their optimization in the future taking into account height differentiation of the territory have not been planned. Moreover, for the further exploitation of the RLES (repair of roadbed, construction of roadside windbreaks, infrastructure, liquidation of unfavourable processes, etc), the same costs are allocated for the areas of Podilllia Prydnistrovie with low hills and the level Middle Pobuzhia, Podilski Tovtry and the Kremenets Mountains and the flat Central Podillia. It is not surprising that the roads within the territories with low hills are in catastrophic condition, and in the plains areas – in more or less normal condition even during current social-economic problems. Such an approach to financing the construction of the RLES needs to be reconsidered. This is especially relevant for local communities.

- *cloudburst pattern of atmospheric precipitations*. This characteristic of atmospheric precipitations in Poddilia is mentioned only when it is manifested significantly, or even catastrophically. Taking into account the significant height differentiation of the surface in some areas of Podillia and the region’s almost complete covering with loess rocks that are sensitive to moisture, rainfall pattern of atmospheric precipitations has a great impact on the functioning of road landscape-engineering systems of Podillia, contributing to development of unfavourable processes within their borders.

Precipitations falling on Podillia measure more (650-550 mm) than the zonal norm (550-500 mm). Their distribution is affected not only by the significant length of the territory from west to east, but the high differentiation of the surface. In particular, on non-weathered slopes of the Podilska and the Prydniprovska Uplands, the precipitations account for 15-20% more than in the rest of the territory (Denysyk, 2014). The main amount of precipitations (75-85%) of the annual sum within Podillia falls over the warm period – April to October. They are often accompanied by thunderstorms and have a cloudburst pattern. On average, 25 to 35 thunderstorms occur in Podillia annually, lasting 72-80 hours in total. Usually, thunderstorms are accompanied by wind squalls rainfall, often with hail. Most thunderstorms with cloudbursts occur in Podillia in June-July. Each thunderstorm lasts on average three hours. From May to July, 10-14 days with thunderstorms take place every month, often accompanied by cloudbursts. Cloudburst pattern of atmospheric precipitations within Podillia has not been taken into account in any of the construction projects of the RLES and their further use. Such an addition needs to be made, for great sums are allocated for the liquidation of unfavourable processes in the RLES of Vinnytsia-Mohyliv-Podilsky (120 km) caused by cloudburst precipitations.

The characterised natural indicators – height differentiation of the surface, presence of loess cover, which is easily washed by away by streams of water and the flood inducing character of atmospheric precipitation create only a precondition for the appearance and development of unfavorable processes in the construction and functioning of RLES in Podillia. For their active development a push is necessary. Such a push is ill thought-out or wrongly projected activity of people in the process of construction and further usage of RLES. The total effect of these indicators sometimes leads to partial reconstruction, rebuilding or relocation of separate RLES sites, which requires considerable expenditure of time and finance. We shall look at this in detail on the example of a section of the Vinnitsa-Uman highway on the outskirts of the town Voronovytsya (Fig. 1).

In this area, construction of the RLES started in the second half of the XIX century without taking into account the regional environmental conditions and landscape structure. This has led to gradual deterioration of the road, even after its numerous reconstructions over the first half of the XX century. In the late 1990s, a critically damaged area of the highway was abandoned, and the road was constructed closer to the water divide, but the upper part of the ravine was damaged in the process, and no drainage was made in the road embankment that intersected the ravine. A swamp is gradually forming , which with time will develop into a roadside water body. In the road embankment of the ravine, shift-caused fractures can be seen.

A distinctive feature of the road landscape, especially its microrelief, is a combination of a straight-line, leveled out roadbed and micro-environments of anthropogenic ditches (measuring in depth 1-2 to 5-8 meters and more meters, with width at the foot ranging 3 to 30 m, and up to 50 and more m in the upper part, the steepness of the slopes ranges 3-5 to 45-60°, sometimes with straight walls) and embankments (0.5-1 to 6-8m and more high, 20-30 m wide at the foot, the steepness of the slopes in the upper part, depending on the road width, is up to 60°). Only on the Khmelnytsky-Vinnytsia highway, at the distance of 120 km, in 2006, we recorded 67 ditches ranging in depth 1.5 to 7 m and 72 embankments 1 to 6 m high. In total, they accounted for 12 percent of the road landscape and notably designated in its structure (Valchuk-Orkusha, 2010).

Ditches and embankments are the most dynamic micro-environments in the structure of the road landscapes of Podillia. This is not related exclusively to their internal dynamic potential, but also to paradynamic interrelations with the adjacent landscape complexes. The intensely developing unfavourable processes in the area are shift, landslips, taluses, sometimes collapses and faults. To reduce the actions of these processes as micro-environments, particularly their slopes, they are being fixated using piles, drainage systems are made, as well as stone and wooden support walls and water drainages. Micro-environments of the ditches and embankment are specific local landscape-engineering systems, where the development of unfavourable processes is regulated by humans (Valchuk-Orkusha, 2010).

The intense dynamics in the structure of the road landscapes of Podillia causes aquatic, aquatic-marshy and marshy micro-environments, untypical for the region, of 0.02 – 0.05 ha area. Without drainage, the aquatic-marshy roadside micro-environments enlarge in the areas in spring and autumn, sometimes leading to activation of undesired processes in the road embankments and ruination of the roadbed. Most often, this manifests in activation of unfavourable processes in places where the road crosses the ravines and hollows of the drainage. On the Vinnytsia-Khmelnytsky highway, on the outskirts of Yakushyntsi village, the shifting processes are being activated particularly because of the aquatic-marshy micro-environments on the roadbed (around 260 m). Fractures and micro-terraces emerge, which are constantly being repaired by construction workers. On the slopes of the road embankment, the shifting processes are clearly notable. Gradually, a shifting micro-environment is becoming distinguished in the roadbed. Its liquidation is impossible without draining the aquatic-marshy micro-environment and stabilizing the erosive-accumulative processes that take place in the ravine the road intersects (Fig. 2).

Taking into account regional and local environmental conditions of the functioning of the road landscape-engineering systems is also necessary for rational construction and further effective operation of their infrastructure. This is especially relevant for green spaces, particularly the roadside windbreaks. Creation of them should be made taking into account the specifics of further self-development depending on existing regional and local properties of the environmental conditions. This is more relevant for outer sides of the roadside windbreaks. Inner (roadside) sides are mostly being controlled by humans and are maintained in the required condition (sporadic cuttings, cleaning, new plantations, etc); while the outer ones develop separately under the effect of the landscapes (agricultural field and meadow-pasture, residential, industrial) they adjoin. Within Podillia, the roadside windbreaks

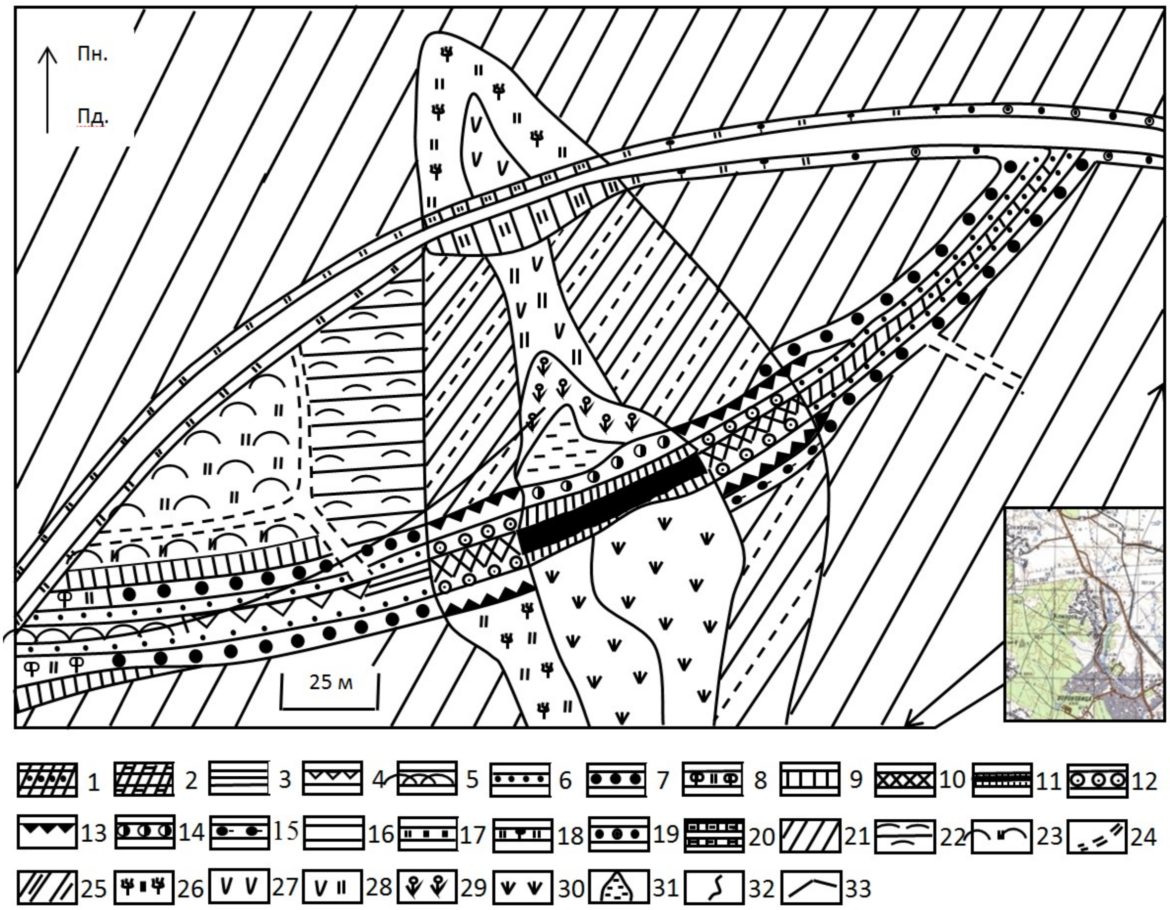

Fig. 1. Impact of regional environmental conditions on construction of RLES in the outskirts of Voronovytsia town in Vinnytsia Oblast

Road landscapes. Specifically road landscapes. Water-divide. Abandoned road site. Complex road tract. Tracts: 1 – asphalted, on low embankment (0.5-0.7 m), 5-6 m wide road, abandoned, with fractures and, partially, ruderal vegetation,; 2 – road on clayey-loam-gravel embankment of up to 0.7 m height, 7 m wide, without road surface, partly covered by turf composed of forbs; 3 – road on clayey-loamy embankment of 0.5 – 0.7 m, up to 8 – 9 m wide, partly covered by turf of forbs, sometimes used for a passage by people engaged in recreation; 4 – remains of road embankment with loess-like loams of 0.7 – 1 m high, and up to 8 m in width, with separate ditches (0.2 – 0.3 m), covered by turf of weeds and forbs; 5 – entirely covered by turf of forbs and grasses, the road embankment with loess-like loams, 2.5 – 2.7 m high, and up to 7 – 8 m wide; 6 – shallow (to 1 m) roadside ditches covered by turf and overgrown by shrubs; 7 – roadside windbreaks of small-leaved lime (*Tilia cordata*) aged 200 – 300 years on dark grey loess soils; 8 – solitarily growing centennial (200 – 300 years) trees of small-leaved lime and common oak (*Quercus pedunculata*) in the roadside windbreaks on dark grey eroded soils; 9 – steep (up to 35 - 40º) slopes of road embankment, composed of loess-like loam and covered by turf of forbs. Slope-ravine. Tracts: 10 – sloping (6 - 8º) road embankments of 0.3 – 0.5 m height, 6 – 7 m width, partially eroded and covered by turf of grasses and weeds; 11 – remains of swamped road of 3 – 4 m width with loess-like loams of dam of 10 m width in the foot with eroded slopes, partially covered by turf of weeds; 12 – shallow (0.5 – 0.6 m), up to 1.5 – 2 m wide roadside ditches, covered entirely by weeds and forbs and shrubs of box elder (*Acer negundo*), silver poplar (*Populus alba*), common sallow (*Salix cinerea*), rose (*Rosa*) and Siberian dogwood (*Swida opiz*); 13 – steep (up to 80º) cliffs of loess-like loams, taluses and single trees of small-leaved lime, poplar (*Populus*) and black locust (*Robinia pseudoacacia*); 14 – hilly turf-covered surface composed of embankment loess rocks, with old (up to 60 – 70 years) poplars and limes (*Tilia*); 15 – sloping loess surface of the ravine with old (up to 200 years) planted limes on the roadside.

Road landscape-engineer systems. Water-divide. Tracts: 16 – asphalt-concrete road, of up to 10 m width, on low embankment (0.7 – 1.2 m), composed of crushed granite stones and sand, with steep (up to 35º) slopes covered by turf; 17 – roadside water-divide ditches of up to 1 m depth and up to 1.5 - 2 m width, covered by turf of forbs and grasses; 18 – young (up to 10 years) roadside windbreaks composed of small-leaved lime and common hornbeam (*Carpinus betulus*); 19 – centennial (up to 300 years) two-row roadside windbreaks of small-leaved lime.

Ravine. Tracts: 20 – asphalt-concrete highway up to 12 m wide, on clayey-gravel-sandy embankment, 6 – 8 m high, with steep (to 35º) eroded slopes, partially covered by turf of ruderal vegetation.

Agricultural landscapes. Field. Water-divide. Tracts: 21 – levelled ploughed surfaces with dark grey loess soils under crop rotation of grain crops; 22 – low-hill surfaces of fallow dark grey, partially covered by turf, soils; 23 – low-hill, sloping, turf-covered dark grey soils for grazing; 24 – field roads of up to 4 – 5 m width. Ravine. Tracts: 25 – sloping (up to 10 - 12º) loess slopes of ravines with weakly eroded dark grey loess soils under agricultural crops; 26 – sloping (8 - 10º) loess slopes of the ravine with dark grey soils, covered by grasses and shrubs of black locust, dog rose, hawthorn (Crataegus); 27 – levelled moistened bed of the ravine with marsh vegetation (*Carex*) for haymaking; 28 – sloping (6 - 8º) moistened bed of the ravine with meadow-marsh soils under forbs and Carex vegetation for haymaking; 29 – sloping (2 - 3º) over moistened surface of the bed of the ravine overgrown with reed thickets; 30 – levelled moistened bed of the ravine occupied by marsh vegetation; 31 – supporting (road) of the water body of 0.1 ha area, up to 1.5 m depth, partially silted; 32 – the upper reach of nameless tributary of the Voronka River, up to 0.5 m wide, 0.3 – 0.4 m deep, silted.

Other signs: 33 – borders of the landscape complexes.

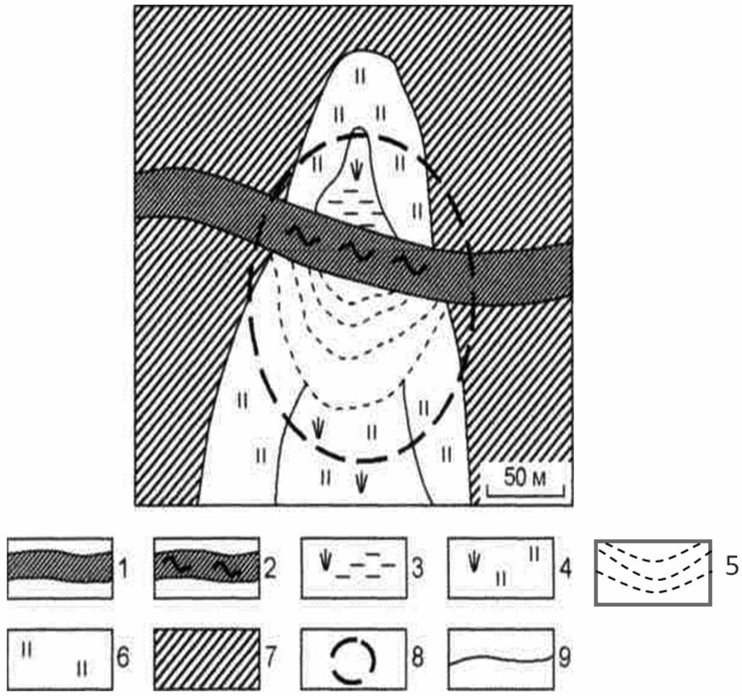

Fig. 2. Impact of local natural conditions on the construction of the RLES in the outskirts of Yakushyntsi village of Vinnytsia Oblast

1 – causeway, up to 1.0 m high, asphalt road is 8-10 m wide, on the water-divide; 2 – causeway within the ravine, with length-wise fractures in the asphalt and signs of shifts; 3 – swamped water-divide in the bed of the upper reach of the ravine, to 1.5 m deep, developed as a result of backwater caused by the road embankment; 4 – moistened bed of the ravine with meadow soils under forbs and marshy vegetation; 5 – shifting slopes of the road embankment with loess-like loams and ruderal vegetation; 6 - steep (to 25°) loess slopes of the ravine, with washed out grey loess soils under meadow forbs; 7 – ploughed loess water-divides with grey loess soils under agricultural crop rotations. Borders: 8 – shifted road micro-environment; 9 - tract.

most often interact with agricultural landscapes, particularly field ones. In such places, the transition from roadside windbreak to the field is contrast, resembling a “wall”. If such sharp outer borders of the roadside windbreaks are not taken care of, they begin to gradually alter. A prototype of forest strip develops. Snowdrifts on such borders increase moisture and alkalinization of soil, which in turn creates better conditions for growth of woody plants, especially shrubs. The development of near-forest area on the outer borders of the roadside windbreaks occurs naturally, and should not only be supported, but also encouraged, and developed (Denysyk, 2005). This is not only a natural transition of roadside windbreaks to other landscape complexes. Such “transitional near-forest areas” are the most practical and ecologically favourable part of the windbreaks for establishing numerous modern temporary places of recreation, various shashlik places, cafes, kiosks and even small markets and camping sites. The central part of the roadside windbreak would well protect them against the harmful influence of the road. Currently, all the existing objects of auto-service are located and being built in the most polluted inner (roadside) part of the protective plantations.

Properly created roadside green belts normalize, and in some cases completely suspend the development of undesired geological-geomorphological, hydroclimatic and biogeochemical processes. At the same time, manifestations of some undesired processes require additional measures to be taken. Analysis of the condition of current roadside landscapes shows that such measures have been mostly planned quite professionally, but not implemented in the processes of creation of road landscapes and their operation. Technogenic (terrace embankments and cut slopes, steep slopes of ditches and embankments, abandoned quarries, etc) tracts and engineering (supporting walls, drainage channels and tubes, bridges, etc) elements of road landscapes are only partially, during road construction, “designed” (as road constructionists say) according to the project. They further develop according to the local nature-roadside patterns and due to this reason geological-geomorphological processes are activated in some places.

In the places of active development of karst processes or underground explorations of carbonate rocks, which lead to activation of karst, one needs to use the principle of partial retreat from the area of karst development – transfer a section (area) of the road beyond the borders of its active development or the borders of underground explorations. In the future, road construction needs to take into account the promising plans of underground explorations. As practice suggests, supporting (with cement or other substances, filling underground cavities, etc) and repairing such roads is unpractical – karst continues to develop, and new faults, subsidence may appear after 30-40-50 years.

Similar processes are also observed while optimizing unfavourable hydrologic processes in the road landscapes. Measures oriented at diversion of water and cleaning the surface runoff from the roads and bridges, according to the projects, are constructed simultaneously with part of a road or bridge – these structures are retention ponds, settling-basin filters, and drainage basins and other highly simple structures.

Conclusions

In the current structural organization of road land- scapes of Ukraine, we should clearly distinguish three genetically interrelated constituents: road landscape- engineering and road landscape-technogenic (block) and specifically road (geocomponent) systems. The leading ones are the RLES. The indicated structural constituents of the road landscapes are given enough attention by environmental geographers and land- scape scientists of Ukraine, though the nature block is only partly taken into account . In Ukraine, this is seen at both regional and local levels. Our research into the impact of regional specifics of the environmental conditions and functioning of the RLES in Podillia re- vealed that the main environmental factors in the fur- ther reconstruction, construction and exploitation of the road landscape-engineering systems of the region are broad distribution (72% of the territory of Podil- lia) and large layers of loess rocks (up to 5-7 metres), high differentiation of the surface of Podillia and cloudburst pattern of atmospheric precipitations. The impact of local environmental conditions most often takes place due to landscape structure of the two most dynamic types of habitat: sloped – presence of tracts of steep slopes and ravine, and floodplain. Although the road landscape-engineering systems are identi- fied to the azonal anthropogenic landscape structures, taking into account zonal factors, especially in the process of their exploitation, is necessary. During the development of regional projects and plans of rational nature-use, one needs to pay attention not only to the prevention of unfavourable processes caused by the construction and functioning of RLES, but develop- ment of measures of their protection as well.

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