

RISK FACTORS OF LAND DEGRADATION IN MANAGEMENT OF STATE ROAD INFRASTRUCTURE

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Abstract. Land is one of the most important natural resources; its use is determined by several factors, especially resources and infrastructure. Without proper land management and maintenance as well as after abandoning the land favourable conditions arise for land degradation. Land degradation processes are also found in road infrastructure, which are promoted by various risk factors. In order to ensure the sustainable development of land use, it is necessary to evaluate the causes of land degradation risk, identify the degraded areas and areas that are exposed to degradation risk, as well as identify the possibilities for their elimination. The main risk factors for land degradation in the management of state road infrastructure are: errors in determination of roads and abutting property borders as a result of land reform; land reservation for state road infrastructure development objects; non-cultivated land after completion of construction works; activity of beavers and expansion of invasive plants. The aim of the article is to evaluate the main types of land degradation in the management of state road infrastructure and to determine the risk factors. In the article the manifestations of land degradation and the risk factors in the management of state road infrastructure have been explored and summarized. The risk factors of land degradation have been classified according to the type of degradation.

Keywords: road infrastructure, land degradation, degraded area, risk factors of land degradation.

Introduction

Land is one of the most important natural resources that is estimated both as an object of rights and value. Land means not only the surface of land, but also the infrastructure that is developed on it – constructions, various objects as well as land resources and minerals, which are on the ground and under it, and are closely connected to it [1]. Land use is determined by several factors, especially natural, people and capital resources, as well as infrastructure [2].

As it is mentioned above, an important part of land use is also infrastructure, including the state roads. According to the “Law of Roads”, the state roads and their land, including the land zones with all the constructions included in the road complex, are the property of the Republic of Latvia, the responsibility of which has been handed over to the State Stock Company (SSC) “Latvian State Roads”. Duties of the state include constant state road management providing their guaranteed use for the social needs of the public. SSC “Latvian State Roads” fulfils the management of this nationally important infrastructure. The aim of management of the state road infrastructure is to manage the state roads ensuring sustainable mobility needs [3].

In rural regions and cities, state roads promote the development of economy and agriculture, including access to health care and education. That confirms the importance of state infrastructure and determines the necessity to create a uniform possession of the roads and the adherent areas, so ensuring a model of effective and rational property management [4].

The land management law defines the general basic principles and requirements for sustainable land use and protection, and they are also referable to the transport infrastructure lands. Land shall be used in compliance with the use of the area of local authorities stated in the planning documentations, or the area use has been started legally, and the land user shall to perform all activities, which could ensure the land and soil maintaining quality by eliminating degradable processes [5].

Without proper land management and maintenance as well as neglected land may cause conditions of land degradation. In the Republic of Latvia, the notion of land degradation is normatively declared in the Law of Land Management. The law defines that land degradation is a decrease or loss of the economic and ecological values of land and related resources due to human activity or inactivity, or natural processes. During the process of land degradation, a degraded area is made. In accordance with the Law of Land Management, a degraded area is the area with a ruined or deteriorated land surface or abandoned constructions, sites of mineral extraction, economic or military activity.

In order to ensure sustainable development of land, it is necessary to evaluate the causes of land degradation risk, to identify the degraded areas and areas that are exposed to degradation risks, and identify the possibilities for their elimination. The land degradation is affected by two unrelated systems: results of natural forces and human activity or inactivity [6]. Furthermore, the causes of land degradation are not only physical, but also socioeconomical and political [7].

Materials and methods

The **aim** of the study is to identify the degradation processes that are under the management of the state roads infrastructure and to determine the risk factors. In order to perform this study the following objectives were set: 1) to assess the theoretical and legal basis of land; 2) to identify and summarize the areas of state roads infrastructure of the Republic of Latvia, which are exposed to degradation processes; 3) to analyze and divide these areas according to their degradation manifestation by determining the risk factors of land degradation.

In the present study, information was obtained from the SSC “Latvian State Roads” as a result of identification of the areas exposed to degradation processes (further in the text – degraded areas) in the state roads infrastructure. The study was carried out on January 1st, 2017, in a form of table on the basis of Excel program. The obtained data were supplemented with distribution of degraded areas according to the manifestation of the degradation process (or the type of degraded areas) as well as according to their risk factor.

When analyzing the summarized information, methods of data comparison, statistical grouping, analysis and synthesis were used.

Results and discussion

In the Republic of Latvia, state motor roads are divided in the main, regional and local roads. Summarizing the information on the identified degraded territories of the state road infrastructure, which are managed by the SSC “Latvian State Roads”, a conclusion can be made that there are 870 such territories in the Latvian road infrastructure. Such degraded areas most often were found in the territory of the state regional roads – 55 % of all identified degraded areas, 29 % of the state local roads, but in the state main road areas only 16 % (Fig. 1).

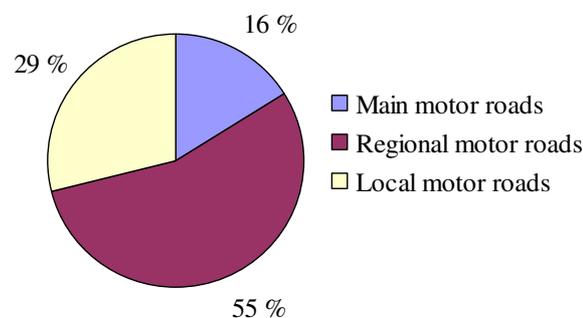


Fig. 1. Division of degraded areas according to classification of roads found in Latvian state road infrastructure, 01/01/2017

These are mainly abandoned areas in road zones after the road track construction or reconstruction, where degradation processes such as road-sides overgrown with bushes and invasive plants, and bogging up were found. More than one third (36.6 %) of these areas constitute lands, which could not be considered as degraded, but under the impact of risk factors they might become degraded, that is why in the present article they are named as potentially degraded areas (Fig. 2).

Evaluating the placement of degraded areas in the management of the state road infrastructure, a conclusion can be made that they are found all over the territory of Latvia. However, when analyzing their placement by planning regions, a conclusion can be made that most of all – 22.2 % of the degraded areas are in Riga planning region, but the least – 8.5 % are in Vidzeme planning region. There are very many of such areas in Ogre (53), Koknese (52) and Jaunjelgava County (51), many degraded or potentially degraded areas are also in Ventspils (43), Kraslava (41) and Vilaka (40)

Counties. There are very few such counties, where there are not degraded or potentially degraded areas in the state road infrastructure (Table 1).

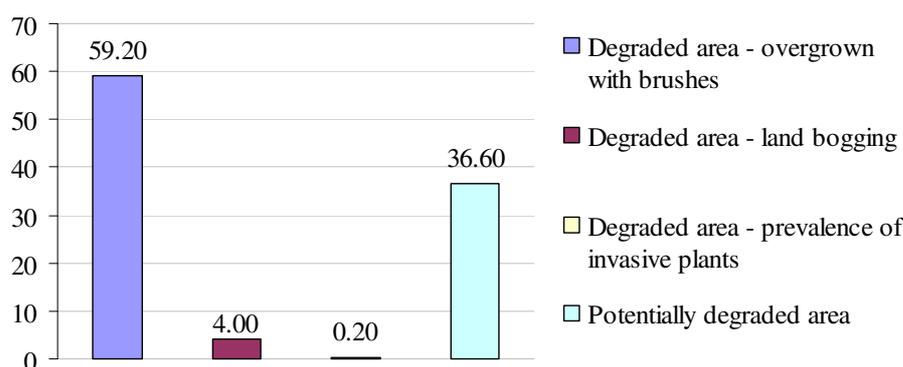


Fig. 2. Division of degraded areas (in %) according to their types in Latvian management of state road infrastructure, 01/01/2017

Table 1

Degraded or potentially degraded areas in the management of state road infrastructure divided by the planning regions of the Republic of Latvia, 01/01/2017

Planning region	Number of degraded areas	%	Area of planning region, thousand ha	Density of degraded areas, number per milj. ha
Kurzeme	172	19.8	1359.5	126.5
Latgale	197	22.7	1451.2	135.7
Riga	237	27.2	1043.0	227.2
Vidzeme	74	8.5	1522.1	48.6
Zemgale	190	21.8	1072.4	177.2
In total	870	100.0	6448.2	134.9

In the above mentioned counties, in the recent 10 years, extensive road construction and reconstruction works have been carried out, for example, the regional road P80 “Tinuzi – Koknese” construction, regional road P45 “Vilaka – Kraslava” reconstruction, which are not fully completed or there are not arranged property right issues for the land units in the road adherent areas.

When summarizing the information on the degraded lands in the management of the state road infrastructure, the risk factors, which are the causes of abandoning and overgrowing with bushes or bogging-up, were determined for these areas. Moreover, some of these areas are affected by at least two degradation factors; therefore, their total number is larger than the degraded areas total number (Table 2).

Table 2

Risk factors of land degradation in the management of state road infrastructure

No.	Risk factors of land degradation	Number	%
1.	Errors in determination of roads and abutting property borders as a result of land reform	309	34.9
2.	Unarranged property right issues of land after the road construction and reconstruction	231	26.1
3.	Land reservation for objects of the state road infrastructure development	328	37.0
4.	Land cultivation with agricultural machinery within the range of the road zone	2	0.2
5.	Activities of beavers	14	1.6
6.	Overgrown land with invasive plants	2	0.2
In total		886	100.0

Further, analysis of the land degradation risk factors was carried out by the degraded land types in the management of the state road infrastructure.

The type of degraded area – land overgrown with bushes

The most prevailing type of degraded areas in the management of the state road infrastructure is lands overgrown with bushes. They constitute 59.2 % of all the identified areas (Fig. 2):

- land reservation for the objects of the state road infrastructure development;
- errors in determination of roads and abutting property borders as a result of land reform;
- unarranged property right issues of land after the road construction and reconstruction.

Most part of the land degradation risk factors in the Latvian state road infrastructure constitutes **land reservation for the state road infrastructure development**. In total, there are 328 cases or 37.0 % of all risk factors (Table 2). Roads are connected with engineering structures, such as viaducts, bridges, side carriageways, parallel access roads or knots, for the building of which the land was expropriated from the neighboring properties. Due to lack of funding not all of the planned engineering structures have been built, but the expropriated lands gradually are overgrowing with bushes. For example, construction of the state regional road P80 “Tinuzi – Koknese” was started in 2009, which is the longest (about 60 km) newly built road since regaining of Latvia’s independence, and it crosses several counties and parishes. When summarizing the data, it was found that this risk factor of land degradation is the most often found among all the risk factors facilitating the land degradation processes both in the state regional and main, as well as local roads.

The second significant condition facilitating the land degradation is **errors in determination of roads and abutting property borders as a result of land reform** that constitutes 34.9 % of all the degradation risk factors and affects land degradation in 309 cases (Table 2). When implementing the land reform in rural regions, especially at the beginning, abutting property borders were not coordinated with the state roads administration, information on road categories, protection zones and parameters of road zones were not demanded. Also, the regulation in force for the land border determination process was not considered. At the beginning of the land reform till June 15, 1993, after establishing border posts and preparing a border act, it was signed by a land surveyor, land user and municipality representative, but the abutting property owner’s signature was not obligatory [8]. As a result, unnecessary road extensions were made in the road zone, because the road zone was wider than that accepted in 1992 by the “Law of Roads”. Therefore, land areas beyond the road zones are ownerless and not cultivated, overgrown with bushes and become degraded territories.

More than one fourth (26.1 %) of the degradation risk factors are made by **unarranged property right issues of land after the road construction and cultivation** (Table 2). Recently in Latvia, extensive straightening works of roads or their parts have been carried out. In order to ensure the road construction process, land was often expropriated that was larger than that road zone in the construction project, and inter-areas were not allowed. However, after finishing construction works and land recultivation under the old road, the property rights of these territories have not been arranged. For example, during 2005 to 2007 the existing structures were reconstructed and new roads for the state main road A1 “Riga (Baltezers) – border of Estonia (Ainazi)” were built [9]. Saulkrasti bypass is one of the largest objects of the infrastructure built anew in the history of independent Latvia and the first newly built highway part after regaining of Latvia’s independence. In order to fulfil this project, land properties were expropriated and bought all along the route. After construction works, the territory of the former track was recultivated; however, not all land units are assigned to the municipality or are in charge of it. Areas, in regard of which the property right issues are not still arranged after construction works, are not economically maintained and are overgrowing with bushes.

The type of degraded areas – bogged up land

Though not many, but still 4 % of identified degraded territories in the Latvian state road infrastructure are constituted by bogged land (Fig. 2). Most of bogged territories are in the state regional and local road infrastructure. Bogging up of state road infrastructure is mainly facilitated by four land degradation risk factors:

- beaver activities;
- land cultivation with agricultural machinery within the road zones;
- errors of determination of abutting borders due to land reform.

As a land degradation factor, which affects bogging up, should be mentioned the increase of beaver population and their activities. Out of total land degradation risks, this constitutes only 1.6 %. In the management of state road infrastructure, 14 cases have been registered (Table 2). Every year in spring beavers become active all over the Latvia's territory. They gnaw on undergrowth and because of the dams built by beavers large areas are overflowed and engineering constructions damaged. For example, Koknese – Plavinas section of the state main road A6 “Riga – Daugavpils”. In this territory, there are typical bogging up processes in the abutting properties and comparatively dense drainage system network. Especially vast bogged territories are in the road neighboring properties, where beavers live in the drainage ditches that facilitates formation of wetlands.

Land bogging has been found on the state local roads in two cases caused by *land cultivation with agricultural machinery within the road zones*. Some cases have been observed, when farmers have not taken into consideration the road zone and have enlarged their land areas up to the carriageway, damaging the ditches alongside the road at the embankment base, which are for water collection and drainage from overground and subsurface. Underground drainage is even more risky than a ditch, because it is not visible, and it is easier to be used for cultivation. However, if the road zone is maintained in accordance with the aim of its use and type, farmers do not cultivate land of the road zone; consequently, the legal landholder must take responsibility for this particular risk manifestation.

Errors of determination of abutting borders due to land reform also have been the reason of land bogging in the state road infrastructure (Table 2). There are five cases, when the state road border was set in the middle of the ditch or before the ditch within the road zone. As a result, the drainage system is not maintained properly, and even a small obstruction of the ditch or drainage facilitates the bogging up.

The type of degraded areas – land overgrown with invasive plants

In the management of the state road infrastructure of Latvia there are two territories, where officially approved invasive plant in Latvia is observed – Sosnowsky's hogweed (*Heracleum sosnowskyi*) (Fig.2). They are land degradation risk factors – *prevalence of invasive plants* (Table 2). One of the two territories is the road section on the main road A5 “Riga bypass (Salaspils – Babite)” in Kekava County, Kekava parish. Sosnowsky's hogweed has prevailed in a vast territory on several land areas including the road drainage ditch. The other territory of the state road infrastructure is in Sigulda County.

Potentially degraded territory

In the management of the state road infrastructure of Latvia there are determined 318 potentially degraded areas, that is 36.6 % of all the identified territories (Fig. 2). These are abandoned road infrastructure built-up areas, which are land degradation risk factors – *land reservation for the state road infrastructure development*. This is also the most prevalent land risk factor in the road infrastructure (Table 2). Their formation is connected with the land reservation for construction of road knots, access roads and other infrastructure facilities, but later works have been stopped, so facilitating the degradation process development.

It is obvious that in the management of the state road infrastructure there are several risk factors that facilitate land degradation processes in areas along the roads. Although the present studies were focused on the division of the degraded territories, they characterize more the manifestation of the degradation processes – overgrowing with bushes, bogging up. In the Latvian legislation there are not yet defined criteria of determination and division of degraded areas. Several investigations have been carried out, where parameters of determination of degraded territories and their types have been offered. For example, in order to identify degraded territories and perform their accounting, proposals for the division of degraded territories into three main groups by determining land degradation criteria are worked out at the Department of Land Management and Geodesy of the Latvia University of Life Sciences and Technologies [10].

Table 3

Classification of degraded territories [10]

No	Type of degraded territory	Criteria for determination of degraded territory
1.	Degraded built-up territory	Depreciation of the buildings
		Built-up territory overgrown with bushes
		Pollution
		Dump-site
		Abandoned production territory or facility
		Abandoned military territory or object
2.	Non-recultivated territory of mining of mineral deposits	Abandoned territory of peat extraction and construction materials
3.	Unmanaged agriculture and forestry activity territory	Agricultural land overgrown with bushes
		Dump-site
		Abandoned production territory or object
		Abandoned military territory or object
		Invasive plants
		Swampy land
		Pollution

However, in this classification it is difficult to include degradation processes, which are going on in the road infrastructure, because they do not meet the division of the degraded territory types offered in Table 3, except the first type – degraded built-up territory, because the land under the roads can be considered as a built-up land. Also, the offered determination criteria of degraded territories, though some of them (land overgrown with bushes, bogging up, invasive plants) are in the road territories too, do not meet the offered division of degraded territories.

Conclusions

1. Degraded territories differ greatly with different types of manifestation. Still up to now, criteria of degraded land, how to find out and eliminate degraded territories, are not defined in order to perform measures of land degradation elimination.
2. In the state road infrastructure of the Republic of Latvia, comparatively many territories occur that are exposed to degradation processes, which are affected by several land degradation risk factors. Land reservation for the state road infrastructure development, errors in determination of roads and abutting property borders as a result of land reform and unarranged property right issues after the road construction and recultivation constitute the most part of them.
3. Evaluating the main land degradation risk factors, a conclusion can be made that they have been facilitated both by objective and subjective conditions; it is necessary to anticipate financial resources as well as to take measures to arrange the property rights.

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