Latvia University of Life Sciences and Technologies

Faculty of Environment and Civil Engineering

Department of Landscape Architecture and Planning

Mg. arch. **Kristine Vugule**

Doctoral Thesis

Road landscapes in Latvia: from the traveller`s point of view

Latvijas ceļu ainavas lietotāju uztverē

for obtaining the scientific degree of architect *(Dr. arch.)*

in the scientific branch of Architecture, the sub–branch of Landscape Architecture

Supervisor
Professor, Simon Bell, PhD _____

Supervisor
Assistant professor, Ilze Stokmane, Dr. oec. _____

The author of the doctoral thesis, Kristīne Vugule _____

DOI: 10.22616/llu thesis/2019.011

Jelgava

2019

ABSTRACT

Kristīne Vugule PhD thesis "Road Landscapes in Latvia: from the Traveller`s Point of View" has been developed from November 2012 till May 2019 in the Department of Landscape Architecture and Planning of the Faculty of Environmental Science and Civil Engineering of Latvia University of Life Sciences and Technologies.

Object of the research: landscape of Latvia's main roads

Subject of the research: perception of the landscape of road users and travelling experience along the main roads of Latvia.

Aim of the research: to provide a greater understanding of how Latvian travellers perceive road landscapes and the implications for road landscape planning and management.

Research questions

- What elements or features of the road landscape are the most important contributors to the traveller's experience?
- What spatial characteristics are dominant in forming a legible and coherent travelling experience?
- What kind of Latvian landscape is the most preferred by road users?

Tasks set in the research

- Analyse theoretical approaches, criteria and methods for road landscape perception, assessment and planning.
- Explore the stages of road landscape development and their characteristic landscape elements in Latvia.
- Explore the impact of normative documents on the road landscape.
- Determine the elements and features of the road landscape that most affect the perception and travelling experience of road users.
- Determine the optimal spatial features of the road landscape to make the journey legible.

The PhD thesis consists of five chapters.

1. Literature review describes human perception and movement, road landscape definition, qualities and characteristics, road landscape assessment technologies and representation techniques. History of road landscape planning and design development in the world and in Latvia are studied. Current characteristic features and problems in the road landscape planning and management in Latvia are analysed and the research problem and research questions are developed.

2. Research strategy chapter presents general approach to mixed methods, case study approach; as well as scenario concept has been used. Choice of study route and characteristics of case study areas are described.

3. Methodology describes data acquisition, three – dimensional (3D) modelling, animation development technology, scenario animation development and testing, questionnaire development, pilot testing, adjustment and administration of the questionnaire. Characteristics of respondents is given.

4. Results chapter presents results of each case area, comparison of cases and results from general questions.

5. Discussion consists of interpretation of the results.

The PhD thesis consists of 127 pages of text, it includes 100 figures and 10 tables. The list of bibliography contains 290 sources. There are 16 annexes. All the figures and tables included without references are materials acquired by the author during the research.

ANOTĀCIJA

Kristīnes Vugules promocijas darbs "Latvijas ceļu ainavas lietotāju uztverē" izstrādāts laika posmā no 2012.fada novembra līdz 2019. gada maijam Latvijas Lauksaimniecības universitātes Vides un būvzinātņu fakultātes, Ainavu arhitektūras un plānošanas katedrā.

Pētījuma objekts: Latvijas galveno autoceļu ainava.

Pētījuma priekšmets: autoceļu lietotāju ainavas uztvere un pieredze pārvietojoties pa Latvijas galvenajiem autoceļiem.

Promocijas darba mērķis: sniegt labāku izpratni par ceļa ainavas telpisko uztveri, kas ietekmē ainavu plānošanu un pārvaldību Latvijā.

Izpētes jautājumi

- Kādi ceļu ainavas elementi vai pazīmes vissvarāk ietekmē autoceļa lietotājus?
- Kādas ceļu ainavas telpiskās pazīmes dominē, veidojot salasāmu un saskaņotu autoceļu lietotāju pieredzi?
- Kādām Latvijas ainavām ceļu lietotāji dod priekšroku?

Mērķa sasniegšanai izvirzītie uzdevumi

- Analizēt teorētiskās pieejas, kritērijus un metodes ceļu ainavu uztverē, vērtēšanā un plānošanā.
- Izpētīt ceļu ainavu attīstības posmus un tiem raksturīgos ainavas elementus Latvijā.
- Izpētīt normatīvo dokumentu ietekmi uz ceļu ainavām.
- Definēt ceļu ainavu elementus un iezīmes, kas visvairāk ietekmē autoceļu lietotāju uztveri un pieredzi.
- Noteikt ceļu ainavu optimālās telpiskās pazīmes, lai brauciens veidotos salasāms.

Promocijas darbs strukturēts piecās nodaļās.

1. Literatūras apskatā aprakstīta cilvēku uztvere kustībā, ceļu ainava, tās kvalitātes un raksturojošās pazīmes, vērtēšanas un reprezentācijas tehnikas, ceļu ainavu plānošanas un dizaina attīstības vēsture pasaulē un Latvijā. Analizētas pašreizējās ceļu ainavu iezīmes, ceļu aianavu plānošanas un apsaimniekošanas problēmas un precizēta pētījuma problēma un pētījuma jautājumi.

2. Pētījuma stratēģijas nodaļa iepazīstina ar jaukto pētījumu metožu pieeju un pamato gadījumu izpētes metodes un scenāriju metodes izvēli, raksturo pētētījuma teritorijas un pamato to izvēli.

3. Metodika izklāsta datu ieguves, 3D modelēšanas un scenāriju animāciju izstrādes tehnoloģijas, un to testēšanu, aptaujas anketas izstrādi, testēšanu, pielāgošanu, aptaujas administrēšanu un ir sniegts aptaujas respondentu raksturojums.

4. Rezultātu nodaļa iepazīstina ar katras teritorijas rezultātiem, to salīdzinājumu un ar rezultātiem no vispārējiem jautājumiem.

5. Diskusijā veikta rezultātu interpretācija.

Promocijas darba apjoms: 127 lapaspuses, 100 attēli un 10 tabulas. Darba izstrādei ir izmantoti 290 avoti, darbā ir 16 pielikumi. Visi bez atsaucēm ievietotie attēli un tabulas ir pētījuma gaitā iegūti autora materiāli.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION

The topicality of the Thesis and Formulation of Problems

Development of transport infrastructure. Road landscape design and planning has long history. In the 1920s not long after Henry Ford and mass production of cars in the USA began, the Olmsted company started to design scenic parkways in California, USA, and elsewhere specifically for touring cars to enjoy recreational driving – cars were known as "tourers" to enable people to enjoy this (Davis, 2008).

Development of road infrastructure and road transport are still an increasing phenomenon. Travelling for work, business and above all – pleasure means that we experience the world around us from the road landscape and it has a major impact on our impressions of a place. Roads serve as transport corridors, providing access to different territories and landscapes (Zeller, 2007; Garré et al., 2009). Road landscapes affect important aspects of road and transport infrastructure as well as the quality of life of local people, traffic safety and tourism development.

With the increase in the intensity of the use of the country's main roads (Latvijas ilgtspējīgas..., 2010) and the increasing mobility, the importance of both roads and the surrounding landscape is increasing. The road landscape today has become an integral part of daily life and it can improve or reduce the quality of life. Roads are a part of public space where daily social life takes place, and the road landscape is an important resource for the development of territories (Ainavu politikas..., 2013). The transport infrastructure, including the road landscape, affects the value of the property (Efthymiou, Antoniou, 2013; Protoglou et.al, 2019), and the aesthetically valuable landscape can rise value.

Since the 18th century, the road landscape in Latvia has developed in close connection with road development, when first alleyways were planted along the roads. On a larger scale, the road landscape developed during the period of Latvia's independence from 1918 to 1940, and essential elements of the road landscape that are present until today appeared during the Soviet Union time. Consequently, many roads with their surroundings today constitute a significant cultural and historical landscape with values, which need to be recognized and preserved, as emphasized in the research by A.Ziemeļniece (Ziemelniece 2011, Ziemelniece 2016).

Road landscape's impact on traffic safety. Research on driver perception internationally (Antonson et al., 2009) shows the relationship between landscape and driver behaviour on the road, highlighting the fact that the landscape can reduce stress and tone up the mind (Parsons et al.., 1998; Grahn and Stigsdotter, 2003). One of the transport development priorities in Europe and Latvia is traffic safety (Transporta attīstības …, 2013). The number of people killed and injured in road accidents in Latvia is still considerably higher than in other European Union Member States (Par ceļu ..., 2017). Since 1991, research on the factors influencing safety has been conducted (Jeļinskis, 2010; Slēde, Vikmanis, 1980), but it does not look at the impact of landscape on road safety. Also, the road safety plan for 2017-2020 measures to improve traffic safety does not include road landscape issues, although the appropriately planned road landscape can improve safe movement on the road (Mok et al., 2006; Piek et al., 2011; Matijošaitienė, Navickaitė, 2012). When working on traffic safety issues, more attention should be paid to the importance of the road landscape and the potential contribution to improving road safety.

Role of the road landscape in tourism development. Deliberate road landscape planning is also important for road users. The road landscape creates the first impression about the state to tourists and guests coming along the roads from other countries (Bell, Nikodemuss, 2000). As tourism industry develops, the number of tourists visiting Latvia increases every year (Tūrisms – galvenie ..., 2013). Latvian Tourism Marketing Strategy (Latvian Tourism ..., 2010) foresees cross–border cooperation to offer all three Baltic States as a single tourist destination. Considering that, as a result of general globalization, each country and place tries to show its

characteristic, unique place identity (Bell, 2003; Antrop, 2004; Kučan, 2007; Zigmunde, 2010; Ņitavska 2014), the road landscape in Latvia needs to be planned aesthetically and must differ from other Baltic countries with the landscape features characteristic to Latvia.

In the context of tourism development, the professional rural tourism association "Lauku ceļotājs", involving the society, has prepared and issued a tourism route map, inviting to get acquainted with seven special routes, or ways of forming the statehood of Latvia (Lauku ceļotājs, 2018) for the centenary of the Republic of Latvia. These materials contain information on major cultural and tourist attractions on designated road routes, but unfortunately, no steps have been taken to assess, design or improve the road landscape.

Topicality of road landscape issues in Latvia. Motorways are divided into national roads, municipal roads, merchant roads and home roads according to their importance and affiliation (Par autoceļiem, 1992). Road landscapes consist of areas adjacent to roads that can be owned and operated by municipalities, businesses or individuals. Owners and managers who influence and shape their landscapes through their activities have different interests and future plans for their properties. Similarly, road users have their own wishes and needs. The diversity of interests, uncoordinated planning and management influences the quality of road landscapes. As high–quality results and positive changes in landscape planning can only be achieved through discussion and collaboration, it is important to find the ways to address all parties involved in a form that they understand. Understanding how society perceives and interprets the landscape, how road users perceive the road landscape, can help planners, designers and managers in decision–making, as well as promote public engagement in road landscape planning and public education on landscape aesthetics issues.

The topicality of the theme about road landscape planning issues and certain elements of the road landscape, such as the problems of alleys with road reconstruction is indicated by discussions among the road sector, landscape architecture, nature conservation specialists and the society in the public space. Public media have been discussing the preservation of trees, tree rows and alleys along the roads, their cultural and historical significance, their impact on the road safety.

Latvia has ratified the European Landscape Convention in 2007. Council of Europe signed the European Landscape Convention in Florence in 2000, with the aim to create a new instrument for the protection, management, and planning of European landscapes (European Landscape..., 2000). In the European Council, discussions on the role of roads in the landscape began at the 2007 meeting of the Council of Europe with the report of I. Echániz "Infrastructure and Landscape: Roads" (Echániz, 2007). In 2009, it was followed by publication "Roads in the Landscape: Criteria for Planning, Placement and Project Design for Roads" (Junta de ..., 2009). In the framework of the ninth European Council meeting on the implementation of the European Landscape Convention 2010 and the Third International Congress on Landscape and Infrastructure, the Council of Europe report “Landscape Infrastructure for Society” (Convention, n.d.) was prepared. The Law on the European Landscape Convention sets out the aim to integrate landscape policy into any policy that can directly or indirectly effect landscapes (Likums par…, 2007). By ratifying the convention, we have agreed to promote landscape protection, management and planning in natural as well as rural, urban and suburban areas that include high–quality, every–day and degraded road landscapes.

Areas of research covered by the thesis and previous research

The theme of the doctoral thesis covers several research directions and road landscapes viewed from different aspects, which include the history of road landscape development, cultural and historical value of road landscapes, visual aesthetic value, landscape perception and connection with traffic safety, normative documents context and planning. In Latvia, research on road landscapes began in the period of the Free State of Latvia, when the first road landscaping elements appeared (Silenieks, 1930). Significant work on the visual aesthetic improvement of the road landscape was made during the Soviet Union in the 1960s/70s, when

road engineer Peteris Dzenis and architect Velta Reinfelde worked on the principles of technical design and improvement of roads (Дзенис, Реинфелд, 1968). Several complex road reconstruction projects were developed and implemented, performing road improvement and landscaping (Andrejsons, Sviķis, 2016). After the end of the work of V.Reinfelde, these principles of landscape planning have not been further developed and widely applied. Changes in the political and economic situation after 1991, when Latvia regained its independence, influenced the road planning and management system. Reinfelde's work on road landscape planning has not been continued, although the projects developed by Reinfelde are a valuable contribution to road landscape planning that should be further developed and adapted to today's situation. Research on roads and their surrounding landscapes has been slightly addressed by A. Melluma (Melluma, Leinerte, 1992).

Research has been carried out in Latvia on the assessment of road spatial perception (Zarins, Smirnovs, 2013), on the impact of roads on the environment (Lieplapa, 2013), traffic safety (Smirnovs et al., 2007), on the role of transport infrastructure development in the use of territory resources (Niedola, Averjanovs, 2011). Andrejson and Sviķis have gathered a wide range of materials on the history of Latvian motorway development and the development of the road sector (Andrejson, 2004; Andrejson 2009; Andrejson, Sviķis, 2016; Sviķis, Andrejsons, 2018).

In the context of normative documents, road design regulations in Latvia (Ceļu projektēšanas..., 2000), methods and regulations for designing and managing the reconstruction of new roads have been developed (Autoceļu un..., 2014). The Law on Roads regulates their use, management, protection and development (Par autoceļiem..., 1992), which mainly focus on road infrastructure and closely adjacent territory but does not cover road landscape issues on a larger scale. Compliance with the rules mentioned in the Regulations on Road Maintenance (Noteikumi par ... 2010) partly affects the aesthetic quality of the road landscape. Some planning regions and municipalities have identified scenic roads in their territorial development plans, thus focusing attention on the road landscape on separate road sections. The Territorial Development Planning Law (Teritorijas attīstības..., 2011) foresees thematic planning, such as the development of landscape plans, in which publicly accessible viewpoints, perspectives, and scenic roads can be identified.

There are many more studies on the road landscapes globally. **Road and landscape development history** has been studied by several researchers. C. Mauch and T. Zeller recover the highway innovation from 1920–39 in Germany, discuss the intensions and values of drivers, their interaction with landscape, define aesthetics of transport infrastructure (Zeller, 2007; Mauch, Zeller, 2008; Zeller 2016). Beginnings of highway development in the USA have been described by K. Raitz (1998), D. E. Nye (2016). R. Vahrenkamp (2010) describes the German Autobahn development from 1920 to 1945. P. Merriman (2006) looks at landscape architecture, movement and the aesthetics of motorways in early postwar Britain.

Studies concerning the **cultural heritage of roads** range from justifications of need and recommended means for the preservation of roads and routes of historic significance (Highways Agency, 2007). P. D. Marriott (1998) examined the complex issues surrounding historic roads and provided design and policy guidelines. I.Grazuleviciute–Vileniske and I. Matijosaitiene have carried out classification of the cultural heritage of roads and road landscapes in Lithuania (Grazuleviciute – Vileniske, Matijosaitiene, 2010).

The research on the road landscape **aesthetics, visual quality and perception** is carried out by many researchers (Steinitz, 1990; Brown, 2003; Kearney et al., 2008; Ramírez et al., 2011; Martín et al., 2018; Jaal, Abdullah, 2012). D. Appleyard, K.Lynch and J.R.Myear were the first pioneers who started to develop aesthetic criteria for an ideal highway system, analyse the attention habits of a driver and suggest notation for specialists (Appleyard et al.,1964; Lynch, 1965). There are studies on visual characteristics of roads (Clay, Smidt, 2004; Tveit et al.., 2006; Blumentrath, Tveit, 2014), descriptors used in scenic highway analyse (Clay, Smidt, 2004). Landscape perception studies look at the way people see and understand the landscape

from psychological, psychophysical, phenomenological and cognitive approaches (Zube, 1987; Appleton 1996; Kaplan and Kaplan 1982; Kent, 1993; Palmer, 2001; Wolf, 2006; Bell 2012). Various methods are used for scenic environment assessment, like model building (Xiao, et.al 2007), landscape character assessment with GIS, using map – based indicators and photographs in the relationship between landscape and roads (Martín, et al., 2016), investigating the relationship of landscape features with scenic preference, using GIS visualisations (Qin et al., 2013). Special attention is paid to perception through movement (Mourant, Rockwell, 1970; Bell, 2008; Smirnovs, 2008).

Road landscape aesthetics, driving behaviour and traffic safety is an important field in road landscape planning (Schutt et al., 2001; Elliott et al., 2003; Mok et al., 2006). Aesthetics and safety of road landscape is studied by I. Matijošaitienė and K. Navickaitė (2012). Horberry and Edquist (2008) analysed destructions outside the vehicle, the effect of visual disorder on the road safety. H. Antonson with a group of researchers (2009) analysed the reliance of drivers' behaviour and safety on the road landscape type–open, woodlands or mixed. Road landscape influence on stress recovery is studied (Russ et al., 1998). Perception studies connected with safety issues often use computer – animated road landscape modelling (Jacobsen, Antonson, 2017), for example, to study the driving behaviour in relation to road markings (Antonson et.al, 2013, Antonson et al., 2015), drivers' perceptions of road and landscape features (Antonson, et.al, 2009; Antonson et al., 2014), evaluation of effect of vegetation (Calvi, 2015; Fitzpatrick et al., 2016). Driving simulators are often used for such studies (Triffault, Bergeron, 2003; Lippold et al., 2006). Scenic beauty of the roadside vegetation and road side management influences drivers perception, safety and is assessed and studied (Akbar et al., 2003; Wolf, 2003; Weber et al., 2014)

Scenic roads and byways, their characteristics, selection, criteria for scenic route designation are a separate field of study (Kocher, 1982; Smith, Smith ,1992; Kent, Elliott, 1995; Spraggins, Mitchell, 1996; Draper, Petty, 2001; Petraglia, Weisbrod, 2001; Kelley, 2004; Davis, 2008;). Scenic routes have been studied from the tourism perspective **(**Larsen, 2016), tourists' satisfaction with and loyalty toward scenic roads are evaluated (Denstadli, Jacobsen, 2011), travellers motivation for taking trips along certain routes is studied (Eby,Molnar, 2001; Jacobsen, Antonson, 2017), economic impact of changes in scenic byways is evaluated (Timothy et al., 1999). There is research on use of augmented GPS navigation system, to incorporate scenic factors into the routing (Zheng et al., 2013).

Road landscape planning and design is covered by researchers from different states. Several authors have studied the infrastructure networks in the landscape (Español Echaniz, 2010; Pozuelo, 2010), road influence on the landscape (Garré et al., 2009) and separate infrastructure elements like tree avenues in the landscape (Pradines, 2009). There is carried out prediction of the visual impact of motorways using GIS (Jiang, et al., 2015). M. Van Den Toorn has defined space typology in landscape architecture, where road landsapes have been defined as infralandscapes (Toorn, 2005; Toorn, 2006). Legibility and self–explaining roads are some of the issues rised in road design (Theeuwes, 1998; Charlton et al., 2010; Theeuwes, 2012). M. Piek M., N. Sorel and M. Middelkoop M. have studied how to preserve panoramic views along motorways through policy (Piek et al., 2011). Regulatory framework of landscape analyses in Swedish road planning process and public participation in road planning process are studied by Swedish researchers (Antonson, Åkerskog, 2015; Henningsson et al., 2015).

National road authorities offer design guides and recommendation for the road landscape assessment and development (Beautiful Roads..., 2002; A Guide..., 2005; Federal Highway Administration, 2001; Transport Scotland…, 2006; Terry, 2008; Schutt et.al, 2001; Federal Highway Administration, 2001; Braga et al., 2013; Transpot and…, 2013; The National …, n.d.)

Conducting an in–depth study of the theme of the doctoral thesis and evaluating and comparing the current level of research in the world and Latvia, it has to be concluded that the road landscape in Latvia has been hardly studied. There is a lack of research on the perception

of road landscapes in the context of Latvia, considering the elements typical to Latvian landscapes and the landscape structure. This aspect is essential to start addressing the issues related to road landscape planning in Latvia. No methodology has been developed for evaluating road landscapes. Moreover, it is necessary to develop a common policy for the planning, management and development of the road landscape, as well as incorporate aspects related to the road landscape into the regulatory documents connected to road infrastructure planning.

Object of the research: landscape of Latvia's main roads

Subject of the research: perception of the landscape of road users and travelling experience along the main roads of Latvia.

Aim of the research: to provide a greater understanding of how Latvian travellers perceive road landscapes and the potential implications for road landscape planning and management.

Research questions:

- What elements or features of the road landscape are the most important contributors to the travellers' experience?
- What spatial characteristics are dominant in forming a legible and coherent travelling experience?
- What kind of Latvian landscape is the most preferred by road users?

Tasks set in the research:

- analyse theoretical approaches, criteria and methods for road landscape perception, assessment and planning;
- explore the stages of road landscape development and their characteristic landscape elements in Latvia;
- explore the impact of normative documents on the road landscape;
- determine the elements and features of the road landscape that most affect the perception and travelling experience of road users;
- determine the optimal spatial features of the road landscape to make the journey legible.

Methods used in the study:

- Airborne Lidar technology, photo and video documentations are used for data acquisition;
- graphic analysis is used for the analysis of the cartographic materials of different time periods;
- case–study method is used to find out the perception of travellers in areas that represent the three most typical landscape types in Latvia;
- scenario method is used to obtain travellers' opinion on different elements and possible landscape structure changes in each of the research areas.
- three – dimensional (3D) modelling and animation is used to get the results of the study using movement, which is a significant aspect in the perception of the road landscape;
- questionnaire survey is used for the evaluation of road development scenario animations, analysis and interpretation of results.

Approbation of the thesis

Results of the research are published in eight scientific articles and two theses. Author has participated in nine international, two local scientific conferences, in which eleven papers and one poster were presented.

Scientific articles

1. **Vugule, K.** The Latvian landscape as seen from the road. *Research for rural development 2013: annual 19th international scientific conference proceedings.* Jelgava: LLU, 2013. Vol. 2, p. 120 – 127, ISSN 1691 – 4031
2. **Vugule, K., Bell, S., Stokmane, I.** Road landscape development in Latvia up to the 21st century. *Landscape architecture and art: Scientific Journal of Latvia University of Agriculture* Jelgava: LLU, 2014. Vol. 4, No.4, p.10 – 16., ISSN 2255 – 8632
3. **Vugule, K., Ieviņa, D., Stokmane, I**. The road landscape in Latvian laws and regulations. Landscape architecture and art: *Scientific Journal of Latvia University of Agriculture*. Jelgava: Latvia University of Agriculture, 2014. Vol.5, No. 5, p. 102 – 108., ISSN 2255 – 8632
4. **Vugule, K., Turlaja, R.** Scenic roads in Latvia. *Research for rural development 2016: annual 22nd international scientific conference proceedings*. Latvia University of Agriculture. Jelgava, 2016. Vol. 1, p. 182 – 188., ISSN 1691–4031.
5. **Vugule K., Vagolins J., Bell, S.** Road landscape project evaluation and future development. *Creation/Reaction: ECLAS Conference proceedings.* University of Greenwich, Department of Architecture and Landscape. London, 2017. p. 1381 – 1393. ISBN 9780993590962.
6. **Vugule K., Mengots, A., Stokmane, I.** Road landscape modelling. *Research for Rural Development 2018: annual 24th International scientific conference proceedings*, Latvia University of Life Sciences and Technologies. Jelgava, 2018. Vol.1, p. 163–168., ISSN 2255–923X.
7. **Vugule K., Stokmane, I., Bell, S., Ile, U.** Public participation in the road landscape planning. *Landscapes of conflict: ECLAS conference 2018: book of proceedings*, University College Ghent School of Arts, Landscape and Garden Architecture and Landscape Development. Ghent, 2018. p. 537 – 544., ISBN 9789491564130.
8. **Vugule K., Bell, S.** The Soviet modernisation of the public road landscape. *Modernism, Modernisation and the Rural Landscape, Proceedings of the MODSCAPES conference2018 and Baltic Landscape Forum*. SHS Web of Conferences Vol. 63, 2019. 9.p., eISSN: 2261–2424

Theses in scientific conferences

Development of Road Landscape Management System in Latvia. Latvia University 72. scientific conference: Geography. Geology. Environmental Science. Riga: Latvia University, 2014. p. 433 – 434.

The Road Landscape in Latvian Laws and Regulations. Latvia University 73. scientific conference: Geography. Geology. Environmental Science. Riga: Latvia University, 2015. p. 175 – 176.

Presentation in international conferences

Ice or dust. The Latvian road landscape. ECLAS 2013 conference, Hamburg, Germany. 22. – 25.09.2013.

The Latvian Landscape as seen from the road. 19.th international scientific conference "Research for Rural Development 2013" Latvia University of Agriculture, Jelgava, Latvia 15. – 17.05.2013.

Development of Road Landscape Management System in Latvia. Letonika congress, Latvia University, Riga, Latvia. 29.01. 2014.

The Road Landscape in Latvian Laws and Regulations. Civil Engineering 15. Latvia

University of Life Sciences and Technologies, Jelgava, Latvia. 14. –15.05.2015

Scenic roads in Latvia. 22nd Annual International Scientific Conference "Research for Rural Development 2016". Latvia University of Life Sciences and Technologies, Jelgava, Latvia. 18.– 20.05.2016

Road Landscape project evaluation and future development ECLAS 2017 conference "Creation/Reaction", London, United Kingdom. 10.–13.09.2017.

Road landscape modelling. Annual 24th International Scientific Conference Research for Rural Development. Latvia University of Life Sciences and Technologies, Jelgava, Latvia. 17.05.2018.

The Soviet modernisation of the public road Landscape. "Modscapes conference 2018" Estonian university of Life Sciences, Tartu, Estonia 11.–12.06.2018

Public participation in the road landscape planning. ECLAS 2018 conference. University College Ghent, Belgum. 10.–13.09.2018.

Presentations in local conferences

Development of Road Landscape Management System in Latvia. Latvia University 72. Scientific conference: Geography, Geology, Environmental science. Riga, Latvia, 23.–31.01. 2014.

The Road Landscape in Latvian Laws and Regulations. Latvia University 73. Scientific conference: Geography, Geology, Environmental science, Riga, Latvia, 2.–6.02.2015.

Poster presentation

Scenic Roads in Latvia. ECLAS 2015 conference "Landscape in Flux", Estonian University of Life Sciences, Tartu, Estonia 20.09.2015.

Approbation of the research results in scientific projects

Project of the research programme "Strengthening scientific capacity in LLU" No. A05 –11 "Road Landscape modelling" from 01.01.2017. to 31.12.2018. Project leader Ilze Stokmane. The author carried out analysis of the road landscape and evaluation of future development using 3D modelling.

Scientific novelty of the doctoral thesis

The doctoral thesis contributes to the research of Latvian road landscape, which has almost no been studied from the point of view of landscape architecture and planning. The paper has a methodological significance, as it combines scientific research methods and uses new data mining technologies in the road landscape assessment. The modelling of the road landscape used in the research and the development of scenario animations for the assessment of the perception of the road landscape in Latvia have not been used so far. The method of evaluating the road landscape, involving the public, the results and lessons learned will serve as a model and as a theoretical basis for further scientific and practical research on road landscapes.

The practical significance of the doctoral thesis

The study deals with today's topical issues, emphasizing the importance of the road landscape and the need to carry out the assessment and planning of road landscapes. The methods used in the study can be used as an example to involve the public and other stakeholders in the planning and development of concrete road landscape projects.

The study reveals the most important aspects of the perception of road landscape elements and structure from the point of view of road users, which can be used to develop road landscape projects and to plan and manage existing roads. The general recommendations of road landscape improvement can be used in the development of road landscape planning guidelines.

1. LITERATURE REVIEW

1.1. Human perception and movement

As the subject of the research is perception of the landscape of road users, it is important to understand how people perceive landscape in general and to recognize, what the specifics of the perception of road landscapes and the role of movement in the landscape perception are. The design and safe use of any roadway depends on visual perception.

The eyes of human receive light of varying intensity and wavelength as an image on the retina, which is transmitted into the processing areas of the brain as a spatially related pattern. The brain interprets and makes sense of that pattern and use the results to inform us how and where to look next. Perception is not a random sampling of the visual array, like an automatic video recording. We use cascades and fixations to register pattern and we search for our visual objective. There is evidence that different people will look at the same scene but perceive different shapes and patterns depending on their knowledge, experience, cultural background etc. Perception acts as a filter to determine what is worth seeing and comprehending. Visual perception is not just about detecting light. The purpose of the eye is to collect information about the world that is useful to us. Therefore, we look actively and selectively, or passively, depending on the circumstances at a time (Bell, 2012).

Humans have binocular vision and can see three dimensions. This type of perception is made possible by stereopsis. Humans have two eyes that look at the same scene from slightly different positions. The two images must be associated simultaneously in the brain and in so doing the perception of depth occurs (Bell, 2012).

Depth perception is facilitated when the observer is moving, or an object is moving relative to the observer. This uses the rules of parallax, where near objects appear to move or pass by faster than more distant ones. Motion parallax is the optical change of the visual field of an observer which results from the change of his viewing position (Gibson, et al., 1959). Humans constantly move eyes, heads, bodies, positions and perceive the landscape through movement. As we move into the landscape the scene flows towards us and past us. This optic flow defines direction. Optic flow is the mechanism by which we can judge distance and speed (Bell, 2012).

Perception of the road landscape depends on vision, physical barriers along the road, travelling speed (Bell, 2008). The relationship between the mobile road user, the driver and the passenger within the vehicle and the roadside landscape is more complex than relationship between people who view the landscape from a stationary position. Road landscape is experienced by movement. Driver and passengers should have a good visual experience while moving along a road. The speed of movement determines the visual angle and the focus towards the landscape. Fast movement along the road has a narrowing effect on the sight width of the driver (Mourant, Rockwell, 1970). Objects standing very close to the roadside such as trees and buildings move along the visual plane of the observer almost as fast as the vehicle speed. Objects in the far distance such as forests remain steady in the visual plane of the driver. And certain features of the landscape can only be viewed at a particular speed.

The speed at which the driver travels determines how far ahead, in what duration, and at what angle it is possible to focus on and appreciate the landscape. Roadside landscape elements are perceived gradually, on a move, in different angles. The movement of a vehicle produces narrowing of the panoramic vision of the traveller. The width of the perceptible panorama is reduced to the faster vehicle moving. This is an important point for the road landscape evaluation and design. Figure 1.1 shows how the speed of traffic along a road can be used to determine the scale of variation along the edge, the duration of views and the size of openings.

Where surrounding objects are far or few, the driver feels like floating and not really moving forward. This can be temporally pleasant, but if one does not feel like reaching the goal it can end in boredom. In such case an object along the road can reassure the driver about his real motion. Simultaneously with object in motion, there occurs the sense of space. The driver

may be down in a concave space or up in convex space. The space may be narrow, wide, transparent etc. Movement along the road consists of approaching goals, which can be landmarks or final destination. Goals can help in self–orientation. Well–designed road and road landscape should present the viewer with rich, coherent sequential form, that has continuity, rhythm, development, contrasts, well joined transition and moving balance. Driver should be able to locate himself and the major features of the landscape (Lynch, 1965).

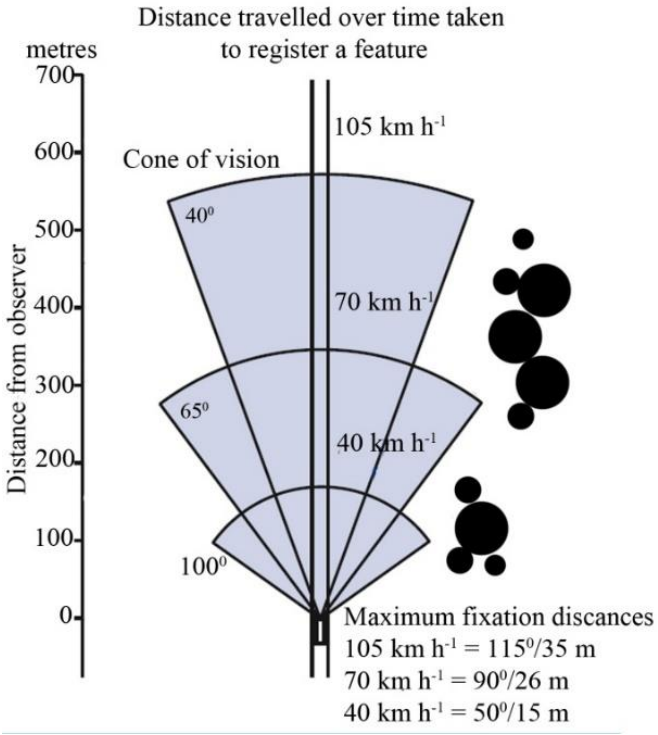


Fig. 1.1. **Distance travelled over time taken to register a feature** (Source: after Bell, 2008)

Landscape perception depends not only on physical elements in the landscape, but on people themselves. Landscape perception studies look at the way people see and understand the landscape from psychological, psychophysical, phenomenological and cognitive approaches (Zube, 1987; Appleton 1996; Kaplan and Kaplan 1982; Bell 2012; Zigmunde et al., 2016).

Road users' perception of the landscape is influenced by the height of the viewpoint and the purpose of the journey. Tourists travelling by bus see the landscape in another way than local people travelling by car, or truck drivers using the same road for many times.

For aesthetic road landscape design, it is important to understand what elements and structures are perceived by people as scenic, how they are assessed and later designed. Studies of Kaplan have verified that common environmental features such as presence of water and vegetation and factors like openness, smoothness of ground texture and ease of locomotion affect preferences (Kaplan, Kaplan, 1982). Relief, land use, presence of flowers, and lack of maintenance are relevant in the assessment of the visual quality of transport infrastructures. Construction materials and treatment of embankments can have an influence on the perceived quality (Wolf, 2006; Garre et al., 2009).

Preferences for road landscapes are determined both by pattern of land cover and land use and by psychological variables which are not directly mappable (Kent, 1993). Interpretation of the perceived landscape relates to cognitive aspects. Kent has used cognitive approach working with the complex human/landscape interaction and scenic qualities of the road landscape. Cultural additions (like land use, historic structures), transportation concerns (motivations for travel, travel speed, frequency of use) all influence the viewer's experience.

Landscape preference can be grouped in two approaches – expert and public approach. Expert and public perception–based approaches differ in how the features of the landscape are

represented, and in the way of determining landscape quality. The expert approach uses indicators of landscape quality from classical models of human perception and aesthetic judgement. The public perception–based approaches treat features of the landscape as stimuli that evoke aesthetically relevant psychological responses through sensory–perceptual processes and/or through intervening cognitive constructs. Expert landscape quality assessments have been criticized for having inadequate levels of reliability and validity. Perception–based assessments have generally achieved high levels of reliability (Palmer, 2001).

This research is based on public approach in road landscape perception.

1.2 The view from the road

1.2.1 Road landscape definition, qualities and characteristics

Road landscape definition. Road landscape is seen as the view from the road with all the surroundings. Visual perception zone from the road can be of different width. In the city is defined by buildings and other structures of the city. In the countryside, it depends on the relief, the placement of forests and their distance from the road. Taking into account the vision possibilities of humans, the road landscape corridor (further called road landscape), including objects visible from the foreground to background in Latvia, is considered to extend to between 1 and 2 km from the central axis of the road depending on the topography, degree of cut and fill and other factors (Slēde, Vikmanis, 1980). Road landscape in Latvia is considered as one of landscape types according to landscape functions (Меллума, 1972). It consists of foreground, formed by objects up to 25–30 m from the roadside, middle ground, which is 130–150 m from the roadside and background (Melluma, Leinerte 1992) (Fig.1.2.).

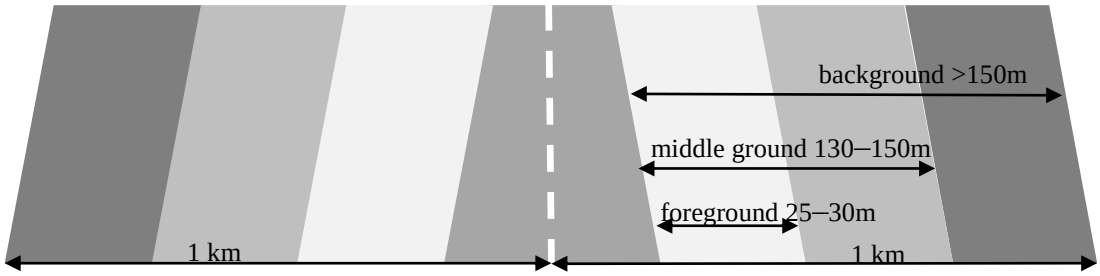


Fig. 1.2. **Distances of foreground, middle ground and background**

Views from the road depend on the placement of the road in the landscape, composition and placement of natural elements in the road corridor and on road infrastructure object architecture and design. Figure 1.3. shows the multidisciplinary of the road landscape planning and design, the connections between road engineering, landscape and architecture (Smirnovs, 2008). In order to achieve the best results specialists from all the involved fields need to understand each another and to cooperate.

Road landscape corridor is perceived in movement, where images change in time and space. Movement along the road corridor takes place in two directions and it is essential to evaluate and plan landscape on both directions. Each object is visible only for a certain time. Road architecture can be considered as kinetic art (Smirnovs, 2008). Road corridor is perceived within certain route, which changes only due to seasonality, but most of elements stay intact and are always the same. Road corridor can be perceived in a certain length depending on visibility. N.Orntaski has developed a theory for road landscape planning in these sections (Орнатский, 1986). As different road types can be distinguished (highways, major roads, local roads, historic roads and new road layouts), the environment and landscapes they pass through have different functions and purposes, which must be identified. Road corridor has characteristic features, which need to be considered in road landscape design and planning.

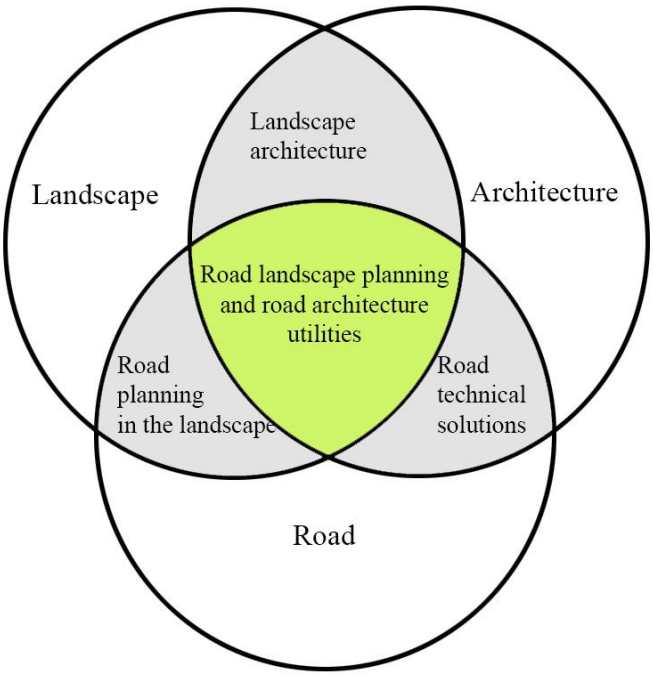


Fig. 1.3. **System of the connections between road, landscape and architecture**
(Source: after Орнатский, 1986)

Road users are in motion, when they travel in one direction through the landscape and their travel experience depends on the road infrastructure quality and road landscape qualities, which can be assed and designed considering certain characteristics (Fig.1.4.).

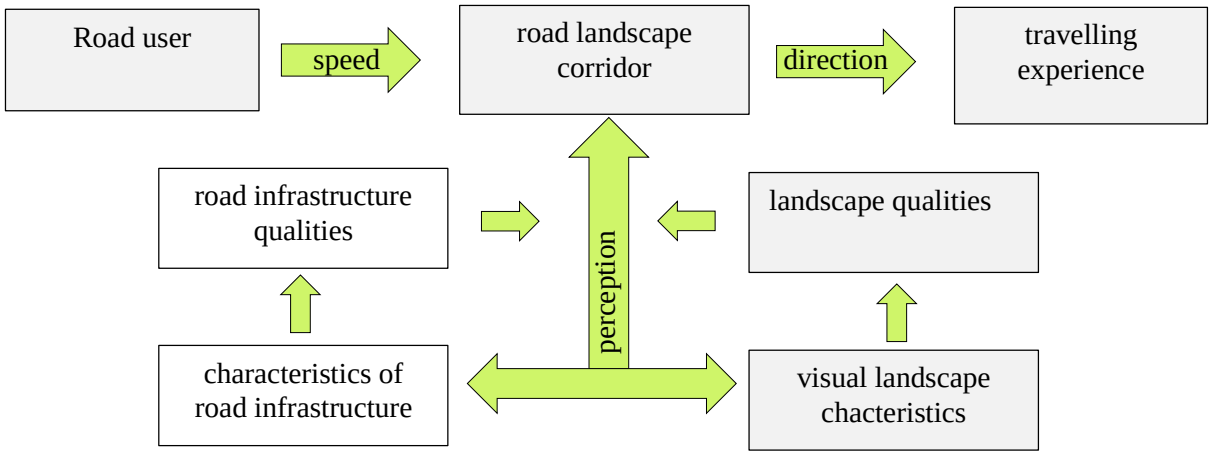


Fig. 1.4. **Scheme of of factors influencing travelling experience**
(Source: by author after Орнатский, 1986)

Road landscape qualities are well described in National Scenic Byways program assessment methodology, developed in the United States (Kelley, 2004). The program helps to recognize, preserve and enhance selected roads throughout the United States, foresees evaluation of six "intrinsic qualities" or intrinsic resources of the road landscape corridor (Vermont Agency..., 2000). They are assessed, mapped and further actions for their preservation and development are described in the Scenic byway corridor management plan. These qualities are important in any road landscape and should be taken into consideration in road landscape evaluation and planning. These qualities are:

1) Archaeological quality. Archaeological quality is physical evidence of historic or prehistoric human life or activity that are visible and capable of being inventoried and

interpreted. It can be identified through ruins, artefacts, structural remains and other physical evidence with scientific significance that educate the viewer and promote appreciation for the past.

2) Cultural quality. This is evidence and expressions of the customs or traditions of a distinct group of people. Cultural features can be crafts, music, dance, rituals, festivals, speech, food, special events, vernacular architecture, etc., and are currently practiced.
3) Historic quality. This resource is associated with physical elements of the landscape, it can be natural or manmade. The historic elements reflect the actions of people and may include buildings, settlement patterns, and other examples of human activity. They possess integrity of location, design, setting, material, workmanship, feeling, and association.
4) Natural quality. Features of the visual environment that are in a relatively undisturbed state. These may include geological formations, fossils, landform, water bodies, vegetation, and wildlife. There may be evidence of human activity, but the natural features reveal minimal disturbances.
5) Recreational quality. Outdoor recreational activities directly associated with the road corridor's landscape. The recreational activities provide opportunities for active and passive recreational experiences. They include, but are not limited to, downhill skiing, rafting, boating, fishing, and hiking. Driving the road itself may qualify as a pleasurable recreational experience. The recreational activities may be seasonal, but the quality and the importance of the recreational activities as seasonal operations must be well recognized.
6) Scenic quality. This is visual experience derived from the view of natural and manmade elements of the visual environment of the road corridor. All elements of the landscape – landform, water, vegetation, and manmade development – contribute to the quality of the road landscape (Kelley, 2004).

The scenic quality and visual character of the road depends on several factors, some of them are constant, e.g. physiography, but others, e.g. land use, are subject to change. It implies that character of road landscape can be controlled and managed to certain extent.

Road landscape characteristics for assessment and design. The character of the landscape is based on the aspects which make it unique: the landform, different types of vegetation, trees, crops, materials used in landscape construction, traditional features etc.. Visual characteristics of roads can be evaluated from three perspectives: 1) the road seen as an independent construction, 2) the road seen in relation to its surroundings, 3) visual characteristics of road landscape related to traveller's movement along the road (Blumentrath, Tveit, 2014). C.Blumentrath and M.S.Tveit in their research have identified 12 visual characteristics, which are expected to influence the visual perception of roads and visual design principles in road landscape design. There are twenty–nine visual design principles according to the visual design characteristics, which seem to be of importance, but they often contribute to more than just one visual characteristic (Table 1.1.).

The first design dimension includes six visual characteristics, which influence the aesthetical perception of a road and its roadsides, seen as a construction or a piece of architectural work itself: coherence, imageability, simplicity, visibility, maintenance and naturalness. The second dimension focuses on the relationship between roads and their surroundings and includes the perception of the road from the surrounding landscape. Two strategies can be distinguished here: either, the road is adapted to the surrounding landscape or it is constructed as a contrast. The four visual characteristics in the third dimension of road design are connected to the movement of users along the road, and their perception of the road and its surroundings (Blumentrath, Tveit, 2014).

This research is focused on the third visual dimension related to traveller's movement along the road and on patterns, elements and road structures, which influence road users' experience while on the road.

Table 1.1.

Visual characteristics and design principles in road landscape design

Dimensions of road design	Visual characteristics	Design principles
I **Visual characteristics of road as an independent structure/ construction. Characteristics concern road itself.**	1) Coherence	Design follows one principal idea Uniformity of road elements Comprehensive/ holistic design Good road alignment Good proportions
	2) Imagebility	Design follows one principal idea Sequences Road art Local material Create and highlight landmarks Facilitation of distinctive/ memorable views
	3) Simplicity	Simplicity in design So less equipment as possible
	4) Visibility	Design with regard to human scale Open, sheer, transparent form/material Lighting and bright colours
	5) High quality and maintenance	Material requirements Quality of workmanship Preservation in original design Regular maintenance work
	6) Naturalness	Replacement of technical elements with more natural elements Greening
II **Visual characteristics of roads in relation to its surroundings. Integration of roads into the surrounding landscape**	7) Integration	Greening Minimal intervention Neutral design Local material Good road alignment Design/form of roadside areas Replacement of technical elements with more natural elements
	8) Contrast	Create and highlight landmarks Road art
III **Visual characteristics of roads related to traveller's movement along the road. Patterns and road structures which stimulates and influences travellers experience while travelling along the road**	9) Variety	Diversity of landscape elements and activities Facilitating varied and long enough views Sequences Create and highlight landmarks Temporary effects Road art
	10) Aesthetic of flow	Design follows one principal idea Facilitating varied and long enough views Sequences Good road alignment Scale and details adapted to place
	11) Legibility	Visual guidance Good road alignment Simplicity in design So less equipment as possible Lighting and bright colours
	12) Orientation	Facilitating varied and long enough views Sequences Create and highlight landmarks Road art

(Blumentrath, Tveit, 2014).

Variety. The first of the characteristic features in this group is variety, which is defined as ‘‘the diversity and richness of landscape elements and features, their interspersion as well as the grain size of the landscape’’ and it ‘‘has been identified as the key concept of visual quality’’ (Tveit et al., 2006). Variety of views and designs from the road are believed to enhance the attractiveness of roads. Variety is also considered to be important particularly for drivers when considering road safety. It helps to avoid monotony and reduce fatigue (Blumentrath, Tveit, 2014). Variety should not be mixed with visual complexity, when the background and the number of objects in the scene combine to the point of creating an information load that is excessive, confusing. Visual richness evokes interest, but visual clutter reduces preference.
Variety is enhanced by sequence design. Landscape sequencing improves user perception through changes in visual cues. It can also effectively promote distinctive character of the road corridor. Potential visual cues useful to developing sequences are: form; scale; pattern; light and and arrangement of spaces and associated perceived density (Transport and …, 2013).

Aesthetics of flow, the second feature is connected to time and movement.

Movement at different speeds includes quite different experiences and consequently also demands for a different design approach. One of issues for design of road landscape is: design for acceleration and deceleration. Movement and speed in relation to traffic safety is a major factor determining the design and the design approach. The design of a motorway is different from that of a bicycle route, not only because of size and scale but mainly due to difference in (design) speed (Toorn, 2005; Toorn 2006).

Movement at different speeds includes quite different experiences and consequently also demands for a different design approach. One of the issues for design of the road landscape is: design for acceleration and deceleration. Movement and speed in relation to traffic safety is a major factor determining the design and the design approach. The design of a motorway is different from that of a bicycle route, not only because of size and scale but mainly due to difference in (design) speed (Toorn, 2005; Toorn 2006).

Speed and design are interconnected. Design of road infrastructure can influence the driving speed. Long straight section of the road, wide and clear road surroundings, wide road and road with a smooth surface have accelerating effect on the drivers, which leads to speed exceeding. Xiao, Yun, and Xu (2007) found that the main cause of accidents on a long, level, straight stretch of road was monotonous scenery and a lack of fixed points against which the driver could accurately judge speed. Shorter stretches of the road, speed limiting features, narrow road and narrow surroundings, uneven surface have decelerating effect and drivers reduce speed (Table 1.2.). Roadside plantings can affect speed. Research shows that on straight roads side planting does not influence speed behaviour, no influence was determined. On roads with dangerous bends, plantings outside the curve have a speed–lowering effect (Lippold et al., 2006).

Table 1.2.

Characteristics of road infrastructure and their impact on speed

Characteristics of road infrastructure	Accelerating effect (desire to exceed speed)	Decelerating effect (desire to reduce speed)
Straight road section	Long straight section of the road	Short straight section of the road
Speed limiters	Not installed	Are installed
Road environment	Wide and clear road surroundings	Narrow road surroundings
Road width	Wide road	Narrow road
Road surface	Smooth surface	Uneven surface

(Source: Par ceļu ..., 2017)

Aesthetics of the flow depends not only on the speed, but on the way the road landscape is designed, and it can be described as ‘‘travel experience’’, ‘‘rhythm and balance’’ and ‘‘experience of different sequences’’. Due to limited spatial dimensions, objects cannot be continuously in the field of vision. For this reason, it is important to create a section where attention can be relaxed before any object. Appleyard and his colleagues looked at road landscape planning from a different perspective stressing that road watching can be “a delight. … The view from the road can be dramatic play of space and motion, of light and texture’’ (Appleyard et al., 1964, p.3). The existing visual design principles that design should follow one principal idea, there should be varied and long enough views, sequences, good road alignment, scale and details adapted to place, are mostly based on the literature of the 1960s and 1970s, when the interest in seeing roads as a journey first arose (Blumentrath, Tveit, 2014).

Legibility is the third visual characteristic feature, by which drivers can foresee the road alignment ahead, so they can adapt their vehicle movement and speed to the approaching stretch of road. Roads with good legibility show their alignment to drivers clearly along several hundreds of meters while bad legibility is typical of curved roads whose next stretch is hidden behind a bend or the top of a hill (Convention, n.d.). Legibility is the degree to which a road is understandable (Schutt et al., 2001, p. 32). Legibility is affected by depth perception, spatial definition, and orientation. Textures and colours of elements and view units will have a great influence on legibility. Legibility is also the central issue in the discussion around ‘‘self–explaining roads’’ (Theeuwes, 1998; Charlton et al., 2010) and road safety. Design principles like clear road alignment and simplicity in design contribute to the legibility of roads. Additionally, visual guidance can be enhanced through signs, road lighting, tree rows along the road and the like. It is possible to identify and use road designs that allow desirable driver behaviour (Elliott et al., 2003).

Orientation in space, the third feature means that road users are able to locate themselves in an area, can observe the progress of their journey and get an understanding of the landscape they pass. Many of the visual design principles are foreseen to improve orientation (see Table 2). Facilitating views from the road, the creation of sequences which are designed in coherence with the surrounding landscape, the use of road art, to the illumination of landmarks in the darkness help road users to orient themselves (Blumentrath, Tveit, 2014). Landmarks and spetial features like road art should be provide at interchanges, town entries and service road roundabouts, gateways to local area for better orientation according to road design manuals (Transport and …, 2013). Landmarks provide a strong individual symbol or focal point within a road landscape, providing identity, visual structure, character and a sense of place. Landmarks can be hard structures, such as a building or artwork, and soft vegetation such as distinctive individual tree specimens, masses, stands or groves of trees.

Vividness. Most of US scenic highway programmes apply four descriptors to assess scenic quality along roads: naturalness, vividness, variety and unity. Clay and Smidt have recognized that of the four descriptors only vividness has significant relation with preference, and most correlated with the construct scenic beauty (Clay, Smidt, 2004).

Vividness is defined as “being the overall extent to which a landscape scene could be considered memorable. This scenic characteristic can be associated with landscape distinctiveness, which can be generally thought of as being some recognizable level of landscape diversity and/or landscape contrast that seems to visibly exist between the various elements within the scene. A vivid landscape makes an immediate and lasting impression on the viewer. This descriptor variable can be applied to either a natural/naturalistic scene, or to a scene with human elements in varying degrees” (Clay,Smidt, 2004).

The characteristcs of landscape described above can be used in road landscape assessment, planning and design.

1.2.2 Road landscape assessment and representation techniques

Road landscape assessment

Landscape quality is evaluated using various techniques and methods – through analysis of cartographic material, photography and video analysis, field visits, interviews and surveys, producing landscape models and testing them in driving simulators.

Determination of road landscape quality involves inventory of physical elements of the territory. Maps have been and are used to represent the physical character of the territory. New technologies like mobile and airborne LiDAR (light detection and ranging) remote sensing offer new possibilities for mapping the landscapes and large territories. Remote sensing provides high resolution data in short time and is used to portray the topography of the landscape and structures of the landscape. LIDAR applications have transformed remote sensing and scientific research of landscapes, especially research targeting ecological systems and cultural resources. It has the potential for applications in landscape design, ecological planning, and geodesign as an interpretive tool beyond inventory and mapping (Murtha, et al., 2018). Landscape ecology, landscape archaeology (Chase et al., 2011) and preservation are using LIDAR data with positive results. Williams et.al discusses the use and advancements in mobile LIDAR technology, techniques, and current and emerging applications in transportation (Williams, et al., 2013). Mobile LIDAR technology has been chosen in this research to acquire topographic data and aerial photographs of the case study areas for the analysis of the present situation.

Since the 1960s photographs and photomontages have been widely used for landscape assessment and in public preferences research (Nassauer, 1983) (e.g. Sheppard, 1989, Al–Kodmany, 1999). Due to the technological development since early 1990 the analog photomontage is replaced by the digital photomontage (e.g. Lange, 1990). In landscape preference studies visual landscape quality often is measured using photographs of current situation in combination with survey of road users (Matijošaitienė, 2010; Martín, et al., 2018). Several studies from the 1970s and 1980s investigated how landscape is perceived from the road by showing photographs to the subjects. As the road corridor became increasingly built–up, the landscape was ranked as decreasingly valuable, useful, and beautiful. Removing the built–up features (e.g., billboards) from the images by retouching increased the appreciation of the landscape. Using digitally manipulated photographs of American freeways, it was found that trees and parks became more important and preferred by drivers, as the environment became increasingly built–up (Wolf, 2003). Researchers studying road scenic quality assessment have used photography method (Clay, Smidt, 2004). Considering former research on road landscape assessment in other countries (Denstadli, Jacobsen, 2011; Ramírez et al., 2011; Clay, Smidt, 2004; Akbar et al., 2003) photography method was used in preliminary research and for capturing the present state of landscape elements in the case study areas. But static photographs have limitations. They do not represent the movement, which is essential in road landscape perception, assessment and representation.

Video documentation of a road is useful in a landscape assessment (Bell, 2008) and has been used in this research.

Interviews and surveys have been widely used by researchers in landscape preference studies in general and in studies about road environment as well. Several studies have investigated the prevalence of a wide range of driving distractions using different forms of interviews: telephone interviews, Schroeder et al., 2013), face–to–face interviews (Prat et al., 2017). Drive along interviews when drivers or pasengers can comment landscape they see and to point out landscape elements are used.

A questionnaire survey has the advantage of reaching a reasonably representative group of people in a short period of time, providing the means to generate data that can be quantified and analysed (Oppenheim, 1992). The rapid development of surveys on the Internet has led to increased use of web based surveys, which replace traditional printed survey data collection and on site studies (Olwig, 2005). Web based internet surveys are tested to be successful in

landscape related research as well (Bishop 1997;Wherrett, 1999; Wherrett 2000). From the research by Roth the internet survey has proved to be an objective and reliable tool for gathering valid data on landscape perception and visual landscape assessments. The results of online scenic quality surveys have a high potential for broader generalizations (Roth, 2006). Research on road landscapes has been carried out using surveys as well. Brown in his research about how people perceive, value and use transportation system in Alaska carried out a mail survey (Brown, 2003). The overall response rate was about 20 %. Web based survey of road users is used in this research.

Driving simulators have been accepted as good substitutes for on–road surveys and are used for many purposes – for example, to study drivers' impairment (Anund et al., 2008), stress (Hill and Boyle, 2007), experiences of landscape (Antonson et al., 2009), landscape heritage objects' effect on driving (Antonson et al., 2013), experiencing moose and landscape while driving (Antonson et al., 2015), and choice of speed (Calvi et al., 2015). Limitation of driving simulators is smaller number of participants compared to other types of surveys.

Road landscape representation techniques

Analogue landscape visualisation. The classic visualisation tools for landscape analysis and representation of ideas in planning and design are plans, sketches, hand–drawn perspectives, section drawings by hand and physical models. Physical models and sketches are the oldest ones. Charcoal drawings of rhinoceroses and bisons in the cave of Chauvet–Pontd'Arc (Ministère de ..., 2002) and models found in Egypt and early Chinese tombs (Zube et al., 1987a) date back to more than 30'000 B.C. Perspective drawings became a common tool in architecture for the presentation of the final design in the Renaissance. The oldest known perspective from this period is a mural dated after 1317 by Giotto in the Bardi chapel of Santa Croce in Florence (Lange, 2002).

Perspective drawings and illustrations, before–and–after views in open space planning have a long tradition. Humphrey Repton (1752–1817) was a pioneer of using montage techniques in landscape architecture. He presented his designs and ideas to the clients by watercolour picture books. He painted the as–is state of his projects on a moveable cover. The client could see the current state and planned scenario by turning that cover back and forth. Repton combined conventional media like books and sketches with interactivity, he denoted his pictures as slides. This historical form of a New Media can retrospectively be considered as the first interactive, even though analogue technique of landscape visualisation (Rekittke, Paar, 2008).

In the first road landscape research studies Appleyard et al. (1966) analysed the perception of car drivers along a highway by using a set of photographs or perspective sketches combined with written descriptions of this sequential experience. They were pioneers in dynamic simulation. In the Berkeley Environmental Simulation Laboratory (Appleyard, Craik, 1978) a miniature endoscopic camera was used that was hung from overhead gantries. This setup gave users freedom of movement through the physical model of central San Francisco at eye level (Swaffield, 2017).

In 1970s, the use of digital techniques for landscape representation developed and it has increased particularly since the 1990s when visualizations started to reach greater realism and more interactive viewing capabilities (Bishop and Lange, 2005, Lovett et al., 2009).

From the 1990s, the improved capabilities to link CAD, GIS and landscape visualization software have enhanced the possibilities for digital representation. At the present time a common approach is to compile information for a study area in a CAD or GIS database and then generate three main types of 3D outputs. These can be summarized as rendered still images (or scrolling panoramas) from defined viewpoints, animated sequences (showing fly–through along specified paths or changes over time) and real–time models (or virtual worlds) where the user has the ability to freely navigate a landscape (Appleton, et al., 2002). GIS–based landscape visualisation has developed over last 20 years (Sheppard, 2000). Limits of realism for

environmental decision–making using GIS–based visualisation of rural landscapes has been discussed by Appleton, Lovett and Lange. Results of their research do not show evidence of a 'sufficient' level of realism, but strongly indicate that some elements are more important than others (Appelton, Lovett 2003; Lange 2001). Several studies have discussed the role of visualizations at different stages of a planning process (e.g. Lovett, et al., 2015), Pettit et al., 2012). Other studies have reported a tendency for younger and/or more technically inclined workshop participants to favour computer–based real–time visualizations, whilst older ones preferred photomontages (Lovett et al., 2015).
Development of techniques used in landscape representation and preference studies is presented in figure 1.5.

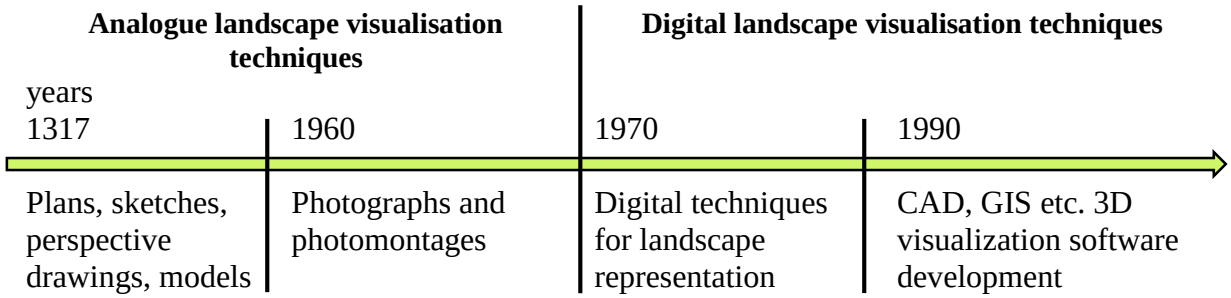


Fig. 1.5. **Development of techniques used in landscape representation**

Digital three–dimensional visualisation of simulated landscapes. Specialists like road engineers and landscape architects are trained to understand two–dimensional project plans. Other people frequently have difficulties in reading such plans and understanding how proposed changes – views, trees, road infrastructure elements etc. – would look and how it would change the landscape. Studies confirm that people perceive visual information about landscape design and planning in three–dimensional (3D) visualisations better than text and regular maps and that 3D visualizations are especially useful for collaboration involving untrained people in community decision making (Bishop, 2005; Hassan, Hansen, Nordh, 2014; Kwartler, 2005). Visualisation has become important in the context of participatory planning and designing of landscapes. Landscape visualisation not only has the potential to visually communicate spatial characteristics of possible future landscapes to stakeholders, it can also be used to explore conflicting interests by involving the relevant stakeholders early on, for example by adapting models for public involvement such as focus groups, public hearings, round tables, workshops, design charrettes and so on or, further, it could be the basis to integrate adaptive, analytical and systematic approaches (Milburn and Brown 2003) in research into a design context (Swaffield, 2017). At the same time 3D visualisations help practitioners to evaluate the new space and check mistakes during the design development (Zigmunde et al., 2015).

As road landscape is perceived in motion, it needs to be considered in landscape assessment and presenting road landscape projects to the parties involved in road planning and to road users. Landscapes through motion, and related traffic issues using 3D models have been studied by researchers (Antonson, et al., 2009). For studying the effects that infrastructure design have on perceived safety and attractiveness 3D visualizations of existing and possible future conditions have been used (Chamberlain, Liu, Canfield, 2016). Computer–animated road landscape models are used in driving simulators in studies connected to road landscape perception regarding safety issues (Jacobsen, Antonson, 2017) to study driving behaviour in relation to road markings, safety studies (Antonson et al., 2013; Antonson, et al., 2015) and drivers' perceptions of road and landscape features (Antonson, et al., 2014; Antonson et al.., 2009). Driving simulators have been accepted as good substitutes for on–road surveys. It has some drawbacks – simulator sickness, a well–known side effect why some people cannot take part in such tests.

In Triffault and Bergeron's (2003) simulator study of tiredness/exhaustion, digital landscapes were projected in front of the windscreen and steering wheel movements were measured. One road had trees repeatedly occurring in pairs along both sides that could already be seen at the horizon. Another lacked repetitive features, but contained other common visual stimuli, such as scattered trees, houses, and farms. The first road was judged more monotonous and to have a greater effect on driver tiredness, producing larger steering wheel movements. Using a driving simulator, Lippold, Dietze, Krüger, and Scheuchenpflug (2006) conducted a pilot study of the influence of roadside vegetation on driver behaviour. The test subjects were five young male drivers with extensive experience of driving the simulator. The pilot study found that speed and lateral position were influenced by the presence of different vegetation types along the roadsides.

The experience discussed above conforms the point made by Appleton et al. (2002) that there is no universal landscape visualization solution. Usually it is a matter of selecting the most suitable technique for a task.

3D models of road sections are designed in this research. As speed and movement through the landscape are important factors in road landscape perception, animations are developed from 3D models. Viewer travels along the road at a speed of 90 km h^{-1} (the legal maximum speed limit in Latvia) and observes the landscape from 1.1 m above ground level (which is the average eye level of a person travelling by car) in the developed animations. This technique is chosen in order to reach a larger audience of road users through questionnaire survey and acquire information about road landscape perception from a large group of respondents. Tests in driving simulators have limited number of participants, 10 to 20 persons in average.

1.3 History of road landscape planning and design development

History and the way how roads and of road landscapes were planned differ from state to state and show the cultural features of the period they were built. Throughout most of the 19th century roads were necessary for postal system and coach service. During most of the 19th century rivers, canals and railroads were more important to transportation than roads. Roads and streets were in better condition and mattered more inside cities (Mauch, Zeller, 2008). At the end of the 19th century development of automobiles created revolution in travel in the United States of America. Road network was built in the US more quickly and efficiently than in other countries. The first ideas for road planning were based on linking urban civilisation with nature. Frederick Law Olmstead and his partner Calvert Vaux introduced the term "parkway" The initial idea was to connect suburban parks with urban centres by means of landscaped parkways. First parkways resembled European boulevards. Parkways gained their popularity during 1920s and 30`s as an international model for harmonious integration of engineering and landscape architecture (Davis, 2008). Parkways provided access to recreational areas and from broader planning perspective, they were important in revitalizing rural regions. The beginning of the 20th century is the time when road planners started to consider scenic qualities of roads in the US. Scenic roads, parkways and landscape roads were planned and built for landscape enjoyment. These roads assumed landscape watching as the main project goal (Convention, n.d.) By the mid–1920s, due to increasing speed and usage parkways were turned into wider highways. The Committee on Roadside Beautification in the USA in 1930 adopted a resolution targeting roadside beautification. The resolution addressed conservation of natural growth, beautifying town entrances, roadside plantings, the establishment of parks and comfort stations, and the promotion of roadside improvement. The committee published reports that, in addition to the vegetation aspects of the roadside, focused on integration of engineering, architecture, and landscape design (Sutton 1947).

After 1940 with development of technologies, many of existing roads were radically transformed, they created a new environment and highways became as sites for mass consumption. During the decades between 1910 and 1940 roadsides became a place where public use and private value came together, roadside became commercial places with gasoline stations, restaurants, tourist camps, billboards (Raitz, 1998; Nye, 2016). By 1970, there were more cars than households in the United States. In 2000, the highway system in the United States was 40 percent longer than systems in twenty–five European states together (Mauch, Zeller, 2008).

In Europe the first new motor way called *autostrada* was built in Italy by Italian engineer Piero Puricelli. The design of *autostrada* was based on railway parameters, with almost no attention paid to landscaping and with billboards allowed alongside the roads (Zeller, 2007). The Bonn–Cologne Autobahn was the first Autobahn in Germany, opened in 1932 (Vahrenkamp, 2010). In Germany, much attention was paid to the nature and road landscape. Autobahn`s landscapes reflected German social values and ideology of Hitler, which aimed to foster regional style, homeland (Heimat) and nationalism. Zeller describes ideas and background of German Autobahn development in his book "Driving Germany: The Landscape of the German Autobahn, 1930–1970". Instead of providing the shortest connection between two points, German motorways were designed to form the most elegant connection possible. The country's main economic centres were connected directly to nearby cities, while motorways connecting to other main centres passed through open landscapes (Piek et al., 2011). German engineers learned from American achievements in motorway development and used ideas of American parkways in their autobahn development. American parkways and German autobahns had differences in philosophies behind them. German landscape architects carried racial theories into landscape. American parkway designers were more concerned about appearance, economics, use of native plants in aesthetic proportions. German autobahns were intended to harmonise with nature, but the foreseen travelling speed was higher, and it was harder to keep the picturesque intimacy of parkway landscape (Davis, 2008).

Political situation and decisions have influenced road development in all countries. Today US and German motorways are often referred to as examples of design combined with landscaping, but there have been different periods of development.

The visual aspects of highway planning and design became an important issue in the 1950s. In 1960s, discussions how the highway was affecting settlement patterns and the need to harmonize the relationship among the highway, open–spaces, commercial developments, housing, and historical sites started in the USA (Tunnard and Pushkarev, 1963). Architectural designers, such as Appleyard, discussed the highway as a platform for experiencing the city and considered the highway a corridor of motion that creates a sequential rhythm that they expressed in a unique notation system (Appleyard et al. 1964; Schutt et al., 2001).

The national scenic byway program was one of the first programs to embrace amenity in highway transportation systems. The US Forest Service began its National Forest Service Scenic Byways designation program in 1988. In 1991, the US Congress enacted legislation providing for the establishment of a National Scenic Byway Program to promote and protect America`s scenic roads under the Intermodal Surface Transportation Efficiency Act. Scenic Byways program designates special scenic routes and has a methodology for selecting them. The most scenic roads must meet at least two out of the "six intrinsic qualities "(Intrinsic qualities …, n.d.). Identification and measuring of general public awareness about the scenic byway system in Alaska; comprehensive assessment and measuring of actual and potential scenic byway qualities was carried out (Brown, 2003) Selection and designation of scenic byways (Vermont …, 2000; Smith, Smith,1992), research on scenic byways planning (Spraggins and Mitchell, 1960) was carried out. Research on scenic byways approves their importance in the route choice (Eby, Molnar, 2002). There are studies how to incorporate scenic driving in GPS navigation system (Zheng et al., 2013).

Similar to parkways in the United States, mountain roads, lakeshore or seaside drives were built in many European countries to provide scenic views while travelling. In 1930s, during the era of National Socialism, the German Alpine Road (Deutsche Alpenstraße) was built, which was 450 kilometres long and was located on the northern mountain crest of the Alps (Zeller, 2016). In France and in some parts of Europe, themes like architecture, handicraft and beverages have been represented in road routes (Mitchell, Hall, 2006).

During the 1940s, the Institute of Landscape Architects in Great Britain tried to involve their members in the landscaping and planning of future roads. Landscape architects criticized the tendency of local authorities and organizations such as the Roads Beautifying Association to plant ornamental trees and shrubs which would interrupt the flow of the landscape and distract drivers travelling at speed. Brenda Colvin, Sylvia Crowe and Geoffrey Jellicoe argued for a focus on simplicity, flow and the visual perspective of drivers. Roadside planting must improve safety, guide the attention of drivers, screen unsightly views, prevent boredom, reduce dazzle and enliven the scene. Sections of the first M1 motorway were criticized for failing to adopt a contemporary, modernist design. Colvin, Crowe and Jellicoe all suggested that British engineers could have drawn important lessons from the design and landscaping of motorways in Germany and the USA. British landscape architects and preservationists had been admiring German and American motor roads since the early 1930s (Merriman, 2006).

Nowadays, the Highways Agency of the United Kingdom in discussion with English Heritage, the Landscape Institute, the Institute of Field Archaeologists and the Council for British Archaeology, has developed a guide "Assessing the Effect of Road Schemes on Historic Landscape Character", which is intended to assist in the preparation of environmental assessments of the changes that will be made by road schemes to historic landscape character by identifying principles and emerging best practice. These include their definition, the role of historic landscape character, baseline data sources and collection, historic landscape analysis, assessing sensitivity and magnitude of change, outlining mitigation strategies and finally assessing the significance of effect (Highways Agency, 2007)

With the pronounced aim of bringing car tourists to the countryside, the Norwegian Public Roads Administration in collaboration with Norsk Form, an organization promoting Norwegian design and architecture established Tourist Route Project (TRP) in 1999. Their aim was to designate and develop eighteen stretches of road throughout Norway as official tourist routes or scenic byways. Several of these roads are finished, and the plan is to complete the last one by 2020. The Tourist Routes were mainly established on roads built between 1880 and 1940, they run through mountain passes, along the fjords of Western Norway, and along the coast of Atlantic Ocean Road or the Lofoten Road. TRP's focuses only on the reconstruction or maintenance of these scenic routes, upgrading and even restoration take place to a certain degree, but more intensely on the architectural structures built along the routes. The TRP organizes architectural competitions for pull–out points, laybys, viewpoints, parking spaces, ferry quays and visitor centres, and the selection process is based on artistic, architectural and planning value. So far, more than 60 projects have been built and many more are under way. Norwegian Public Roads Administration has a long tradition of building roadside amenities, and simple rest areas have frequently been established next to natural viewing sites. The Tourist Route Project involves 80 municipalities and 9 counties, as well as more than 20 tourist organizations, working closely with local tourist information groups, local administrations. While the overall structure – planning, selection of sites, the system of architectural installations – is a national responsibility, local administrations have a strong influence in planning and building the installations (Larsen, 2016).

The Netherlands formally started to plan road landscape with the establishment of a special group at the Dutch Forestry Service in the beginning of the 20th century. Task of this group was to advise the Minister of Public Works on plantation along major roads and waterways (Toorn, 1996). Landscape architects started to make landscape plans for all major new motorways in the country before the Second World War (Harsema et al., 1991) and

infrastructure has become mainstream subject in landscape architecture in Holland (Harsema et al., 2000). "Infralandscapes" – landscapes which are directly or indirectly influenced by infrastructure become a new typology and together with urban and rural landscapes form three basic landscape typologies in the Netherlands (Toorn, 1996). Motorways initially were built to connect cities. In the high–density land use with rare open spaces today, urbanisations along motorways have led to cluttered landscapes, which was identified as one of the more urgent problems. In 2006, the Netherlands started to develop the structural concept for the motorway environment. Generic policy on panoramas and motorway zones was developed in the National Spatial Planning Act to protect the Dutch motorway panoramas and it was incorporated in the policy programme Cooperation Agenda for Attractive Netherlands (Piek et al., 2011). Dutch Road Authority has paid much attention to the road safety and has invested in infrastructural networks, focusing on the desired behaviour of the road user (Theeuwes, 2012).

Countries have different examples on road and landscape design. The motorway from Seville to Cadiz in Western Andalusia in Spain, planned and built at the beginning of the 1970s, was one of the first high capacity roads in Spain. Lanes were wide and straight, ready to bear high traffic flows; very few junctions connected to only the main regional roads. The landscape was fat and extensive along most of the route. Most of the time its platform was framed by two dense tree screens, standing up on each side, hiding landscapes behind them. This motorway belongs to that model of progress, which favoured high economics and relied on unlimited resources. The A–381 built at the end of the century by the Andalusian public agency for infrastructures is a good example of the last generation of motorways. The aim of this motorway was to connect the industrial area of Algeciras in the South, next to Gibraltar, to the main urban areas of Cadiz, Xerez and Seville. Its outlay is not as designed individually and detached from the landscape as the first motorways (Español Echaniz, 2010). Lately two initiatives, instigated by the Junta de Andalusia and carried out by the Centre for Landscape and Territorial Studies, have been implemented. A handbook entitled "Roads in the Landscape, Criteria for Planning, Layout and Design" has been published and a catalogue of scenic routes in Andalusia is being prepared (Pozuelo, 2010).

There are countries where research and practice of road landscape does not have long history and traditions. Researchers from Turkey discuss the necessity to create awareness about the importance of the visual effect of the road and to plan more effective scenic roads especially in national parks, protected areas and those of regional heritage, which consist of natural and cultural environments in Turkey (Akalin, 2016).

Overview of important years and periods in the road and road landscape planning development is given in figure 1.6.

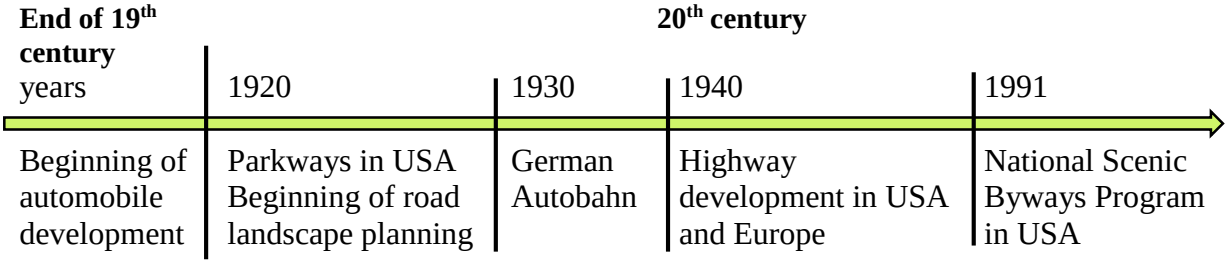


Fig. 1.6. **Road and road landscape planning development**

Nowadays, many national road authorities offer design guides and recommendations for the road landscape development (Beautiful Roads..., 2002; A Guide..., 2005; Federal Highway Administration, 2001; Schutt et.al, 2001). Landscape design guidelines for the state roads and railways have been prepared and published in the end of 2013 in Lithuania (Braga et al., 2013).

European countries, which have signed the European Landscape Convection have to integrate landscape protection, management and planning in national policies and programmes. In some European countries, landscape analysis has long been used in support of large–scale

planning or major projects such as new roads, in line with both the UN's Convention on Environmental Impact Assessment and the European Landscape Convention. Some countries, however, lack a regulatory framework for landscape analysis and planning including issues regarding road landscape.

1.4 Development of road landscape planning, design and management in Latvia

1.4.1 History of road landscape development

Road landscape development in Latvia can be divided in several historic periods. The first one is road landscape development up to the 21st century with the first unpaved roads. The second from 1919, when the Latvian state was established to the First World War in 1940. The third from the end of Second World War in 1945 to 1991, when Latvia gained independence and the fourth from 1991 to our days. Development of road landscape in these periods are described in this section.

The first road landscape development up to the 21st century. Many Latvian roads are several centuries old. Old chronicles from the 13th century mention important roads in the territory of what is now Latvia. Road network which developed from 13th to 15th century was similar to the one which exists ourdays. Today these historical routes can be traced by old trees which served as landmarks along the road, such as the Kaive oak near Tukums or the Zauska pine near Smiltene. Important post roads crossed Livonia and Courland during the 17th century. The post system was enlarged in the 18th century after the territory of Livonia and Courland was added to the Russian Empire.

Roads in the modern sense of surfaced routes capable of withstanding traffic all year round first emerged in the middle of the 19th century after the Russian Empire started to build strategic roads from St. Petersburg to Warsaw through Rezekne and Daugavpils and from Pskov to Riga, Jelgava and Taurage (Andrejsons, 2004). Old engravings of the period show the beginning of roadside landscape development during the 18th century, when the first alleyways or avenues were planted along the entrance roads to manor houses from the point where they left the highway (Valsts ražošanas apvienība…, 2013).

The first roadside plantings were arranged to protect pedestrians and drivers from the sun, wind and heavy rain. Alleyways or trees roes also performed practical tasks. They prevented the roadside soil from drying out and protected the roadbed from the influence of wind and water. Usually the older alleyways were planted on the road shoulders and rarely behind the roadside ditches. Trees were planted close each together and formed crowns with dense foliage (Valsts ražošanas apvienība…, 1998). Tree rows also marked the edges of the snowbound roads in winter. Plantings to prevent snow drifting appeared in the 19th century for railway protection and later on similar plantings were located along the main roads.

The period 1919–1940. The foundation of the Road and Building Board in 1919 marks the beginning of the Latvian road industry. There were few plantings to be found along Latvian roads at the beginning of the 20th century according to the statistical data. After the First World War only 434 km roads managed by the state were planted with trees and bushes. Road landscapes were mainly influenced by the Forest Day activities in 1930s. These were started in Varakļāni in 1928 on the initiative of the district forester Pēteris Purviņš in order to plant a city boulevard (Elksis et al., 1967). Table 1.3 shows the number of trees planted during the Forest Days.

Many alleyways were planted using different trees species, like alleé along the section from Tukums to Birzule, cherries from the Lithuanian border to Ventspils, birches along the main road from Riga to Jelgava and a 60 km long cherry allée between Rudbarzi to Skrunda and Saldus (Valsts ražošanas apvienība…, 1998). At the same time the road engineer Silenieks described the experience of road landscape design in Western Europe and Germany in the

journal “Road traffic” in 1930, where tree rows were replaced with tree groups because of safety problems associated with the increase of driving speed (Silenieks, 1930).

Table 1.3.

Data about the first category state road tree planting

Year	Length in km	Number of trees planted
Up to November 18 1918	434	64 000
From November 18 1918 to spring 1935	66	13 000
1935 spring	484	78 000
1936	446	60 000
1937	283	35 000
Total	1713	250 000

(Source: journal “Road and Traffic” Nr.1, 1930)

Latvian road engineers learned road planning principles in connection with the landscape from other countries. Attention was also paid to tourism and the way tourists saw the country (Dripe, 1940). Several tourist roads were built, see Table 1.4.

Table 1.4.

Data about tourist roads

Road section	Length, km	Cost, LVL
To Staburags	3.5	12 000
To Gaiziņkalns	1.5	9 000
To Dēliņkalns	0.9	3 000
Tauleskalns near Krāslava	1.3	2 000
Tietiņiezis (on the right bank of Gauja river)	1.4	4 300
To Zilaiskalns	1.0	500
To Skaņaiskalns near Mazsalaca	3.2	400
To Cesis sanatorium	1.8	10 000

(Source: journal “Road and Traffic” Nr.13, 1940)

The period 1945–1991. First decade after the Second World War was spent in reconstruction of destroyed roads and bridges. Many of the road plantings had also been destroyed. In parallel with reconstruction work improvements to the public transport sector were carried out. In first years after the war, the care of the road landscape was in the hands of road foremen or repairmen (Valsts ražošanas apvienība…, 1998). Existing alleyways were reconstructed and new decorative plantings made.

In 1948, Forest Days were re–established. The main organizer was the Council of Ministers of the Latvian SSR. The name was changed to “Forest and Garden Days”, but the action was prohibited in 1968, being considered to be a bourgeois remnant (Elksis et al., 1967).

There were different views about road landscape development until road landscape planning theory was developed. The work was planned in several main directions:

- the aesthetic formation of road landscape and the placing of new roads in the landscape;
- improvements to traffic safety in such a way so that different road plantings did not disturb visibility and did not cause accidents, prevented road snowdrifts, protected agricultural land from car exhaust fumes and reduced traffic noise;

- carrying out nature protection measures by solving surface water drainage problems; preventing soil erosion and road lane pollution;
- building bus stops and car parking and resting places (Andrejsons, 2004).

Roads plantings were classified according to their functions and tasks:

- engineering and operational tasks (strengthening of slopes with vegetation cover, protection against snow);
- increasing safety (road visual perception reinforcement, preventing drivers from being dazzled by the sun;
- road aesthetics (screening of unsightly views);
- biological, agricultural and forestry tasks (improvement of microclimate, reducing the risk of forest fire) (Taubenbergs, 1972).

Landscape principles in Soviet normative literature for the first time were reflected in 1950 mentioning "The road has to blend with relief forms. The road axis should be perceived as a line the placement of which depends on surrounding landscape". These design regulations were included in SNIP II–D.5–72 „Roads: Design regulations" as recommendations (Бабков, 1940).

In 1965, the Latvian SSR State Road and Transport Design institute "Ceļuprojekts" was formed. Starting from 1962 the principles of spatial planning of roads became widely applied in practice. Initiator of this method was engineer Peteris Dzenis and almost all roads in Latvia are designed according to these principles. Road landscape design work also started at this time. The architect Velta Reinfelde started to work in road design in 1959 and in cooperation with Peteris Dzenis, a book about road design and landscape design was published. The book was also translated into Polish. Cooperation between engineers and architects helped in spreading landscape ideas among road designers. However, the introduction of landscape design principles into road planning was delayed because of missing instruction materials and the prevailing opinion that landscaping was too expensive and over–beautified the road (Andrejsons, Sviķis, 2016).

Debates for and against roadside trees and avenues, their impact on road reconstruction and possible actions continued in 70s. One of the recommended solutions was to design a new road leaving the original tree rows to one side of the new road, as was widely practiced in the Democratic Republic of Germany.

Techniques for replanting of large trees were successfully used in road reconstruction (Fig.1.7.). Trees from previous railway protection plantings were used. They were dug up in late autumn shortly before the frost and replanted when the soil around the roots was frozen. Trees with roots up to 3m diameter and those which grew three or four together in a clump were transplanted this way. This technique was used in the reconstruction of the road between Riga and Bauska where planting of tree groups was planned.

Large trees were replanted from alleyways (Fig. 1.8.) using a variety of techniques, for example holding tree rootballs together in covered boxes or replanting them when the root balls were still frozen. In cases when it was necessary to widen the road, trenches were made and trees were moved away from the road by 3 to 5 metres. It was necessary to get permission from the Ministry of Forestry for tree cutting or replanting (Taubenbergs, 1972).

Different campaigns were organized in the Soviet era. One of these was under the slogan "Let's turn the roads into blooming gardens". As a result, approximately 126 000 apple, cherry and other fruit trees were planted along roadsides in the 1960s. There was a precise accounting of the number planted trees in each road district. Fruit trees comprised one fifth of the all trees planted (Andrejsons, Sviķis, 2016).

In the 1960 – and 1970s special attention was paid to the appearance of the road and road user comfort. Work on the refurbishment of bus stops was planned and carried out by the road administration. It was possible to choose from a variety of centrally offered solutions that minimized individuality of road design features.

The design institute „Ceļuprojekts” developed different individual projects for rest areas, and bus shelters (Fig. 1.9. and 1.10.).

Fig. 1.7. **Tree planting in the road section Pļaviņas – Madona – Gulbene, 1960.** (Source: Latvian road museum)

Fig. 1.8. **Digging out trees from alleyways, 1970.** (Source: Latvian road museum)

Fig. 1.9. **Bus shelter type "Б–1", 1960, architect V. Reinfelde and engineer Gunārs Binde from the institue "Ceļuprojekts" are sitting on the bench.** (Source: Latvian road museum)

Fig. 1.10. **Bus shelter near Baltezers on the road Riga–Tallin, built in the beginning of 60th, photo of 70th.** (Source: Latvian road museum)

One can see the scope and course of development of these activities from an overview of results achieved in the seventieth (Table 1.5.). In several road maintenance and construction departments local tree and flower nurseries were set up in order to implement the road landscape improvements in the Soviet era (Valsts ražošanas apvienība…, 1998).

After evaluation of experiences from other countries, Latvian specialists reached the conclusion that small rest areas along main roads and tourist routes were necessary every 10 – 30 kilometres.

Table 1.5.

Data about the refurbishment work for road users

Built	Year 1971, number of elements	Year 1979, number of elements
Car parking places	46	221
Rest areas	20	126
Bus shelters	826	1 260
Enlargements of bus stops	1 884	4 270
Benches at bus stops	5 967	9 060

(Source: Andrejsons, 2004)

Rest areas were classified as:

- places with a view point and wide panorama;
- places with facilities and attractive landscape;
- parking places – rest areas with elevation raised area for car inspection (Jeļinskis, 2010).

In addition the allowing techniques were also used in allée reconstruction:

- trees endangering the road safety close to the road and those on the inner side of road curves were felled;
- new groups of mixed trees were planted at the beginning and the end of the allée;
- breaks in allées were made in winding and hilly sections of roads;

An important aspect of road plantings were the hedges designed to protect the road from snow drifting. Spruce trees were mainly used. These plantings were extensive in open areas and in places were the road went into cuttings (where snow drifts could easily block the road). The first plantings were placed crosswise in 2 rows spaced 1 to 1.5 m apart, 17 to 20 m from the road and they were cut at 2– 3 m in height. Such hedges could last for 50 years (Valsts ražošanas apvienība…, 1998). Technical regulations for snow protection plantings were developed which envisaged several types of hedges, mixing rows of different trees with various types of bushes (Eleksis et al., 1967).

Complex road and landscape design projects were prepared by the Latvian Road and Transport Design institute and carried out during road reconstruction (Slēde, Vikmanis, 1980).

The first experimental project was for the 60 km long road between Pļaviņas and Madona. Several other projects in the sections of the main roads between Rīga and Jūrmala and the Rīga–Pleskava road close to Riga, were carried out after the experience gained elsewhere (See Annex 1).

The main tasks were:

- to remove bushes that restricted landscape visibility, taking care of trees of great value;
- planting new decorative plants in farmyards;
- to maintain existing avenues, to cut out dead wood and plant new trees of the same species
- to rehabilitate former quarries as agriculture or forest;
- to demolish derelict buildings, to cut down orchards which had lost their practical and decorative value,
- to improve the visual flow of the road by planting groups of trees or shrubs;
- to tidy up the bus stops, make decorative plantings , erect bus shelters ;
- to build rest areas with tables and benches, fire places, toilets etc.;
- to carry out roadside forest maintenance cutting down dead wood;
- to maintain the elevations of buildings close to the road (Slēde, Vikmanis, 1980).

Latvian road designers and engineers were proud of several successful projects. In 1972 the resort road with six lanes was built from Riga to Jūrmala. It had the latest infrastructure of the time – car dividing barriers across the road, nocturnal lighting, traffic signs giving variable

guidance on the permitted speed or on the risk of fog or ice on the road. Above all six lanes flyovers were built without intermediate support and on both sides of the road were petrol stations. People called this road "six minutes west".

In year 1977 2.7km long four lane section of the Vidzeme motorway from Riga to Sēnīte was finished together with the most modern traffic junction in the Baltic states at that time. A large roundabout or traffic island, six light–weight overpasses, one 162 m long pedestrian walkway, four car parks, pedestrian walkways and two 89 m and 75 m long respectively pedestrian tunnels made this junction convenient and easy to understand. For the first time in post–war practice, a plate bearing the names of the project designers and construction managers was placed on the tunnel wall. The project of a particular section from Garkalne to Sēnīte was original in concept and paid special attention to forest protection. One of traffic lanes was routed along the forest firebreak leaving a 130 m wide section of forest between the carriageways. Most traffic junctions on first category roads were built in a form of cloverleaf with large radii. In the 1960s and later ring roads were constructed around many cities.

Road landscaping work reached its maximum impact in the middle of the 1970s and started to decline after Velta Reinfelde retired (Andrejsons, Sviķis, 2016).

Information about all activities for each road was included in the road passport. Road passports were prepared for the technical accounting of the road and they reflected the actual road condition throughout its lifetime. Road passports included the following information: the plan of the road in scale 1: 20000 in 50 m wide zone on both sides of the road, general data about the road (the lengths, distance between larger cities, history of the road), economic characteristics of the road, technical characteristics of the road (intensity, dimensions, load), information about repairing works carried out, list of road equipment, list of decorative planning and snow protection plantings, list of building for road users, list of quarries (Eleksis et al., 1967).

Appearance of landscape elements in different time periods is presented in figure 1.11.

Time period **Road landscape development up to the 20th century**	**Elements in the landscape**
13th century 17th century 18th century 19th century **The period 1919 –1940**	• trees as land marks • post roads with horse changing points, road side pubs • alleyways or avenues in manors • snow protection plantings
1930 Forest Day activities **The period 1945 –1991**	• tree rows and alleyways • replacement of alleyways with tree groups • tourist roads
1948–1968 Forest Day activities, tree planting campaigns 1960–1970 Road landscape design	• road, bridge reconstruction and new roads • tree rows and alleyways (apple, cherry trees) • snow and wind protection plantings • individual design bus stops • rest areas • experimental road landscape projects.

Fig. 1.11. **Appearance of landscape elements in different time periods**

Historic elements on the roadsides give identity to the place and during the road reconstruction it is necessary to pay special attention to the presence of historical elements, their management and protection (Vugule et al., 2014a).

Historically and emotionally important event took place on the road from Tallinn through Riga to Vilnius on 23 August 1989. Around two million people stayed hand in hand and made a 600 km long human chain through the three Baltic States. It was a peaceful action called "The Baltic Way" with the aim to show the longing for freedom. This action in included in the UNESCO list of documental heritage "World memory". A sign dedicated to the 25th anniversary of "The Baltic Way" was put at the 25th kilometre of the major road Riga –Bauska on 23 August 2014 (Sviķis, Andrejsons, 2018).

As a result of land reform in 1990 rural areas of the Republic of Latvia, former landowners or their heirs regained their property. Buildings of collective farms (kolhoz) have been reconstructed or demolished, but there are still many elements from the Soviet time present in the landscape and their future destiny needs attention. There is some research by Melluma, Bell et al. (Melluma, 1994, Bell et al., 2007) about the changes, that have occurred in the landscapes of Latvia during fifty years of communist rule and afterwards. Perception of Soviet time heritage has been little studied and discussed. It remains to be researched, if everything from the Soviet time should be forgotten as being negative and wrong, or there is something that should be kept as evidence in the landscape.

Current status of the road landscape planning in Latvia. Roads in Latvia are classified into state roads, municipality roads, business company roads and farmstead roads according to their importance. State roads are divided into main, regional and local roads. State roads and road partition zones are the property of the Republic of Latvia and are managed by the state holding company "Latvian State Roads". Municipality roads are owned and managed by the municipalities, enterprises and private roads are managed by their owners (Likums par..., 1992). The Ministry of Transport currently plans, organizes and co–ordinates road development policies nowadays. The state holding company „ Latvian State Roads" administers the road network. Roads are managed by their owners – the State holding company "Latvian road provider", municipalities or other owners. Design, construction and maintenance work is carried out by private contractors. Hierarchy of road administration, management and use is presented in figure 1.12.

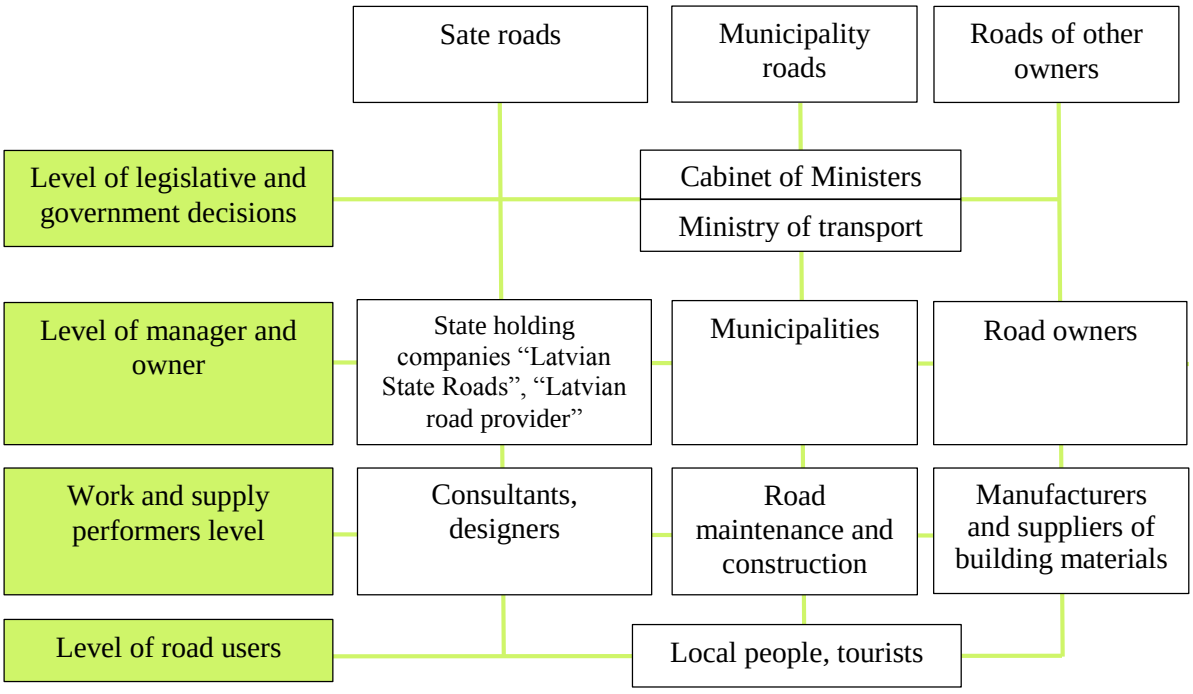


Fig. 1.12. **Road administration, management and use**

Density of road network in Latvia is sufficient, but road surface quality is not sufficient (Transporta attīstības ..., 2014). Most of current investments are designated to improvement of road quality and safety. Much less attention is paid to landscape in comparison to Soviet time (Sviķis, Andrejsons, 2018). Design and planning of the road landscape – or lack thereof depends on various stakeholders and can be addressed at different planning levels. The actual road landscape we see when travelling, its aesthetic quality and scenic beauty depends not only on road infrastructure and actions right at the edge of the road within the zone owned by the road authority, but also on decisions and plans made by designers, road managers and land owners of the wider territory beyond and other parties. Their actions are defined and influenced by normative regulations, planning documents and development policies in different sectors.

Transport infrastructure is integrated in forest, agriculture and urban landscapes, it is influenced by policies in these fields. Quality, planning, design and management of the road landscape is closely connected to road planning and reconstruction. It also depends on and influences several other fields like agriculture, forestry, tourism, nature and historic, cultural monument protection. Road landscape is influenced by sustainable development, spatial planning policies and activities of entrepreneurs in the road landscape corridor (Fig. 1.13.) (Vugule et al., 2014b).

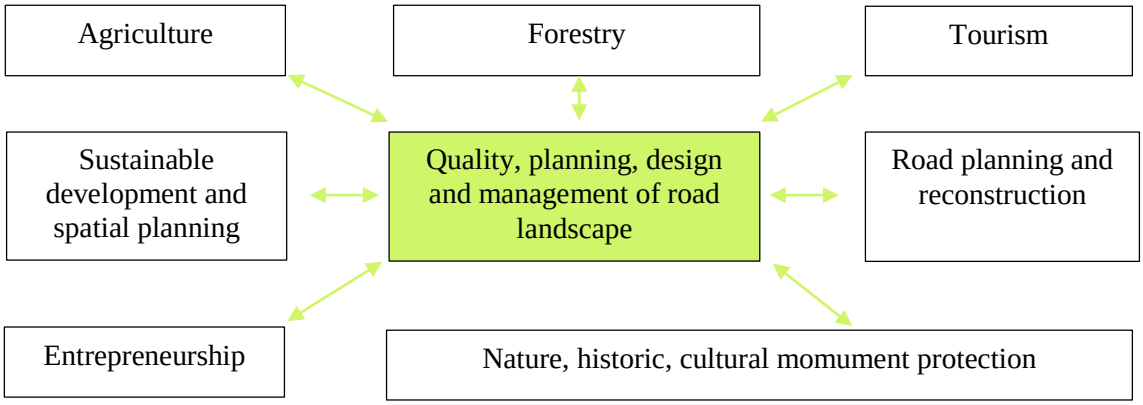


Fig. 1.13. **Connection of road landscape quality, planning, design and management to different fields**

The main recent influence on the road landscape outside urban areas comes from road reconstruction work which has increased in recent years due to the need for upgrading roads, improving road safety and accommodating increasing traffic intensity. Very few new major roads are being built. Road reconstruction projects generally include a road protection zone extending up to 100m distance from the centre of the road on each side depending on the road significance (Aizsargjoslu likums, 1997).

In cases of road reconstruction, land owners have the possibility to evaluate the foreseen changes when an Environment Impact Assessment of the project is carried out or when the local municipality has anticipated a public discussion of a project due to important aspects. According to Latvian legislation all involved parties can examine the Environmental impact assessment report and take part in the public discussion (Ministru kabineta..., 2015).

From discussions with road planners it is clear that levels of public participation in Latvia are low. Public discussions about road development projects only take place in cases when the route of the road is expected to change or when cutting of large trees close to the road is foreseen. Information which is prepared for such public discussions usually includes layout plans, technical drawings, including detailed technical plans for construction, sections and other materials not very easily understood by non–experts. Rarely are presented visualisations of the planned changes are. Research shows that obstacles to effective public participation in Latvia include the inertia of society; there is a lack of belief within society that participation can actually change something. Citizens only show interest in cases, which directly affect their own interests (related to their ownership or the neighbourhood itself). The success of the procedure

depends on activity by municipalities responsible for the implementation of public participation and the way in which new projects are presented (Vugule et al., 2018b).

1.4.2 Road landscape in normative documents

Analyses of normative documents concerning road design, construction, management, as well as normative documents which have influence on territories adjacent to roads was carried out in year 2014. The aim of the study is to examine if and how much the term "road landscape" is reflected in laws of Latvia, to analyse the impact of different regulations on road landscape development. The main focus was set on the countryside and road landscapes outside the cities. Laws, regulations of Cabinet of Ministers and standards influencing development and management of the road landscape were examined. It was checked if actions influencing the road landscape and road landscape as a term are mentioned in the regulations. Analyses of the results of the restrictions were carried out. The road landscape was divided in the landscape corridor adjacent to road and landscape of the road route. Road landscapes in specially protected territories was analysed separately due to more strict regulations. Planning documents and spatial plans of 5 planning regions Kurzeme, Vidzeme, Zemgale, Latgale, Riga and 110 regional communities have been reviewed and compared in order obtain an overview of scenic roads, which special roads defined in Latvian Landscape Policy Guidelines. According to the Guidelines, they are roads with significant landscape value for the identity of the territory, and they should be set in spatial planning documents on the bases of evaluation carried out by the society and might need specific management and planning (Vides aizsardzības …, 2013). Theoretically, the public should be involved in the process of scenic road designation process, but was not checked to what extent public has been involved in this process. For example, in the USA, the Vermont Byways Program requires a nominating committee, which seeks to represent the interests of a wide range of people and organizations along the road (Vermont Agency …, 2000). Road landscape is effected by policies and regulatory documents of territories adjacent to roads (Fig. 1.14.).

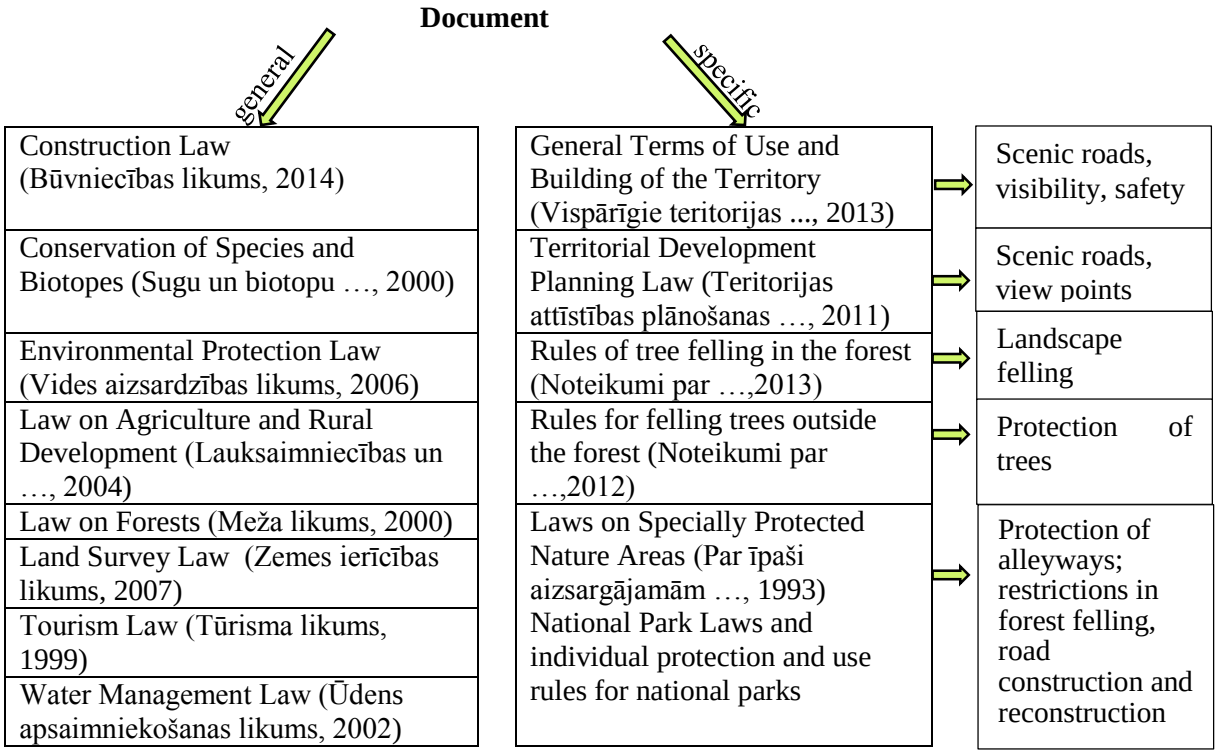


Fig. 1.14. **Legislative enhancements concerning the territories adjacent to roads**

The below–mentioned laws and rules govern the activities of the respective sector, which may also affect the landscape; however, road landscape is not separately mentioned in many of these documents and influence on the road landscape can be considered as general.

Several laws concerning territories adjacent to roads have a specific and direct influence on the road landscape. The Spatial Development Planning Law stipulates development of thematic plans at all spatial development planning levels solving specific issues related to the development of separate sectors, including, transport infrastructure, or specific themes, for example, valuable landscape areas (Teritorijas attīstības plānošanas…, 2011). A landscape plan may be developed as a thematic plan containing recommendations for further action. As regards to road landscapes, the landscape plan may establish publicly accessible viewing points and perspectives, scenic roads. The same issues about landscaple plans are included in the General Terms of Use and Building of the Territory, which also mentiones issues of visibility at the crossroads and design of parking areas.

Tree felling rules in the forest define aims and rules for tree cutting in landscape felling (Noteikumi par …,2013). Landscape felling can be designed along the roads and it can improve the road landscape quality. Rules of felling trees outside the forest regulate tree felling along the state and municipality roads, define the cases and procedure of obtaining the permission for tree felling. It is a positive trend that the municipality has to evaluate the significance of trees in the landscape, their dendrological and ecological state, the importance of trees in preserving biodiversity and reducing anthropogenic effects on surface water bodies, their influence on safety on buildings and people (Noteikumi par …, 2012).

In territories with a special status, road landscape is subject to requirements raised by the provisions of the special status and, therefore, is more protected from changes than landscape in other territories. Road landscape is affected by the Law on Specially Protected Nature Territories (Par īpaši aizsargājamām…, 1993). Further are described some of the regulations regarding road landscapes issued by the specific territories.

In the landscape protection zone of Gauja National Park and North Vidzeme Biosphere Reserve along the motorways (if the adjacent territory is defined as a valuable landscape area in the territory plan of the local government), restrictions exist in respect to forestry activities affecting the conservation of landscape quality and nature. In the entire territory of Gauja and Kemeri National Park and in the territory of the protected landscape area *Northern Gauja*, the State motorways within the width of the zone of their section are defined as the neutral zone, where the main restrictions apply to forest management and clear fellings (Gaujas nacionālā parka…, 2009, Ķemeru nacionālā parka…, 2001, Aizsargājamo ainavu apvidus …, 2008; Ziemeļvidzemes biosfēras rezervāta…, 2011).

In the protected landscape area *Northern Gauja*, some alleyways, which are not in the list of Cabinet Regulations on the Protected Alleys are protected. In the entire territory of the protected landscape area, except for the neutral zone, it is prohibited to perform road construction or road reconstruction. It is allowed to perform construction or reconstruction of household roads, reconstruction of State and local government motorways within the width of the existing road alignment, construction or reconstruction of merchant roads in the road alignment reaching 10–12 meters in width, in the road alignment reaching 20 meters in width or within the width of the existing road alignment. During road construction, reconstruction or periodic maintenance, it is prohibited to alter the natural relief surface of inland dunes by more than 1 meter, thus ensuring the protection of the road landscape (Aizsargājamo ainavu apvidus…, 2008).

When performing road reconstruction in the landscape protection zone of North Vidzeme Biosphere Reserve, it is prohibited to change the location of the alignment of a scenic road (if such have been prescribed in the spatial planning of the local government) without a written consent from the Nature Protection Board (Ziemeļvidzemes biosfēras rezervāta…, 2011).

In Teici Nature Reserve, the protection of aesthetically significant landscape elements is ensured in the outer protection zone of the Reserve. The outer border of the protection zone

runs along the edge of the zone of the land section of several motorways (E22–A12 Jekabpils–border of Russia P62 Kraslava–Madona, P82 Jaunkalsnava–Lubana and P84 Madona–Varaklani) (Teiču dabas rezervāta…, 2008).

Regulations differ in each protected area and it would be necessary to carry out more detailed analysis of current protection plans and develop guidelines for road landscape planning and management in protected territories.

Construction of new roads, reconstruction of the existing roads and roadside maintenance leave a direct impact on the surrounding landscape. Overview of normative documents regarding road construction and reconstruction is given in Figure 1.15. and described more in detail below.

Document		Impact
Construction Law (Būvniecības likums, 2014)		
General Construction Regulations (Vispārīgie būvnoteikumi, 2013)		
Motorway and Street Construction Regulations (Autoceļu un ielu…, 2014)		
Latvian Standard and Construction Standards, Road Alignment LVS 190–1:200	⇨	placement of road route in the landscape
Standard Sections LVS 190–2:2007	⇨	regulation about plantings and visibility, assessment of views due to the changes of road height is missing
Environmental Impact Assessment Act (Par ietekmes uz…, 1998)	⇨	applies to sections of roads to be reconstructed or under construction longer than 10 km

Fig. 1.15. **Normative documents concerning landscape during road construction and reconstruction**

Road construction and reconstruction. Design and construction of State motorways in Latvia is carried out in accordance with the schemes for the development of the road network drafted and approved by the Ministry of Transport. Local government roads and streets within the populated areas are designed and maintained by local governments, whereas the household roads and merchant roads – by the road owners. Activities related to the construction of roads and engineering networks are governed by the Construction Law (Būvniecības likums, 2014), General Construction Regulations (Vispārīgie būvnoteikumi, 2013) and Motorway and Street Construction Regulations (Autoceļu un ielu …, 2014).

Landscape is mentioned in the Road Design Regulations issued by the Latvian Standard, which governs the design activities in relation to new roads and roads to be reconstructed. Part 1 of the Road Design Regulations *Road Alignment* LVS 190–1:200 sets tasks for spatial planning of road and the surrounding landscape. Road must be included in the landscape terrain, respecting nature and landscape protection requirements. The Standart says that "road tracing and shaping the surroundings of a road is a creative task to be individually addressed" (Latvijas valsts standarts, 2007), which is positive, as each case differes, but it also means that there is necessary some methodology or at least guidelines about landscape planning along the new or reconstructed roads.

Part 1 of Road Design Regulations *Standard Sections* LVS 190–2:2007 regulate construction of standard cross sections of roads, placement of the equipment, engineering and communication systems, greenery. Existing trees and new plantings may not disturb road side visibility according to norms set in standards. Rows of trees, as well as individual trees and shrubs may be left in the visibility triangle, if they only slightly reduce the visibility and serve as a visual orientation system for traffic management. The potential distractions, such as, anti–noise fences and walls, must be placed to ensure the required visibility triangles (Latvijas valsts standarts, 2007). Visibility is one of the indicators of landscape aesthetic quality and it affects

road landscape quality. Visibility and views from the road are influenced by making changes in the relief. The driver has an opportunity to observe the surroundings from a higher or lower point of view, which requires assessing the sights being exposed or concealed. But this aspect is not included in the legislation.

According to the Law on Environmental Impact Assessment, the motorways and express roads to be built require to assess the effect of the proposed activities on the environment, if the section of constructed, realigned and/or widened motorway is 10 or more kilometres long. When carrying out this assessment, it is necessary to characterise the location of the intended activity and the geographical properties of such location. The law says that special attention should be paid to landscapes of historical, archaeological and cultural and historical significance, territories covered by forest and protected nature territories (Par ietekmes uz…, 1998). This law does not include the remaining landscapes, as well as landscape values are not always adequately respected, while reconstructing or repairing shorter road sections.

Overview of normative documents concerning road side elements is given in figure 1.16. and described below.

Document		Impact
Regulations on Latvian Construction Standard LBN 223–15 (Noteikumi par Latvijas…, 2015)	⇨	requirements for drainage systems and environmental protection, integration of drainage systems into the surrounding landscape is missing
Rules for protected alleys (Noteikumi par aizsargājamām…, 2005).	⇨	protection of 60 alleyways
Law on Motorways (Likums par autoceļiem, 1992)	⇨	constructions for environment protection, restrictions in forest growing
Protection Zone Law (Aizsargjoslu likums, 1997)	⇨	restrictions in tree cutting and forest growing
Rules for Placing Advertising Items or Information Objects Along the Roads, Procedures for Coordinating the Placement of Advertising Objects or Information Objects (Noteikumi par reklāmas …, 2005).	⇨	placement of information and signs along the road
Rules for operation and maintenance of drainage system (Meliorācijas sitēmas …, 2010)	⇨	maintenance of road side ditches, removal of trees and bushes

Fig. 1.16. **Normative documents concerning the road side elements**

Road side elements. When carrying out construction or reconstruction of motorways, a motorway drainage system is also built altering natural water runoff, which may cause erosion and landslides of road slopes, embankment deformations, waterlogging of local terrain, thus affecting the surrounding landscape. Regulations Regarding Latvian Construction Standard LBN 223–15 *Structures of Drainage* contain requirements to ensure the functionality of drainage systems and environmental protection (Noteikumi par Latvijas…, 2015). Lines of rain water drainage ditches along the road are planned in a complex together with the road design. Parameters of transverse profiles (depth, width) are set by hydraulic calculations. Slopes are designed considering engineering, geological and hydrological parameters of the area (Noteikumi par Latvijas…, 2015). Rain water drainage ditches and storage voids can be designed, so that they could perform the functions of biotopes and be integrated into the surrounding landscape. In some sources, these issues have been examined only as recommendations (Projektēšanas un būvniecības …, 2018), but not included in binding legislative documents.

For safety reasons, winding road alignments are straightened in dangerous sections, when carrying out road reconstruction work. Straightening of road, as well as felling of trees on the

roadside aims to provide higher road safety. But it significantly affects the quality of road landscape. As a result of road reconstruction for safety reasons, tree alleys growing too close to the road may be felled down. Sixty alleyways included in the list of protected alleyways are currently under protection (Noteikumi par aizsargājamām…, 2005).

The visibility and aesthetic quality of landscape may be effected by special constructions built in the protection zone of motorways under the Law on Motorways, so that the impact of exhaust gases, noise from vehicles and other harmful factors on the environment would comply with sanitary norms (Likums par autoceļiem, 1992).

For construction, maintenance and protection of motorways, the Law on Motorways stipulates the establishment of zones of a land section along the state, local government and merchant motorways (Likums par autoceļiem, 1992) (Table 1.6). There are defined specific actions and conditions for using the zone of the road land section. It is prohibited to grow forests in the zone of the road land section. This provision may slightly improve the visibility of the landscape and, consequently, the aesthetic quality of the landscape.

Table 1.6.

Minimum width of zones of a section from the centre of the motorway to each side

Width, m	Type of motorway
25	for a dual carriageway motorway with a dividing lane up to10 meters
15.5	for a single carriageway motorway with roadbed width from 12.5 meters to 20 meters
13.5	for a single carriageway motorway with roadbed width from 10.5 meters to 12 meters
11	for a single carriageway motorway with roadbed width from 8.5 meters to 10 meters
9.5	for a single carriageway motorway with roadbed width up to 8 meters

(Source: Likums par autoceļiem, 2014)

In order to reduce the negative impact of motorways on the environment, as well as to create a building–free zone required for reconstruction of streets and motorways, the Protection Zone Law stipulates establishment of protection zones along roads (Aizsargjoslu likums, 1997).

The width of protection zones in rural areas:

- along major State motorways – 100 meters from the centre of the road to each side;
- 1st grade State (regional) motorways — 60 meters;
- 2nd grade State and local government motorways — 30 meters.

The protection zone lands of motorways remain available for land users and the owner of the land must properly maintain them. General restrictions in protection zones are determined by laws and Cabinet regulations, they may also be prescribed by the binding rules of the local governments. Without the consent of the owner of the motorway, the landowner or user is prohibited to plant trees and shrubs, fell trees in the protection zone of the motorway. If it is necessary to reduce the impact of exhaust gases, noise from vehicles and other harmful factors on the environment and people, special constructions are built or rows of trees and shrubs (hedges) are planted in the protection zones of the motorway (Autoceļu aizsargjoslu noteikšanas…, 2001). In order to ensure visibility of a motorway and traffic safety for vehicles, according to restrictions in protection zones along motorways, it is prohibited to fell trees in the zone of 30 metres from the centre of the State motorway to each side without a written agreement from the State Joint Stock Company "Latvian State Roads*"* for the felling of trees (Aizsargjoslu likums, 1997). Restrictions in relation to planting and felling of trees in road protection zones as well as planting decorative shrubs affect the visual quality of road landscape.

The quality of road landscape is effected by information objects located along motorways. The placement of promotional objects and information objects along roads is governed by Cabinet regulations (Noteikumi par reklāmas…, 2005). They mostly emphasize the safety of drivers. With regard to the visual pollution of the landscape, it is positive that attention is paid to the minimum distance between promotional objects and the number of information objects.

There are many different normative documents in Latvia each of them regulating different area – design, construction and maintenance of roads, ditches, communications and others, but links between those documents are missing. In the reality situations when one regulation is against the other can occur. For example, regulation on Melioration systems and hydrotechnical buildings clearly define that trees and shrubs may not grow in ditches (Meliorācijas sistēmas ..., 2010). It is not clear what to do in situations when lines of designed rainwater ditches are very close to large trees.

Road maintenance. The routine maintenance of state roads, bus stops and pavilions, car parks, parking areas, recreation areas, snow protection fences and greeneries is provided by SJSC "Latvian State Roads*"* and of local government roads – by the local government concerned. It is ordered by the Law on Motorways (Likums par autoceļiem, 1992). The routine maintenance of motorways is carried out according to the Regulations on the Routine Requirements for Maintenance of the State and Local Government Motorways and the Procedures for the control of the fulfilment thereof according to the road maintenance class (Noteikumi par valsts…, 2010). The landscape quality is affected by motorway maintenance works, such as liquidation of washouts; ditch cleaning and reconstruction of their profile, shoulder grading, profiling and repairs; cutting of shrubs in ditches, slopes and motorway lanes, cutting of shrub sprouts; mowing; greenery cultivation; adding greenery and snow–protective plantings; hedge trimming; cutting of dead branches; clearing individual trees. The requirements approved by the Cabinet of Ministers regarding the maintenance of State and local government motorways and road maintenance classes are presented in Annex 2. The lack of requirements regarding mowing of shrubs within the range of motorway roadbed, repairs of the damaged equipment in recreational areas on class C and D roads and recquirement for mowing on class D roads may be considered negative. The requirements approved by the Cabinet of Ministers for maintenance of the State and local government motorways could provide a higher level of aesthetic quality of road landscape. Rules for operation and maintenance of drainage system (Meliorācijas sitēmas …, 2010) regulates maintenance ditches, including road side ditches. It is defined that land owners must remove trees and bushes from the drainage ditches, but according to the preliminary study there are problems in the road side landscape in this aspect (Vugule et al., 2014b).

State of scenic roads. There are 110 regional communities in Latvia (Vides aizsardzības..., 2016). Thirty nine of them in year 2014 mention scenic roads, landscape roads or sections of scenic roads in their spatial plans or sustainable development strategies. Some communities have information about scenic roads both in spatial planning and in sustainable development strategies. Sustainable development strategies describe the potential scenic roads. Twelve regional community planning documents mention road landscape elements that are present along the scenic roads.

There are five planning regions in Latvia. Each region has its spatial plan or regional strategy for sustainable development. They include information about scenic road development. The Spatial Plan of Riga Planning Region foresees development of interregional scenic roads connecting larger and smaller cities and regional scenic roads in several road sections (Rīgas reģiona…, 2007). Twelve from 28 regional communities from Riga Planning Region have defined scenic roads in their planning documents. Only a few regional communities have included scenic roads defined by Riga planning region in their planning documents. And not all of interregional scenic roads are included community planning documents.

The Spatial Plan of Latgale Planning Region foresees development of scenic roads in order to maintain cultural landscapes of Latgale and promote tourism there. It is stated that road

reconstruction and improvement of road surface is necessary, and it should be done taking into account the Landscape character (Latgales reģiona..., 2006). Scenic road sections should be defined more precisely in the spatial plans of regional communities and local municipalities (Latgales reģiona ..., 2006a). Currently several of Latgale planning documents foresee the development of various scenic road sections. Eleven out of 19 regional communities in Latgale Planning Region have defined scenic roads in their planning documents. Some regional communities like Aglona, Dagda, Rezekne foresee to develop scenic roads defined in regional spatial plans as interregional scenic roads and develop some local scenic roads (Aglonas novada..., 2013; Reģionālie projekti ..., 2012; Rēzeknes novada …, 2013). The interregional scenic road along the Daugava River has been taken into account only in the Daugavpils Regional Community, but not in other municipalities through which it is passing (Rīgas reģiona …, 2007).

Sustainable evelopment strategy of the Vidzeme Planning Region sets out a long–term plan to develop the region's scenic roads (Vidzemes plānošanas …, 2014). Six out of 25 regional communities have defined scenic roads or sections of scenic roads in their planning documents. One community defines the criteria for high value landscape views.

The Kurzeme Planning Region Spatial Plan mentions that local municipalities should foresee development of scenic and tourism roads in their spatial plans (Kurzemes reģiona…, 2007). Four out of 18 regional communities have mentioned scenic roads planning documents. Two communities – Dundaga and Talsi – have defined precise scenic roads and some of the municipalities have mentioned reconstruction of scenic roads. Scenic roads are not mentioned in any of Zemgale Region planning documents.

There are 20 regional communities in Zemgale and six of them have defined scenic roads or sections of scenic roads. The results of document analyses show that regional communities of the Latgale Planning Region are most active. Next comes Riga Region, followed by Zemgale, Vidzeme and then Kurzeme as the last one. Some spatial plans include guidelines in the form of recommendations and compulsory requirements for landscapes with outstanding value along the roads and viewing points. The most frequent requirements are: road character and landscape vividness should be preserved; afforestation, large buildings or other structures blocking valuable views from the road are not allowed; road surface quality needs to be improved; resting places and tourist infrastructure should be provided. These requirements are essential for the scenic road development (Vermont Agency …, 2000) and should be considered for all scenic roads. The distribution of scenic roads listed in the planning documents is uneven. There are unlisted roads with high aesthetic value and potential to be designated as scenic, for example, roads along the Baltic sea coast in Kurzeme and Baltic Sea gulf, roads in areas of outstanding natural landscapes and historic sites which are set in Spatial development perspective "Latvia 2030".

Two terms – scenic road and landscape road are used in Latvian planning documents. The term 'landscape road' appears mostly in planning region documents, the term "scenic road" is used more often in regional community plans. The terms have the same meaning and this should be discussed further, which of the two should be used in planning documents. There is no consistency between different planning levels. Regional communities do not follow regional plans regarding scenic road designation. One of the reasons could be lack of information and communication between the planning levels. The criteria for scenic road nomination and landscape assessment methods are set individually in every region. A comprehensive approach for assessing aesthetic road qualities and classification of scenic roads is missing. It is necessary to examine what kind of methodology is used in regional communities for scenic road designation and see how public can be involved in this process. No uniform criteria have been developed and established for the assessment of road landscapes and classification of scenic roads in Latvia. Experience from other countries show that initiatives about scenic road designation should come from local municipalities, but the process of road designation should

be developed and regulated by one institution, which should provide common methodology for road landscape assessment and scenic road designation (Vugule, Turlaja, 2016).

Road design standards define requirements for landscape elements located within the road alignment. Attention is paid to drivers' safety, environmental protection; however, the aesthetic quality of the landscape is poorly reflected in legislation and standards. Landscape quality requirements are not always clearly defined. Consequently, the road designers perform the tasks related to landscape based on their understanding of the protection and improvement of landscape.In areas further away from the road, the quality of landscape and landscape elements depends on the type of use and status of the area. Legislation includes some of factors affecting the quality of landscape, for example, the Law On Environmental Impact Assessment mentions landscapes of historical, archaeological and cultural and historical significance; however, considering the law of the European Landscape Convention, attention should be paid to all landscapes which can be regarded as outstanding and everyday or degraded landscapes.

The possibility to include thematic landscape plans identifying scenic roads, publicly accessible viewing points and perspectives in spatial planning can be regarded as positive, but there is a lack of uniform criteria for the assessment and classification of road landscapes.

Legislative documents relating to roads and adjacent territories pay little attention to the landscape. Road landscape planning in Latvia lacks common policies and methodological recommendations for the assessment, maintenance and further development (Vugule et al., 2014b). It confirms with other studies on the existing legislative documents in Latvia influencing landscape planning, which conclude that it is essential to develop the common principles and actions that would be incumbent on all municipalities to provide the landscape integrity and to protect its values according to the main principles defined in the European Landscape Convention (Nitavska, Zigmunde 2017).

1.5 Development of the research problem and clarification of the research question

As there is no research on road landscape development in recent years, the preliminary research was carried out in July and August, 2011 and August, 2012 by the author, in order to get a general overview of the present state of road landscape in Latvia, the most characteristic elements, actual problems and development tendencies. This information helped to select shorter sections for further research and to take decisions in scenario development. Landscape elements were analysed according to the distance from the road and were grouped into the point and line elements according to their size and form (Table. 1.7.).

Table 1.7

Road landscape elements

Points elements			**Line elements**		
Name	**Foreground**	**Middle and background**	**Name**	**Foreground**	**Middle and background**
old trees	*v*	*v*	ditches	*v*	
stork nests	*v*	*v*	protection plantings	*v*	
road signs and signs to houses	*v*		safety walls and sound protection fences	*v*	
billboards	*v*	*v*	electricity lines	*v*	*v*
rest areas	*v*		tree avenues	*v*	
bus stops	*v*		wind breaks, snow protection plantings	*v*	
family houses	*v*	*v*			
other buildings	*v*	*v*			

During the field survey along sections of the main road E–77 Meitene – Jelgava – Riga, sections of E–77 road Rīga – Cēsis, E–22 Rīga – Rēzekne, A–6 Rīga – Daugavpils, E–22 Jelgava – Ventspils and on some sections of regional and local roads, photographs of the road landscape were taken from the passenger's seat at the average driving speed of 90 km per hour in a driving direction to the right side of the road.

Landscape elements in foreground. The following point elements were observed in the road landscape: old trees, stork nests on electricity poles, road signs, road utility houses and other buildings. The most significant differences between these elements were on those sections of the roads were road reconstruction work has taken place recently. In these sections road utilities were in better condition, old Soviet time bus stops had been changed to more modern, but minimal facilities. Most of the building close to the road were in poor condition or abandoned (Fig.1.17.). It seems that only those, who cannot afford to move to another place, live next to busy roads. There are more houses that are abandoned or ruins of houses visible from the road in the countryside due to the decrease of inhabitants in rural areas, migration to cities, and abroad (Iedzīvotāju skaits …, 2019).

The state holding company "Latvian State Roads" takes care about existing recreation places, bus stops and roadsides as much as possible (Sviķis, Andrejsons, 2018). Existing rest areas built several decades ago are physically delimited by barriers, they are not reconstructed and entry to some of them is not allowed. There are no new areas suitable for rest built (Par ceļu..., 2017). Rest areas have no benches, picnic places, garbage bins. In the best case there is information sign with map of the municipality for tourists (Fig.1.18.). Rest areas are necessary not only for people driving cars, but they are very important for truck drivers, who need to rest between their working hours (Par ceļu..., 2017).

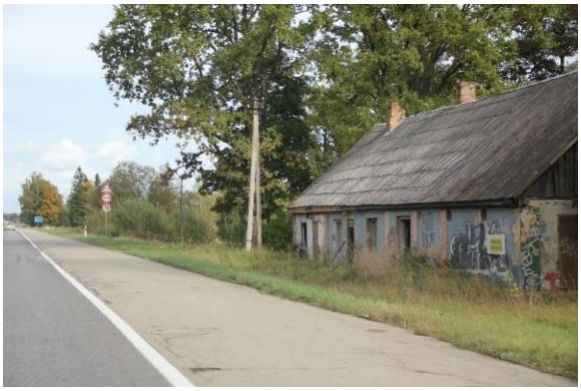


Fig. 1.17. **Abandoned house next to road A–8, Jelgava–Riga**

Fig. 1.18. **Rest area, road A–12, Rezekne Jekabpils**

The following line elements were observed in the road landscape: ditches, protection plantings, safety walls and sound protection fences, electricity lines, tree avenues. Grass along the road sides is cut several times per summer, but ditches often are overgrown with bushes and block the view to the landscape behind. Here rises the question about the ownership, owner's interests, capacity and wish to manage the property. Most of the problematic situations were noticed on the border between state property and private owners.

Spruce tree hedges, which were planted to protect the road from drifting snow in winter are present along some roads in different aesthetic quality and state. Today these hedges are mostly overgrown and block the view to countryside. In some places they are trimmed, but often the plants are in not very good conditions. Often there are electricity lines along the road; and trees close to electricity lines are trimmed or cut down without respect and any consideration about the way they and the whole landscape look afterwards (Fig.1.19). These places often stand out as scars in the landscape. This type of management is carried out for

safety reasons, but it should be done by taking into account nature and landscape. Sometimes large valuable trees are damaged.

Different style and quality fences and safety walls dividing private houses from the road appear close to the road (Fig.1.20).

Fig. 1.19. **Snow protection hedges from spruce trees along the road A–9, Rīga–Liepāja**

Fig. 1.20. **Sound protection wall, road A–1, Rīga– Salacgrīva**

Protection plantings, which were foreseen as wind breaks or for agricultural field protection against exhaust gases continue for several kilometres along some roads. (Fig. 1.21. and 1.22.). They block the view and diminish the aesthetic quality of the landscape.

Fig. 1.21. **Continuous protection plantings along the road E–77, Meitene – Jelgava**

Fig. 1.22. **The view to the agricultural landscape behind the protection plantings along the road E–77, Meitene – Jelgava**

Rows of fruit trees from the Soviet era tree planting campaigns still grow along many roads (Fig. 1.23.) and are part of historical and cultural heritage of Soviet time. Tree avenues and rows of different age oaks, lime trees and sometimes other tree species are present in the roadside landscape (Fig.1.24.).

Sixty alleyways are protected by law (Noteikumi par..., 2005a), the rest are endangered in the case of road reconstruction. Road planning and managing authorities consider tree avenues as dangerous and tend to remove them. It is argued by part of society, landscape architects and planners, representatives from nature protection organizations. This landscape element was once widespread across Europe and draws on a long and rich heritage. It offers numerous benefits for the landscape and the environment, and also for safety and economic terms (Pradines, 2009).

Fig. 1.23. **Apple trees along the road A–9, Rīga–Liepāja**

Fig. 1.24**. Tree avenue on the road A–3, Riga – Valmiera**

Landscape elements in the middle ground. The following elements were spotted in the road landscape in the middle ground: solitary trees (Fig.1.25.), farmsteads, new villages, remnants of Soviet time farms (Fig.1.26.), advertisements.

The structure of the countryside management from Soviet–era is clearly visible from roads. Large fields, canalised small rivers, apartment houses in the middle of the rural landscape and kolkhoz buildings are still present in many places in the Latvian countryside. Farm buildings are often reconstructed or demolished, but many abandoned and ruined ones are still present in the landscape

Fig. 1.25. **Old oak trees, road A–1, Rīga – Salacgrīva**

Fig. 1.26. **Remains of farm buildings on the road P–96, Jelgava – Kroņauce**

Solitary trees in the fields from the former farmsteads, typical to the Latvian countryside are still present in the rural landscape. EU greening regulation scheme (Platību maksājumi, 2018) helps to protect solitary trees and tree alleways. They are part of ecologically valuable areas in a cases when land owners have to follow EU greening regulations.

Houses further from the road are in better condition than the ones in foreground and new houses are built in this zone. Often house owners do not pay attention to the view of their property from the road. Farming equipment, unnecessary household things are stored away from the owner's eyes but in the sight of road users.

New villages close to cities appear in the landscape. They bring in new elements and variety in the landscape. But the lack of planning and design, which does not harmonize with their surroundings often causes negative visual impact. Recent research on this topic shows that new family house villages bring visual, aesthetical, structural and functional changes into the landscape and there is a need for tools of landscape ecology and sustainable landscape planning for designing the interior landscape compositional space of the new private house territories (Zigmunde 2010).

Advertisements appear close to cities, villages or separate objects connected with tourism. Distance of placement is at least 30 m from the road (Noteikumi par..., 2005b).

Road landscapes were analysed according to the landscape type roads. Research by Antonson et al. (2009) indicates, that drivers are affected by different landscape types.

There are three main landscape character types based on land use/cover found in the Latvian countryside: 1) the landscape dominated by agriculture (which may be on flat, undulating or hilly landform); 2) landscape dominated by large–scale forest (also on the three landform types); 3) a mosaic landscape of forest and farmland, most frequently found on hilly landforms (Bell, Nikodemus, 2000) (Fig. 1.27.)

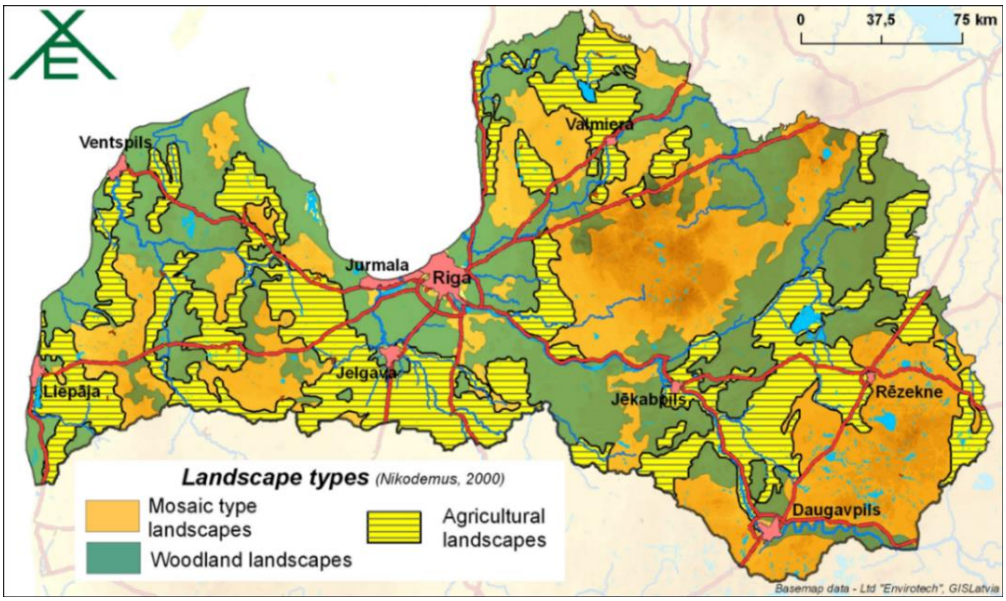


Fig. 1.27. **Landscape types in Latvia based on land use** (Source: Nikodemus, 2000)

Tendencies of road landscape development in agriculture landscapes, forest landscapes and mosaic landscapes, where forests change with open agriculture fields, pastures or meadows were analysed. Results from the preliminary research, described further are supplemented with photographs from later observation of the road landscape. Photography method, which was used, allows noticing general tendencies and processes in the landscape, spot separate features.

Positive tendency in agriculture landscape is returning of herds to landscape. Driving along the countryside one can notice cows, horses, sheep and goats. Cattle are the best open landscape managers. The area of pastures and meadows has increased from 605.7 thousand hectares in year 2000 to 648.3 thousand hectares in the year 2018 (Latvijas Lauksaimniecība, 2018).

Nowadays landscape changes are more and more affected by new technologies in agriculture, new and even non–typical agricultural production has arrived (Zigmunde, Jankevica, 2015). Due to changes in land management techniques hay racks change to hay rolls (Fig. 1.28.). Such elements as milk can stands disappear. New crops like rape and corn appear. The high crops seasonally influence landscape visibility (Fig. 1.29.).

Clear cuttings with freestanding ecological trees are the most noticeable features in the forest road landscape. Contrasts between the forests, open areas and few lonely trees are so high, that is has negative visual impact (Fig. 1.30.). There are only a few clear cuttings along the road E – 77 Riga – Sigulda where the landscape design principles have been applied. There is available some information on forest landscape design (Bell, Nikodemus 2000), but it is not used in practice very much. Today forest covers 50.9 % of the country's territory according to the State Forest Service data. Forest landscapes are often seen from the road and there is large potential to enhance them by the application of landscape design principles.

Fig. 1.28. **Hay rolls. Road E–22, Rīga – Tukums**

Fig. 1.29. **Corn fields. Road P–98, Jelgava –Tukums**

Fig. 1.30. **Ecological trees, road P–76, Sērene –Jēkabpils**

Fig. 1.31. **Overgrowing of agriculture land, the road A–3, Valmiera – Rīga**

Tendencies in mosaic landscape show that agriculture land overgrows with bushes and trees, while forest areas expand (Fig. 1.31.). This corresponds with the research about patterns of afforestation on abandoned agriculture land in Latvia (Ruskule et al.., 2012). Abandonment of agriculture land and subsequent natural afforestation have been common features of the contemporary Latvian rural landscape, particularly in the period since 1990. This process affects the structure, ecology and visual qualities of the landscape. In the beginning of the 20th century mosaic landscape with forest, fields, meadows, wet areas, which were connected by lineal elements like rivers, small roads dominated. Traditional Latvian countryside landscape is associated with cultivated fields, small farmsteads without hedges or fences (contrary to those in other parts of Europe) (Bell et al., 2007; Kļaviņš et al., 2008). Keeping open mind to agriculture landscape and traditional countryside landscape elements is essential in road landscape design, as well as managing the edges along the road.

According to the research of D. Peneze, Latvian people are not indifferent to the processes happening in the countryside landscape. Countryside in general is associated with nature, forests, agriculture fields and fresh air. When asked about the characteristic features of the Latvian countryside in the 21st century, respondents paid most attention to overgrowing of agriculture land, forest cutting, left farmsteads and poor quality roads. Overgrowing is valuated as a negative trend (Penēze, 2009). It is a problem which needs attention in future.

Following problems in road landscapes were detected: open landscapes and views from the road are formed chaotically; objects with historical and cultural value start to disappear from the zone of visibility, thus decreasing the visual quality of the landscape and losing the identity of the place. The negative trend is the disappearance of long – distance views because of field overgrowing and afforestation. New landscape elements bring variety to the landscape in territories were new houses have been built, but it does not lead to higher aesthetic quality in all cases. The landscape reflects priorities and life style of today`s society and economic status

of the state. Functional solutions and economic issues are the basis for today`s landscape development (Vugule, 2013). Figure 1.32. shows an overview of the described development tendencies which can be seen from the road in agriculture, forest and mosaic landscapes.

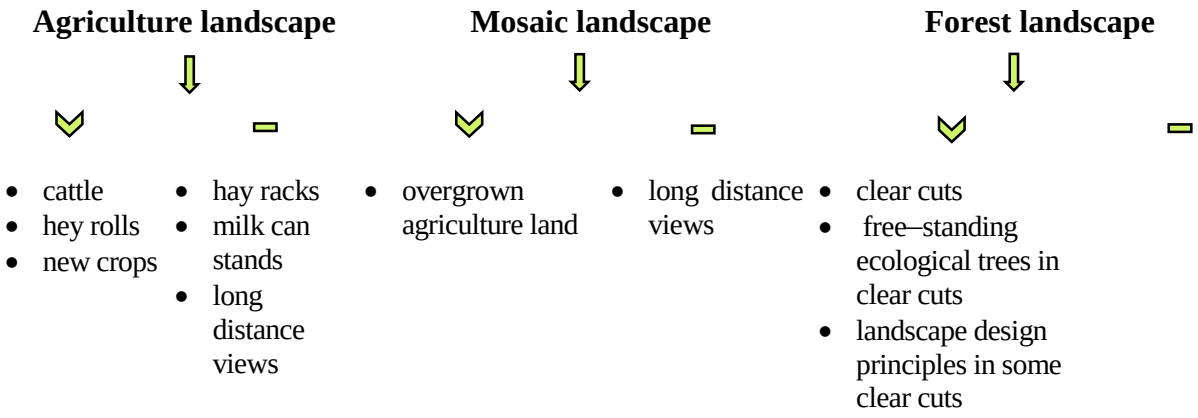


Fig. 1.32. **Tendencies in different road landscapes according to landscape type**

Research objectives and questions. Analysis of normative documents referring to road infrastructure development or influencing development and management of territories adjacent to roads, show that the term "road landscapes" is rarely mentioned. More research is necessary to find the ways, how to incorporate road landscape quality improvement into legislation and planning in road construction and reconstruction as well as in other fields affecting road landscape.

The overview of road landscape development history in Latvia shows, that each period has left some traces in the landscape. Preliminary research showed that road landscape is changing, and historic elements disappear. In order to preserve national landscape identity, it is necessary to take care of the historical and cultural heritage in the road landscape. The work, which was started in the road landscape design and planning by V.Reinfelde, is not continued. The principles of landscape design have not been further developed and widely applied.

Currently, there is a lack of research in Latvia on perception, assessment and development of road landscapes. The research carried out on road spatial perception (Zariņš, Smirnovs, 2013) deals only with the perception of road and does not look at the road landscape.

Road landscape is a public space, where principles of democracy, bottom up approach, opinion of road users, should be considered. A better understanding of what elements road users consider important in the road landscape, what is perceived as scenic can help later in road landscape planning, in scenic route planning (Zheng et al., 2013).

Movement is one of key aspects in road landscape perception and it has to be taken into account in road landscape assessment. Understanding the road landscape as a moving entity is fundamental. Evaluation of road landscape using modelling approach is a new area in Latvia and has not been carried out before. It is fundamental from the theoretical point of view, as the perception of road landscape and movement are connected.

All the aspects mentioned above lead to the aim of the research – to provide a greater understanding of how Latvian travellers perceive road landscapes. The following research questions are put forward:

- What elements or features of the roadside landscape are the most important contributors to the travellers' experience?
- What spatial characteristics are dominant in forming a legible and coherent travelling experience?
- What kind of Latvian landscapes are the most preferred by road users?

2. RESEARCH STRATEGY

This chapter explains the strategy of the research, justifying the chosen methods and choice of study route. Case study areas are described, and the concept of the scenario method is presented. Overview of the research strategy is given in a figure 2.1 and explained more detailed in the following subchapters.

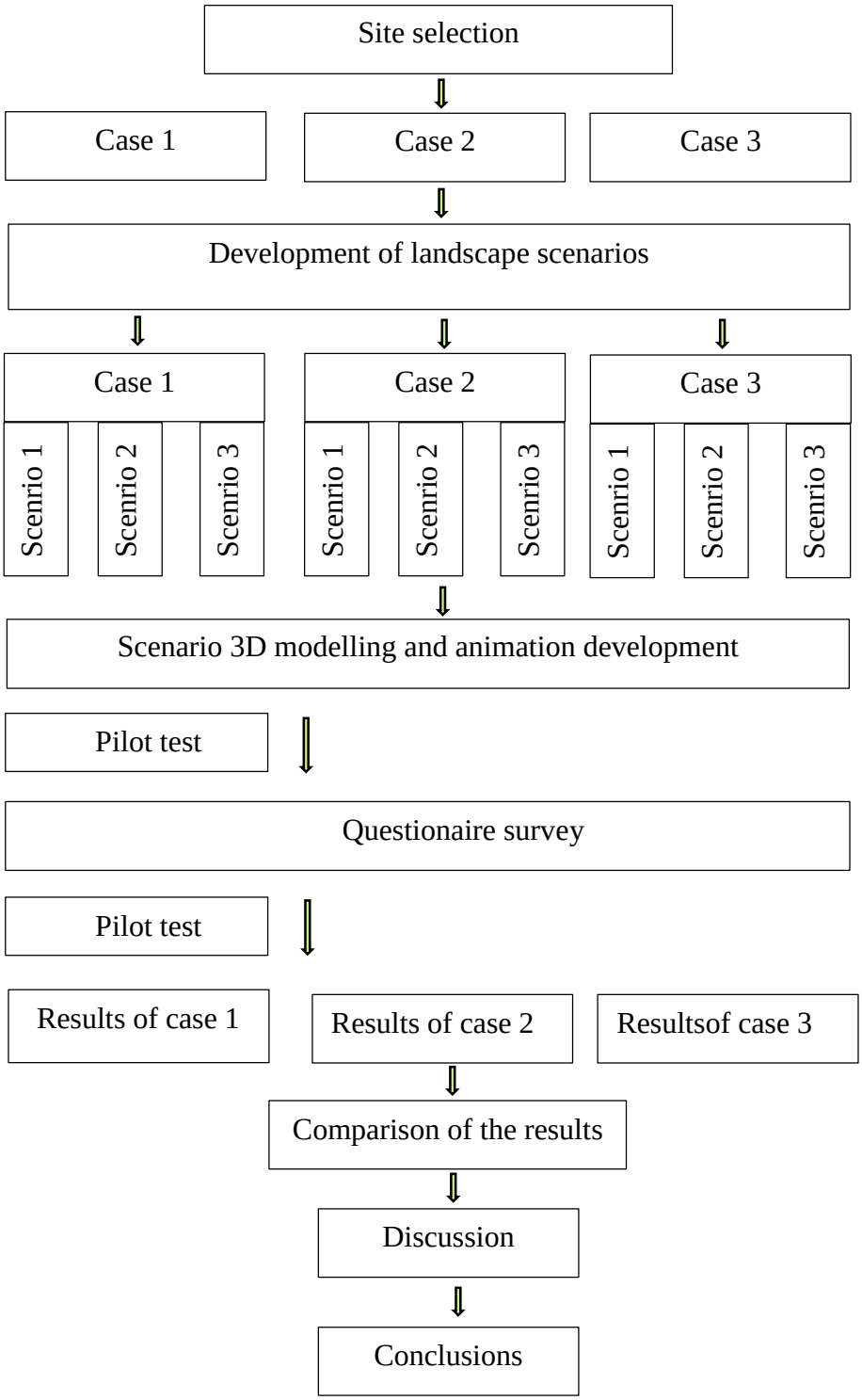


Fig. 2.1. **Research strategy**

2.1 General approach to mixed methods and case study approach

Landscape architecture is a multi–disciplinary field and research within landscape architecture has borrowed methods developed and tested in many other fields (e.g. Deming and Swaffield 2011). Frequently, mixed methods are used from the wide range of neighboring disciplines (Brink et.al, 2017). The concept of mixing different methods originated in 1959, when Campbell and Fiske used several methods to study validity of psychological traits. They encouraged others to examine multiple approaches to data collection (Cresswell, 2014). Integration of different research techniques in one project opens opportunities for data collection and analysis. Soon approaches such as observations and interviews (qualitative data) were combined with surveys (Quantitative data) (Sieber, 2002). Triangulating data sources in order to seek convergence across qualitative and quantitative methods was discussed by Jick in 1979 (Jick, 1979). Mixing different types of data emerged from the original concept of triangulation. The introduction and popularity of mixed methods is based on the complementarity of both quantitative and qualitative methods.

The methods generally used for assessing landscape scenic quality are cartographic representations, simulated assessments and questionnaire surveys. This research is carried out using combination of several methods and techniques: data acquisition using airborne LIDAR technology, photographic and video documentation of the present situation, case study approach, scenario method, 3D modelling, animations and road user survey and analysis of the results.

Case study as defined by Francis is "a well–documented and systematic examination of the process, decision making and outcomes of a project that is undertaken for the purpose of informing future practice, policy, theory and/or education" (Francis, 1999). A case study may be broadly defined as a study of a specific event, situation or complex phenomenon investigated in their real–world context (Yin, 2014; Swaffield, 2017). Case study analysis involves designing, conducting the case study, analysing the results, and disseminating the results. Case studies can be based on geography, documenting projects within a region, or based on type of project (Francis, 1999).

The case study approach has been used in many fields like law, business, medicine, engineering, community studies etc. as a method of education and research (Yin, 1993). It can be used in combination with other methods. Case studies have well–established history in landscape architecture and are popular research method in the discipline. Research by Francis approves that the case study method is a highly appropriate and valuable approach in landscape architecture (Francis, 1999). Case studies can help to answer questions at the intersection of policy and design. They are useful in participatory planning, for culturally sensitive design, and for testing emerging concepts. In landscape architecture many master and PhD theses are based on examples of case study analysis. Case studies are effective for communicating the results of landscape architecture projects to wider public (Francis, 1999). Case studies are well described in academic landscape architecture publications. For example, over the period 2011–2014, cases were cited in 78 per cent of published peer reviewed articles in the journal Landscape Research. The Journal of Landscape Architecture (JoLA) includes a section in each issue called 'Under the Sky' dedicated to case studies, and case studies featured in 32 per cent of all peer reviewed articles in JoLA from 2006 to 2014. Both landscape architecture professionals and academics (Swaffield, 2017) present case studies in conferences.

2.2 Choice of study route and characteristics of case study areas

In this research, cases are chosen as purposive samples (Swaffield, 2017), which enable conclusions drawn based upon their type. Case studies are used to test preferences of landscape types and landscape elements by road users of road sections in three typical landscape types.

Landscape types were described in the section about development of the research problem. Maps available on https://topografija.lv/ were analysed in order to choose case areas.

Three road sections on the major roads A3 (Inčukalns – Valmiera – Estonian border) and A7 (Riga – Bauska – Lithuanian border) were selected for the research, marked with red dots on the Baltic State map in figure 2.2.

Major roads A3 and A7 were chosen while they are part of historic Via Hanseatica road, which connects the three Baltic States and are important for tourism development. Latvian Tourism Development Guidelines 2014–2020 foresee the development of cross–border cooperation and include Latvia as a tourist destination in the market of Baltic Sea region countries (Latvijas tūrisma…, 2014). The Roads A3 and A7 are part of Pan–European Transport Network and transport corridor 1A. The entire route passes through cities such as Lübeck – Gdansk – Kaliningrad – Šiauliai – Jelgava – Riga – Valka/Valga – Tartu – Narva – St. Petersburg, which is an important tourism route connecting the three Baltic States with other countries.

Fig. 2.2. **Sections of case studies marked with red dots on the map of the Baltic States** (Source: by author using OpenStreetMap)

The area of each chosen section is 2 km². The length of each road section is 1 km. It is chosen due to the result of the research – animations of 3D models, representing real – time

movement along the road. There are technical limitations on modelling larger areas. With a driving speed limit of 90 km per hour it takes 50 seconds to look at each model, which was considered to be the appropriate time for online road user survey. Respondents have to look at nine animations, which takes 7.5 minutes and answer questions about each animation. Survey should not be too long in order to get responses for road landscape evaluation. The road landscape corridor is considered to be one km to each side from the central axes of the road according to the praxis of road planning (Slēde, Vikmanis 1980).

2.2.1 First case. Section of the road A7 in Iecava regional community

The first case area is a section of a major road A7 in Iecava regional community from picket 50.3 to picket 51.3 representing open, mostly flat agricultural landscape (Fig.2.3.). Pickets indicate the distance from Riga in kilometres. The road is 8.00 m wide and has one lane in each driving direction. The analysis is carried out in the driving direction from Bauska to Riga, from North to South. The traffic intensity on the road in 2018 was 10492 cars per 24 h (Satiksmes intensitāte …, 2018). Statistics about traffic accidents on the road A7 in the section from Bauska to Iecava show dangerous situation. There are two black points on the road from Bauska to Iecava, where at least eight traffic accidents have occurred over a period of three years or at least three people have died (Melno punktu …, 2016). One of these balck points is just before case area in picket 52. From year, 2014 to 2016 there have been five traffic accidents, one person has died and three people have been injured.

Fig. 2.3. **Current situation, A7 road, Iecava regional community**

This is a typical agricultural landscape, which belongs to West Zemgale plain in the Latvian language called "āraine". This is a type of landscape dominated by farmland. The landscape structure is made up of large and wide fields with small stand–alone forest clusters and tree groups. It is the most common type of plain cultural landscape that has developed as a result of farming. As a result of land amelioration, the natural structure of the landscape has been modified. Very important landscape elements with great visual and ecological value are typical to rural areas – estates and villages, as well as separate trees, tree groups (Vides aizsardzības…, 2000).

The motorway Bauska–Iecava–Riga was built from 1928 to 1935 (Sviķis, Andrejsons, 2013). Analysis of historical maps and orthophotomap of the current situation (Annex 3) show that route of the road in this section has been slightly straightened since the beginning of the 20th century. Three local roads have disappeared and two new appeared. In 1924–1935 there

were four estates with house names “Šautleri”, “Smedes”, “Ūdri” and “Sansavas”. The last two are not present anymore. Estate “Šautleri” now is devided into two iestates and “Smedes” into four estates. There are 10 estates with names “Lejasūdri”, “Kalnaūdri”, “Birzkaktiņi”, “Smedes”, “Kalna Smedes”, “Lejas Smedes”, “Vecsmedes”, “Šosejnieki”, “Kalna Šautleri”, “Lejas Šautleri” now in the case study according to the data from the State Land Service. Estate “Šosejnieki” on the left side on the road has appeared from 1940 to 1990 and is the most recent. All land is private or belongs to legal entity (Valsts zemes …). Territory has been used for agriculture, map of 1924–1935 shows agriculture land and wet meadows, which are ameliorated now. Maps of the period from 1940 to 1990 and 2001 to 2002 show large plantation of trees and planted row of trees on the right side of the road, direction Bauska – Riga. Only a small part of tree plantation is present today. Landscape structure has become more linear over the years. Orthophotomap of current situation is added in Annex 4.

The bus stop on the right side of the road has a similar design to the ones designed by Road and Transport Design institute “Ceļuprojekts” in the sixties and has not been removed during the road reconstruction (Fig. 2.4., Fig. 2.5.). There are more bus stops along the road A7 in the same style.

Road landscape in this section has cultural quality, evidence of the traditional way of living in the countryside in separate estates and the traditional way of land management – farming is present. Landscape scenic qualities are open as distant views. There is not very high diversity of landscape elements and activities. There is some temporary effect due to the changing size and colour of crops. Road alignment is good, and details are adapted to place.

Fig. 2.4. **Bus stop**
(Source: Latvian Road Museum)

Fig. 2.5. **Bus stop from A7 road**

There are grain fields, which create temporary effect in the landscape by changing colour and height. It does not affect visibility. Fields are crossed by drainage ditches filled with overgrown shrubs and trees, which create a negative visual complexity, which is considered as negative feature according to scenic road design guidelines (Dewan, Dewan, 2008). Only one of the existing houses “Šosejnieki”, which is close to the road, is visible. The others, further from the road are hidden by trees and other vegetation around the houses or are not visible due to topography. Views from the road are open and distant, closed by forest and groups of trees around farmsteads in the background. Tree plantation mentioned above is situated at the beginning of the section and is not visible in animation due to the angle of view. Only a short row of old willow trees along the road are present on the right side at the end of the section. The road has good alignment, which contributes to the aesthetics of flow and road legibility. Design is simple, there are only some necessary traffic signs, no signs of house names. There are no special landmarks or road art elements, which would help to orientate, no lighting, only road signs. Electricity line is visible over the road. Scale of landscape elements is adapted to the place.

2.2.2 Second case. Section of the road A3 in Kocēni regional community

The second case area is a section of a major road A3 in Kocēni regional community from picket 43.5 to picket 44.5, situated in a landscape type called "mežāre". This is a landscape type, where agricultural lands change with forests. The relief is easily wavy or flat. Landscape structure is mosaic. Very important elements of the landscape are farmsteads, natural meadows and groups of trees. Close and medium–close views, which end in a forest wall or in farmhouses surrounded by tree groups (Vides aizsardzības…, 2000). The road is 6.50 m wide and has one lane in each driving direction. The analysis is carried out in the driving direction from Riga to Valmiera, from south west to north east. The average number of cars in 2018 was 5859 cars per 24 h (Satiksmes intensitāte…, 2018).

Analysis of historical maps from https://topografija.lv/ years 1924 –1935, 1940 –1990, show that in the period from 1924 to 1935 the A3 road did not exist (Annex 5). Villages Stalbe and Rubene were connected by a road V191 named "Stalbe – Jāņukalns", which still exists today. A straight section of the current road A3 from Stalbe to Rubene was built after the Second World War through the "Maķēni" bog. A historic road V286 starting from the road "Stalbe – Jāņukalns" to Daibe crosses A3 in the case study area. In the years 1924 –1935 there were three farmsteads with house names "Mālis", "Vitka", "Kaiba". There are four farmsteads "Robežnieki" in the place of former house "Mālis", "Lejas Vitkas", "Kaibas" and "Jaunvītautas" in the case study are according to the data from the State Land Service now. "Jaunvītautas" is the most recent house, which has been built after 2005 according to www.topografija.lv ortho photo maps. Arable land and smaller forests are private or belong to legal entity, larger areas of forest and the bog belong to the state (Valsts zemes …). Land is ameliorated. Landscape structure has changed since 1924 – 1935. There is a forest on the tops and slopes of hills and the only plain areas are used for agriculture.

There is a forest on both sides of the road in the first metres of the area, driving direction from "Stalbe'to "Rubene". The landscape is enclosed, Maķēni bog on the left side. Further the view opens to meadows on both sides (Fig. 2.6.). According to LIFE Viva Grass project planning tool it is permanent grassland on plain relief, organic soils (Life Viva …). After meadows the road goes into the trench through several hills (Fig. 2.7.).

Fig. 2.6. **View to meadows**

Fig. 2.7. **Trench through hills**

There are bushes and trees on the hill tops and slopes and landscape is enclosed again. Section of a case study finishes with a distant open panoramic view to arable land on plain relief, medium soil fertility on both sides of the road and some meadows on right side. As the view opens after an enclosure and the road goes down hill, it can be marked as special and impressive comparing to previous landscapes along the road (Fig.2.8.). There are two bus stops, one on each side of the road in the case study area and an electricity line crossing the road. Existing traffic signs and road infrastructure is present. Orthophotomap of current situation is available in Annex 6. Road landscape has cultural quality. Meadows, which are used for animal grazing, cultivated fields present the traditional way of land management. Section of the road

is crossed by historical road, which adds historical quality. “Maķēni” bog presents natural quality and distant views contribute to the scenic quality. Diversity of landscape elements and activities is higher than in the previous case due to landscape structure formed by topographically open space of meadows and enclosures of forest. Arable fields add temporary effect with changing crop colour and height during the year.

Fig. 2.8. **Panoramic view**

There are no special landmarks in the territory, which could help to orientate, except a wide panorama over the fields and meadows, through the trench and down the hill at the end of the section. The scale of landscape elements is adapted to place. The sun can affect visibility and driving conditions in the morning, when it is in the eyes in some curves.

2.2.3 Third case. Section of the road A3 in Strenči regional community

The third case is a section of a major road A3 in Strenči regional community from picket 92.3 to picket 93.3 , representing forest landscape. It is situated in a landscape type called “mežaine”. This type of landscape is characterized by flat terrain and high forest coverage. The structure of the landscape is made up of large forests, where the agriculture lands stand as islands. Landscape contrast is determined by the diversity of forest growth conditions. Close and closed views dominate (Vides aizsardzības…, 2000). The road is 6.00 m wide and has one lane in each driving direction. The analysis is carried out in the driving direction from Valmiera to Valka, from south west to north east. The average number of cars in 2018 was 2230 cars per 24 h (Satiksmes intensitāte …, 2018).

Analysis of historical maps from https://topografija.lv/ years 1924 – 1935, 1940 – 1990, show that there has been forest in the case study area except the area around the farmstead Šalkas (Annex 7). The route of the road has been slightly straightened. In the years 1924 – 1935 there was one farmstead “Kaucis” with buildings on both sides of the road. At present there is a farmstead “Kauči” situated on one side of the road. It contributes to the cultural value of the road. All forest areas belong to the state (Valsts zemes …). Landscape structure has not changed. There has been forest in the area since 1924 – 1935 and meadows or fields around the only farmstead. Orthophotomap of current situation is available in Annex 8.

The forest on the right side of the A3 road, direction Valmiera – Valka, is old boreal natural forest according to the database of the Nature Conservation Agency (Dabas aizsardzības pārvaldes…) (Fig. 2.9.).

The territory on both sides of the road is within the Regulatory Area of the Protected Landscape Area "North Gauja" (Aizsargājamo ainavu …, 2008). It has strict limitations regarding forest management. Only few activities in order to preserve the forest are allowed according to the individual protection and management rules of the Protected Landscape Area "North Gauja". No clear cuts in this territory are allowed. The River Gauja flows through the territory and it has a 500m wide protection zone on each side (Aizsargjoslu likums, 1997). Clear cuts are forbidden in 50 m wide zone from the river. Due to the strict regulations landscape will not change significantly in the future.

Due to the presence of natural forest, the road landscape has high natural value. The River Gauja is flowing 50 metres from the road and in case it was visible from the road it would

contribute to the scenic quality of the road. Variety of landscape elements is not high; the views are mostly closed except a short opening to the meadow on the left side at the end of the section.

Fig. 2.9. **View from the road to the boreal natural forest**

Mixed forest with deciduous and broad leave trees creates some temporary effect of changing colours through the year. In the long term, the possibility of clear cuts along the road can create changes in landscape structure. The scale of landscape elements is adapted to place.

2.3 Scenario concept

Scenario method is chosen in order to find out what the preferences of road users in different elements in the same landscape are. The concept of scenarios as a tool for indirectly exploring the future is old and can be traced back to the writings of the early philosophers, like Plato. As a strategic planning tool, scenario techniques were developed and employed by military strategists, generally in the form of war game simulations (Brown, 1968). Modern scenario techniques only emerged in the post–war period in 1960s (Bradfield et al., 2005). Scenarios are widely used in future studies and have a variation of approaches. Bishop, Hines and Collins in their overview of scenario development techniques reveal eight categories of techniques that include a total of 23 variations used to develop scenarios (Bishop, at al., 2007). Since the early 1970s, they have been increasingly used for landscape planning (Shearer, 2005; Tress, Tress, 2003). In Latvia scenario method has been used in landscape ecological plan development (Latkovskis, 2013).

Scenarios provide a useful tool to demonstrate the dynamics of landscape and evaluate the potential consequences of choices in case study areas. Scenario–based studies can be divided in normative studies, which seek to identify preferable futures; and descriptive studies, which aim to identify possible future without regard for preference. In this research Van den Berg and Veeneklaas's (1995) definition of a scenario is used, where a scenario is "description of the current situation, of a possible or desirable future state as well as of the series of events that could lead from the current state of affairs to this future state" (Veeneklaas, 1995). Following this definition, scenarios do not present the most realistic future state, they are not prognosis, predictions, or forecasts. In contrast to forecasts, the scenario concept allows the development of several alternative future landscapes while being aware of the uncertainties.

Scenarios in this research illustrate developments that could happen in the case study areas. The set of assumptions made within each scenario are built on logic, coherence and consistency. Landscape development scenarios are defined by considering legal provisions and socio–economic aspects of landscape development. None of the scenarios is designed to be more realistic than others. Road infrastructure has not been changed in all scenarios. Roadside

management is considered according to the standards (see Annex 2). Roads are treated according to the standard road management practice. Road edges are one metre wide. The surface of roads may show some cracks, it is included to show scenarios more realistically. Scenarios look at the landscape behind the roadside. Scenario characteristics are given in Table 2.1.

Table 2.1

Scenario characteristics of case area development

Landscape type	**Agriculture landscape**			**Mosaic landscape**			**Forest landscape**		
Case number	**1.case**			**2.case**			**3.case**		
Scenario number	1.	2.	3.	1.	2.	3.	1.	2.	3.
Scenario characteristics	Current situation	More intensive conventional agriculture, less landscape elements	Less intensive, ecological agriculture, road landscape design principles, more landscape elements	Current situation	More intensive conventional agriculture, more open landscape	Less intensive agriculture, forestry, more closed landscape	Current situation	More intensive forestry	Forestry applying forest landscape design principles

The first scenario in each case presents the existing landscape and acts as a baseline to which alternative scenarios are developed, the second scenario presents a more intensive use of the territory and the third scenario – less intensive use of the territory. The proposed scenarios are developed on the current topography, but do not represent fully realistic landscape management and design options.

Very important factors in the landscape of agricultural lands, which determine the development of the landscape structure, are the agricultural land policy, including The European Union's agricultural policy, natural factors and economic activity (Lauku attīstības …, 2014). LIFE Viva Grass project integrated planning tool https://vgrass.hnit–baltic.lt/vgsites/vgviewer/ was used for territory evaluation and scenario development. This tool is based on ecosystem services approach and helps to strengthen linkages between social, economic, environmental, agricultural fields and policies in grassland management. The tool helps to plan and make decisions in sustainable grassland management (Life Viva..., 2018). In this case it helped to decide how the agricultural land of the case study could be used in the future.

Forestry activities, practices and related regulatory norms are taken into account in scenario development in forest landscapes (Latvijas meža …, 1998, Meža likums, 2000). In the case of Strenči forest landscape, it would be necessary to involve a forestry specialist, who can assess the current situation of the forest, in order to develop realistic alternatives. When planning any type of forestry work, it is necessary to carry out forest inventory, which can be followed by application of forest design principles depending on the forest management possibilities. Scenarios and design of each case are described in detail in the following chapters from 3.1.1 to 3.1.4.

3. METHODOLOGY

3.1 Three dimensional model and scenario animation building

Three–dimensional computer models were developed for each case. Nine animated sequences of driving on the road based on computer models of case study scenarios were developed. Models were based on real data, topography of case areas. The workflow of animation building, used technologies and computer programmes, starting with data acquisition to animation testing and adjustment is presented in figure 3.1. Each step is described in detail in the following sections.

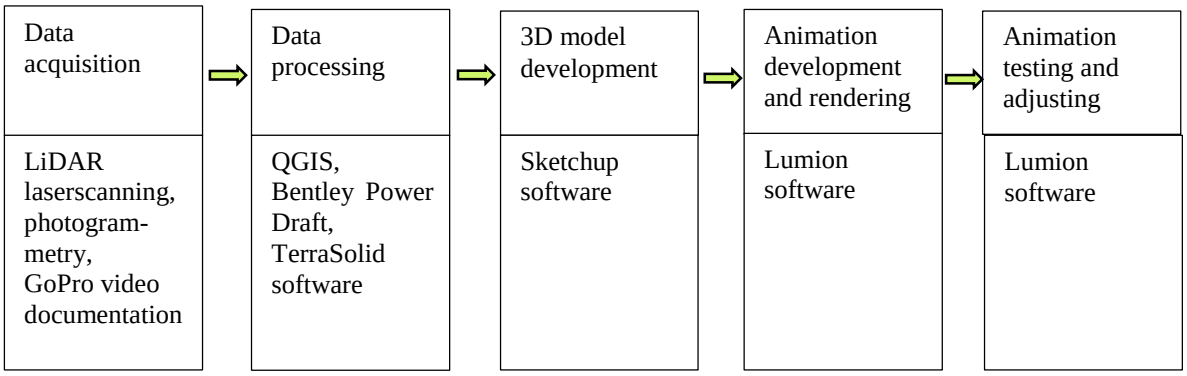


Fig. 3.1. **Data acquisition, 3D modelling and animation development technology**

Data acquisition. Laser scanning and photogrammetry were carried out on all sections in summer 2017 to obtain topographic data and orthophotomaps for 3D modelling. Using GoPro camera, mounted on the car, videos for the road section in both directions were taken. Photographs of roadside elements, e.g. a bus stop, were taken. These data were used in 3D model building and animation development.

In order to develop a road landscape model, a topographic map was necessary. The areas are large, and it would be time consuming and expensive to use common land surveying methods. Airborne Light Detection and Ranging (LiDAR) applications have become well – established surveying techniques for acquiring geospatial information. The use of remote sensing and LIDAR specifically, offers transformative opportunities for Digital Landscape Architecture (Murtha et al., 2018). Transportation agencies around the world have considered LiDAR for road inventory (Guan et al., 2016). Point cloud from the LiDAR inventory can be utilised to perform road inventory mapping, including any road–scene structure, road pavement, traffic signalling devices, etc. (Williams et al., 2013, Landa, Prochazka 2014). This system was used to acquire topography data and geo–referenced orthophotomaps. Using the LiDAR scanner Yellow Scan, surface terrain point cloud model with terrain networks of 50 m each, in scale 1:2000, and orthophotomaps were acquired (Fig. 3.2., Fig. 3.3.).

The point cloud shows vegetation and other details, e.g. buildings. The YellowScan scanner was selected as it can go through vegetation, making it possible to produce a highly accurate digital surface model (DTM), as well as point density of 60 pts per 1m². The system allows to collect data (point cloud) very quickly and in good quality, and it can be processed with licensed computer programs. There is no need for a Civil Aviation Permit as the drones (unmanned aerial vehicles) fly 50 m above the ground.

It took three hours to perform surveying of each territory. There were eight routes, 28 minutes each. The flight heights were different, because the terrain was not everywhere at the same height – in the lowest place it was 30 m, but the highest – 70 m above the ground level. The flight speed was constant everywhere – 20 km/h, which allowed to achieve a good point

intensity and make the exact surface model on average 70 points per square kilometre. The land owners were personally informed before the flight about the purpose of the surveying.

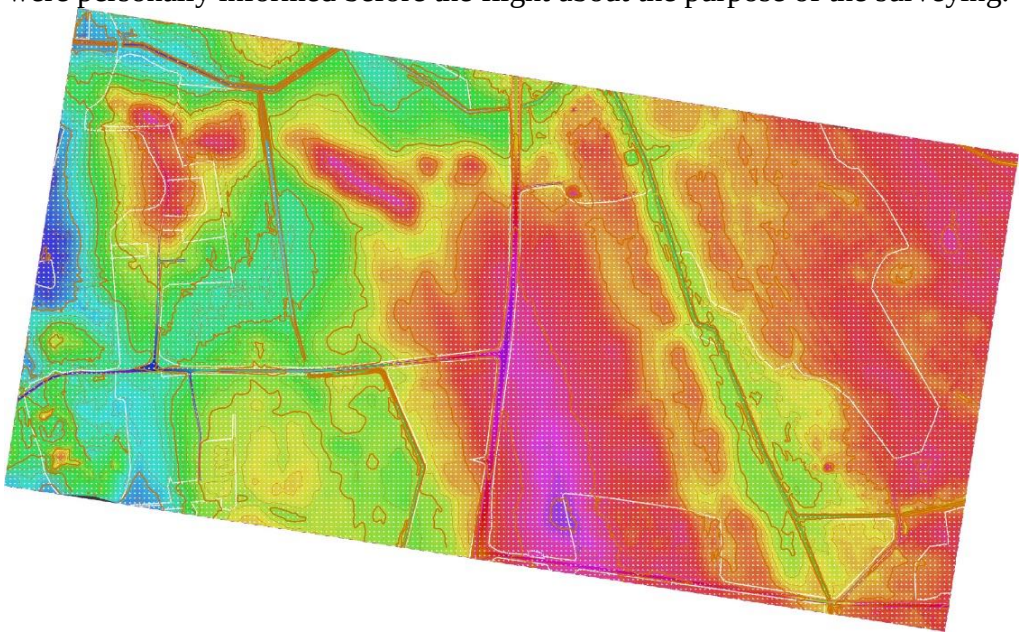


Fig. 3.2. **Topography of first case area** (Source: AGeo)

Fig. 3.3. **Orthophotomap of the first case area** (Source: AGeo)

The flight data were verified on – site using the QGIS and YellowScan plugin. The pilot then performed data alignment and transferred data to a geodesist who carried out data analysis and data processing using the Bentley Power Draft and TerraSolid software.

In some places, where the density of vegetation was 100%, the laser impulse did not pass through. There were few such sites and no defects in the overall model of the relief were detected.

3D modelling and animation development technology. A 3D model for each scenario was prepared based on the current topography. Road landscape animation from each model was developed. There were 9 animations in the end. Scenarios were based on the land use and development possibilities, the differences between each being a variation of the intensity of the use, management and application of road landscape design principles. Scenarios are described in detail after each case study. It would be possible to demonstrate the current situation as a

video taken by GoPro camera, but in such case, it would be hard to compare the changes in landscape. Respondents might start to compare the quality of animations in the video of present situation and that was not task of the research.

Animations show the movement along the road from the drivers position in a car with eye height 1100 mm. All animations show movement in one direction through the case study areas. Direction is chosen from south to north, as if a person would travel from Lithuania through Latvia to Estonia. If the task of the research would be to evaluate the case study areas and offer solutions for case study area development, it would be necessary to develop animations in opposite direction as well. Road landscape should be evaluated in both directions while the landscape is perceived differently in each driving direction (Appleyard, Lynch, 1964).

All animations represent case study areas in summertime. Seasonality is an important aspect in landscape planning and management (Olwig, 2005). Seasonality influences how road landscape is perceived in different seasons and it affects traffic safety issues. In this research this aspect of the road landscape is not studied further. Summer is chosen as the most touristic season and season when weather conditions allow to enjoy the view from the road longer than in other seasons due to the long daylight time.

Sketchup software was used for road 3D modelling from a topographic map, which was imported as .dwg file. As the Sketchup software offers a limited number of tools for modelling, especially for road and terrain modelling there was a need to use several programme extensions. The road was modelled with Chris Fullmer Shape bender extension. Road model was created from the road profile line with this tool. For terrain modelling sandbox tool was used. It was followed by Curviloft and ThruPaint extensions for positioning and orientating the road texture. Large tree groups and buildings were marked in the topography from LiDAR data, some of separate standing trees were marked using the geo–referenced orthophotomap, which overlaid the topography in AutoCad.

Orthographic photos were used to check the size of the trees and to decide about the design, which elements to keep and which to remove in each scenario. Two dimensional linework tree CAD blocks, which were replaced by 3D tree placement mark components, can be seen in the imported topographic map, see figure 3.4.

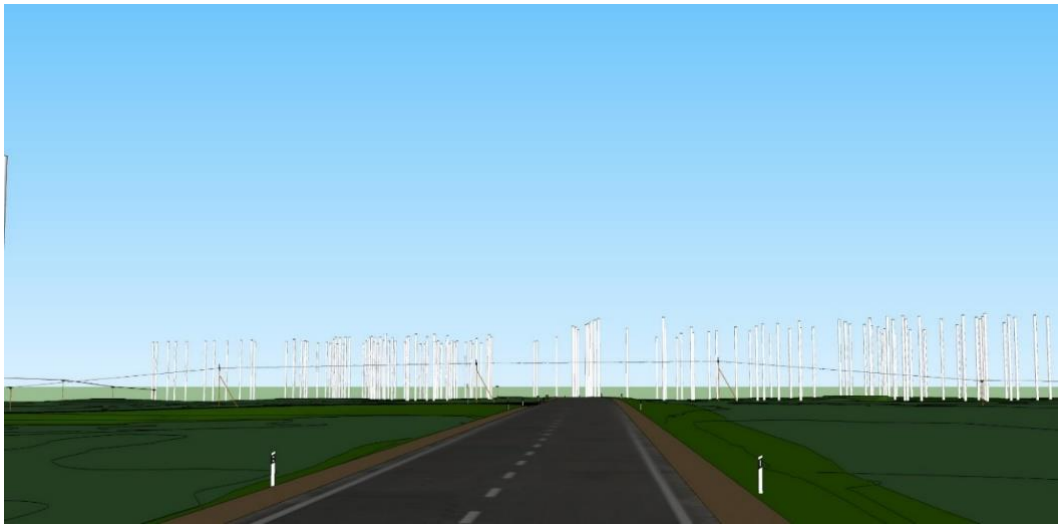


Fig. 3.4. **Sketchup model with the marked places for trees**

This option allows to arrange tree marks instantly and precisely. The right height of the object placement on terrain was carried out with DropGC extension. For a more authentic look of the road, landscape houses, bus stops, road signs and electricity lines were added. They were designed in Sketchup using the photos of the elements and the video taken by GoPro camera.

Sketchup model was imported into Lumion 8 to add trees and to render the landscape, see figure 3.5.

Fig. 3.5. **Model of the current situation rendered in Lumion**

Lumion 8 is a real – time game engine rendering software with LoD (level of detail) algorithm. This algorithm allows to model large areas covered by trees because it decreases the geometry of an object depending on virtual viewer's location. If the viewer is close to the object it will be displayed in detail, if the viewer is far from the object, it will be displayed in a less detailed way. Cars and movement were added in Lumion as well. Latest Lumion improvements for sky light feature and shadows allowed to blend all landscape elements more naturally and get the final rendered animation more immersive and realistic (Vugule et al., 2018a).

Model and animation development took place between September 2017 and February 2019.

Road landscape design principles, which are characterized by variety, aesthetics of flow, legibility and orientation in space, described in the literature review (Blumentrath, Tveit, 2014) were applied in scenario animation design (Table 3.1).

Table 3.1

Overview road landscape design principles applied in each scenario animation

Characteristic	**Design principles**	**1.case**			**2.case**			**3.case**		
		1.sc.	**2.sc.**	**3.sc.**	**1.sc.**	**2.sc.**	**3.sc.**	**1.sc.**	**2.sc.**	**3.sc.**
Variety	Diversity of landscape elements and activities	+	+	+	+	+	+	-	+	+
	Facilitating varied and long enough views	+	+	+	+	+	-	-	+	+
	Sequences	-	-	-	-	+	-	-	-	+
	Create and highlight landmarks	-	-	-	-	+	-	-	-	+
	Temporary effects	+	+	+	+	+	+	+	-	+
	Road art	-	-	-	-	-	-	-	-	-

Characteristic	Design principles	1.case			2.case			3.case		
		1.sc.	2.sc.	3.sc.	1.sc.	2.sc.	3.sc.	1.sc.	2.sc.	3.sc.
Aesthetic of flow	Design follows one principal idea	-	-	+	-	-	-	-	-	+
	Facilitating varied and long enough views	+	+	+	+	+	+	-	+	+
	Sequences	-	-	-	+	-	-	-	-	+
	Good road alignment	-	-	-	-	-	-	-	-	-
	Scale and details adapted to place	+	+	+	+	+	+	+	+	+
Legibility	Visual guidance	+	+	+	-	-	-	-	-	+
	Good road alignment	-	-	-	-	-	-	-	-	-
	Simplicity in design	+	+	+	+	+	+	+	+	+
	So less equipment as possible	+	+	+	+	+	+	+	+	+
	Lighting and bright colours	-	-	-	-	-	-	-	-	-
Orientation	Facilitating varied and long enough views	+	+	+	+	+	-	-	+	+
	Sequences	-	-	-	-	-	-	-	-	-
	Create and highlight landmarks	-	-	-	-	+	-	-	-	+
	Road art	-	-	-	-	-	-	-	-	-

(Source: by author, based on Blumentrath, Tveit, 2014)

It was not possible to use some design principles due to the limited area of case studies. The one km length of road sections was too short to design sequences in all scenarios. Scenarios were designed as possible futures of each territory and there were not many landmarks, which could be highlighted. Road art was not used, as it was considered unsuitable in the chosen territories in the countryside. Route of the road was not changed, the road alignment was considered good, but for more detailed evaluation of the road alignment it would be necessary evaluate a longer stretch of the road, not only one kilometre.

Animation of all scenarios are available on a CD after the Annexes.

3.1.1 Description of the scenario animations of Road A7 in Iecava regional community

The first scenario in each case is the current situation. Scenarios are presented by animations in order to feel the movement through the landscape. Animation of the first scenario shows a one km long stretch of major road A7's current situation in driving direction from Bauska to Riga (Fig. 3.6.).

Description of the landscape is given in the chapter above – 3.3.1 First case. Section of the road A7 in Iecava regional community.

Fig. 3.6. **View from the animation of the current situation, agriculture landscape**

The second animation shows a scenario of more intensive agriculture practice, well–managed, more open landscape, no shrubs in the ditches, providing wide and distant views. This section of the road is situated in the current agriculture area, which is the reason to offer development of intensive agriculture. The current road infrastructure with information signs, the bus stop, electricity lines, the same dwellings with their surrounding yards and old trees are present in the model. There are foreseen minimal, regularly cut edges along the fields. A row of willows along the road next to a farmstead has been removed based on the current practice of tree row cutting along major roads (Fig.3.7.). Characteristic road landscape qualities do not change. Diversity of landscape elements in this scenario is lower, the views are more open.

Fig. 3.7. **View from the second animation, intensive agriculture and removed row of willow trees on the right side of the road**

The third scenario is based on the application of road landscape design principles and practices and more ecological agriculture (Fig. 3.8.).

There are tree groups in the modelled situation, placed according to road landscape design principles and wider edges along the fields. A group of trees and shrubs underneath is placed in at the T junction on the right side of the road, 30 m from the axes of the road outside the zone of a section which is 25m wide (Likums par autoceļiem 1992). Tree groups in T junctions help drivers to read the road and warn about the approaching junction (Eleksis et al., 1967).

Electricity lines have been removed, which are considered to be negative elements in the landscape (Department of transport…, 2013). Edges of fields along the roadside are 20 m wide in accordance to EU greening regulations (Platību maksājumi, 2018). They are not used for production, consist of wild grasses and flowers and are cut at least once a year.

Fig. 3.8. **View from third animation, agriculture landscape, tree group in the T junction**

Diversity of landscape elements in this scenario is higher. The first three animations from A7 road in Iecava regional community were developed without clouds in the sky and without traffic on the road.

3.1.2 Animation pilot testing and improvement of A7 road landscape in Iecava regional community

In order to evaluate if animations present the landscape in a realistic way, pilot testing was carried out in August 2018. Animations were presented to two target groups on large TV screens. One group consisted of six landscape architects and four landscape architecture students. Eight of them are frequent drivers and two are more often passengers. The landscape architect group met together and the interview took place in the form of a group discussion. The other reference group was of eight people from other fields unconnected to landscape architecture. All of them are regular drivers. Discussions and observations were recorded, noted down and analysed later.

The results of the reference group discussions can be divided into three aspects: reflections on the landscape quality and perception; on technical details and problems of the modelled animations and on road landscape design suggestions. While it was not specifically requested, the landscape architects could not help but express their ideas on how to improve the landscape design. Both respondent groups agreed that the animation of the current situation represents a typical agricultural landscape in a realistic way. They could recognize plants and trees as being typical of an agricultural landscape. One person who frequently drives along this road recognized the section in the model.

From the discussions and observations of the reference groups, it was clear that viewers generally look straight ahead and notice elements adjacent to the road and in front of them. Respondents did not notice changes in the landscape at the sides of the screen. It confirms the principles of viewer perception along roads, developed in Appleyard's early studies of road landscape perception from as far back as 1964 (Appleyard, 1964). This is a potentially limiting aspect in the use of animations shown on a flat screen. In the case of a real time model, where

a person can move through the model and turn in any direction, it would be possible to see the designed changes in the landscape much better – but also to experience the fast parallax movement which makes looking sideways at a roadside at speed difficult and uncomfortable. Elements of the model, which were further away from the road axis – at 800 m to 1 km distance tended to remain unnoticed by respondents. A demonstration of a real time model for use in public discussions would be more time and resource consuming to create, but for projects with complicated problems could be more suitable.

The discussions showed, that drivers tend to notice objects on the right side of the road better and they look at the right side more intensively (this is a feature in Europe – it may be the opposite in e.g. the UK). One of respondents stressed, that she cannot manage to read the road signs properly – not due to her eyesight, but due to the relatively small size of text used on Latvian road signs (there are text size standards used in other countries for different roads with different normal speeds or speed limits), and also because of the light – backlit signs are difficult to read in bright conditions. This situation appeared due to the modelled light conditions on the road.

Almost all respondents preferred the third model as the most interesting landscape due to the wide edges of the fields with meadow flowers, which made the landscape more attractive aesthetically. Two of respondents were concerned about safety, suggesting that flowers can take attention away from the road. One of the landscape architects raised the question of seasonality in the road landscape, and it was discussed how the public should be made aware of proposed landscape changes in other seasons besides summer.

Removing the willow trees in the second and third model was perceived negatively. Respondents from both groups considered them as positive elements, which help to denote the space and make the road more interesting. Society in Latvia is very sensitive to cutting down roadside trees, and there have been heated debates and protests in cases, when removing old alleyways and rows of mature trees is proposed. Trees, especially old oaks, have a historical value in the Latvian countryside. Modelling of possible solutions could help the institutions involved in the decision process to understand the visual changes, and to present them in public discussion.

Several respondents noticed the disappearance of the electricity line. In the discussions they admitted, that they noticed the electricity line in the first two models, but did not notice that it had disappeared in the last one. It seems that positive changes are sometimes accepted without noticing them.

The conclusion from the reference group discussion was, that the Lumion computer program is suitable for modelling rural conditions, even if we had problems with a limited wild plant library – no one criticised the models for this fact. It is possible to achieve realistic results and to work on large areas using thousands of plants (as claimed by the program producers) and to communicate the project to a client or audience (Lumion 8..., 2018).

Modelling and visualisations of road landscape in rural areas has the same importance as visualisations of the city environment but has different challenges – especially the scale involved. It is time consuming and might not be necessary for all road projects, but it is possible and valuable in more important or sensitive situations. Results of the pilot testing showed, that it is possible to present changes to a road landscape in a rural area to the public in a way that people can understand and recognize possible changes and to express their opinions. This can be a way to improve the public participation and help to communicate possible plans to all parties involved in road landscape planning (Vugule, et al., 2018a).

Scenarios and animations were improved based on the results of the pilot test. The main aim was to update the second and third scenario animation, in order to make the landscape more diverse. Animation of the current situation was left intact, except clouds in the sky and traffic was added, in order to give a more realistic view of the road landscape.

Several improvements of the second scenario animation were carried out. Tree row along the field on the right side of the road in Iecava direction was extended as a wind break for a

farmstead. Signs with house names were added on the right side of the road to improve the road infrastructure and visual guidance. Signs were designed according to Iecava regional community regulations (Saistošie noteikumi par..., 2016). Apple orchard was planted in front of the house on the right side of the road, and corn field planned on the left side of the road (Fig.3.9.). These both elements create temporary effects during spring, summer and autumn and add variety to the landscape, but limit visibility.

Fig. 3.9. **View to the apple orchard and corn field of the second animation, agriculture landscape**

Third scenario animation was supplemented as well. A group of five trees and decorative shrubs underneath placed in a T junction on the right side of the road were extended to seven trees. A group of current trees on the left side of the road was left and supplemented with decorative shrubs. Design of 20 m wide roadside edges was improved and made more natural looking. Trees and decorative shrubs were planned next to the bus stop (Fig.3.10.).

Fig. 3.10. **View to the bus stop with a group of trees behind, third animation of the agriculture landscape**

It provides better microclimate for people waiting for the bus and helps to integrate the bus stop into the landscape. In the landscape with open and distant views it would be easier for bus drivers to notice the bus stop from a distance, adding visual guidance to the road. Both

broad leave trees and deciduous trees were used, thinking about the seasonality, in order to have some accent in winter. Family house "Šosejnieki" situated close to the left side at the end of the road section, was turned into a café and an information sign before the café was added. Analysis of historical maps show, that the house was built after 1935, which means it is not an old, traditional Latvian house, which would be necessary to preserve. Buildings close to the intensively used roads are more appropriate as service objects rather that dwelling houses due to the noise and lights at night from the intensive transport.

Signs with house names were added on the right side of the road, to improve the road infrastructure with information and visual guidance. Signs were designed according to Iecava regional community regulations (Saistošie noteikumi par ..., 2016)

A row of existing willows along the road next to a farmstead on the right side was put back as an element reducing the speed near houses and noise and pollution protection for the houses. In other countries, old trees in road landscape design are considered a positive landscape element according to the literature.

Modified orthophotomaps, showing landscape changes in the second and third scenario of the first case, are available in Annex 9 and 10.

Animations of next two case study areas were developed by considering the conclusions from the pilot testing. Road users do not notice small changes and there should be more extreme differences between scenarios.

3.1.3 Description of the scenario animations of road A3 in Kocēni regional community

The first animation of the case area shows the current situation in the driving direction Riga – Valmiera. (Fig. 3.11.). Description of the landscape is given in the chapter above – 2.2.2 Second case. Section of the road A3 in Kocēni regional community.

Fig. 3.11. **View from the current situation, mosaic landscape**

Second animation shows a scenario which foresees increase of open landscape and decrease of forest area (Fig.3.12). It is foreseen to preserve and extend area of current meadows. The most appropriate management for this area is moderate grazing because of low grass productivity according to Vivagrass planning tool. Trees and bushes on the hill on the right side and further on the left side are taken down. Meadows are grazed by sheep. Sheep breeding has long traditions in Latvia starting from the 9th century. Nowadays sheep farming is developing and the number of sheep has increased to 112.2 thousand in year 1917 (Agriculture of Latvia, 2108). Sheep add diversity of activities in the landscape. There is foreseen movable electric

fence, which is not noticeable at a driving speed of 90 km h^{-1}. Electricity line is moved underground.

Fig. 3.12. **View to the hills, second animation of the mosaic landscape**

Roadside edge of the arable field on the left side before the crossroad is 20 m wide according to greening regulations (Platību maksājumi, 2018). It adds diversity to the foreground of the landscape seen from the road. It is foreseen to grow flax on the fields on the right side of the road at the end of the animation in order to increase the landscape diversity and add accent of blue colour in the fields next to the road in the flowering time. It would stress the Latvian identity and add diversity to the landscape. Flax has been cultivated historically. Before the World War II, Latvia was among the biggest flax exporters in the world, and flax was growing on more than 60,000 ha (Grauda et al., 2008). Research shows that it could be cultivated nowadays for bioenergy production (Komlajeva, Adamovics, 2012). Crops and flax create temporary effects during spring, summer and autumn and add variety to the landscape.

As landscape becomes more open, there are more distant views, but there is less diversity of spaces and less variety. After trees from the hills are taken down, topography stands out and the place of historic road is highlighted. The wide panoramic view going down the hill at the end of the section is still there, but there is no more the effect of surprise as in the current situation, when a traveller goes through the trench with trees on both sides and suddenly a wide view opens.

Third animation shows a scenario which foresees decrease of agriculture and expansion of forest area, diversity of views, especially the distant views and variety of the landscape elements would reduce (Fig. 3.13.). There is a forest in the area of current meadows. Most appropriate management of current fields is production of bioenergy resources or animal food with high outputs from 8 to 9 tons per hectar. The area is also suitable for crop production with average yields.

There is hemp planted on the left side of the road in the place of current fields. That would temporary close the view to further landscape. Nowadays hemp (*Cannabis sativa L.*) has become very important as a crop for biomass production and the Baltic region is suitable for hemp cultivation as a biomass plant (Poisa, Adamovics, 2010). Spruce edge is planted on the right side of the road along the current meadow as a protection belt for agriculture land and guiding element in the road landscape. Bushes from overgrown ditches on the left side of the road at the end of animation are taken out.

Modified orthophotomaps showing landscape changes in the second and third scenario of the second case are available in Annexes 11 and 12.

Fig. 3.13. **Closed view from the third animation of the mosaic landscape**

3.1.4 Description of the animation of the road A3 in Strenči regional community

The first animation shows the current situation of the road landscape including current road infrastructure with information signs in driving direction from Valmiera to Valka (Fig. 3.14.). Description of the landscape is given in the chapter above – 2.2.3. Third case. Section of the road A3 in Strenči regional community.

Fig. 3.14. **View from the current situation, forest landscape**

The second animation shows a scenario of typical forest management if the case study area would not be part of Protected Landscape Area and there would be a regular forest with no special limitations in management. All rivers in Latvia have protection zones (Aizsargjoslu likums, 2014). Protection Zone of the river Gauja, which is 500 m wide in this area, is considered in this scenario. Clear cuts are not allowed in 50 m wide zone from the river. Foreseen management is based on regulations about tree cutting in the forest (Noteikumi par..., 2013). The current practice of forest management is to concentrate clear cuts if the forest is mature. There is foreseen 5 ha large clear cut on the right side of the road in direction Valmiera Valka. There are two groups with 25 trees left. 50 m wide zone from the river Gauja is regularly thinned. Forest on the riverbank in a 10 m zone from the river is left as it is. Due to steep slopes

there are almost no trees on the slopes. There is foreseen one clear cut on the left side of the road direction Valmiera – Valka before the junction and 10 ha large clear cut after the junction. Two groups of 20 spruce trees are left in the clear cut after the junction. In the present clear cut on the left side of the road, new trees are presented as 3 m high. This is height of a 10–year–old forest. According to Latvian legislation, clear cuts have to be afforested within 3 years after the cutting (Meža likums). Animation shows situation in a year after new trees have been planted. Due to planned changes, views from the road are more open now, but they will close in ten years and will stay closed at least for seventy more years, until the forest grows to the age when it can be cut down again. The edge of the forest is moved back from the road and travelling does not feel like moving through the narrow tunnel (Fig. 3.15.). There are no special landmarks. As the grown–up trees are moved to the background, there are no temporary effects in the foreground, except the changing colour of grass. There is some variety in landscape due to the different height of trees.

Fig. 3.15. **View to clear cuts, animation of the forest landscape case**

The third animation shows scenario where forest design principles are applied, management is less intensive and corresponds to the driver's movement along the road. It reveals the view to the river in short time portions, using goups of trees and diagonal edges of clear cuts, facilitating varied and long enough views and diversity of visible landscape elements.

Clear cut on the left side of the road in direction from Valmiera to Valka is filled with mature forest. It is foreseen to thin the forest unevenly on the right side of the road. View to the river will be opened on the right side. This is foreseen as "landscaping clear cut" according to regulations about tree cutting in the forest (Noteikumi par..., 2013). Limitation of landscaping clear cut area is 0.2 ha. The aim of landscaping clear cuts is to open the views and design and manage scenic views. In this case the view to the river Gauja which runs close to the road is evaluated as potentially highly aesthetic (Fig. 3.16.).

Right after the view is opened, the view on the left side is on a structured clear–cut area. Tree groups on this clear–cut will make the view more divided and natural. One feels that the clear–cut area is smaller than it actually is, because there are partly hidden zones by the trees. In the curve, the right–side view is closed again in order to keep attention to the road until the junction. The forest on the right side after the clear cut is unevenly thinned, followed by the next landscaping clear cut. It would open the view to the river when driving from Valka side.

Landscape structure in the third scenario is more varied than in the second one. Clear cut areas are smaller. As the new forest grows and the views will be closed again, it will be possible to cut down the forest, which is left untouched now, and in long term landscape diversity will be higher. There are some broad leave trees in the mature forest in the foreground, closer to the road. During the year it will give temporary effects, due to the changing colours of the leaves.

Fig. 3.16. **View to the river and desined clear cut, forest landscape case**

Modified orthophotomaps showing landscape changes in the second and third scenario of the third case are available in Annexes 13 and 14.

3.2 Road user survey

3.2.1 Questionnaire development, pilot testing and adjustment

Questionnaire development. Based on the literature review about road perception studies and the use of survey methods, internet–based road user survey was carried out in this research. The intention was to reach road users and collect data about user preferences on road landscape and its elements. Internet based questionnaire was chosen due to the technologies used in the research. Firstly, it was necessary to demonstrate road landscape animations and secondly, to reach enough respondents.

Questionnaire about animations of case study scenarios was developed and pilot tested and adjusted. The first questionnaire for the pilot testing was about three road landscape animations from Iecava regional municipality. The aim of the questionnaire was to test if the questions are understandable by non–landscape architect and to hear comments from landscape architects about the structure of the questionnaire, to see how respondents evaluate animations, if they can recognise positive and negative elements in the road landscape. It consisted of seven questions about each road animation, one question was about animation comparison. Three questions included photographs and respondent had to give preferences regarding roadside management. These questions were included while different options of roadside maintenance were not included in the animations. One question was about landscape type preference, another question about reasons of using a car and five questions about respondent's personal data like, gender, age group, and profession. Respondents were asked to answer if they travel by car as drivers or as passengers. It was assumed that drivers pay more attention to the road and passengers are freer to look around. There was an option to add comments about the questionnaire at the end. Survey was intended for respondents aged 18 and up, when a person in Latvia can have a driver's licence. Three age groups were defined: 18 to 28 years old, 28 to 38, and 39+. Questionnaire was targeted for at least 18–year–old respondents, as this is the age when one can get a drivers' licence, next age group from 18 to 28 has some driving experience and people older than 39 have at least 10 years of driving experience. The aim of such division was to see if driving experience influences road landscape perception. Questionnaire was

developed using google docs form and filled in online. Animations were uploaded on www.youtube.com and links to animations included in the questionnaire.

Questionnaire pilot testing. Questionnaire pilot testing before sending it out to a larger group of respondents, was carried in November 2018. The questionnaire was carried out in Latvian language and it was filled by fourteen respondents – seven landscape architects and seven non–landscape architects. 79 % of respondents were in the age group of 39+ and 21 % in the age group from 28 to 38. Theq questionnaire was filled in by 64 % female and 36 % male respondents. 79 % of respondents mostly use the car as drivers, 21 % mostly as passengers.

Comments from the questionnaire show that questions were understandable for landscape architects, but some of the used terms like – "open and closed views" were not familiar to non–landscape architects. Several respondents, especially non–landscape architects mentioned that animations are very similar, and they did not notice remarkable differences. The way animations were saved and uploaded on www.youtube.com reduced the quality and this issue needs to be solved.

Seventy percent of respondents named positive features, which stand out in the landscape animation, 54 % in the second and 92 % in the third animation. Among the most popular were the trees, cultivated fields with a remark that the land is not abandoned in the first animation. One of respondents mentioned cars as a positive feature. Respondents marked cornfield in the second animation as a positive element. It blocks the view, which usually is a negative feature, but in this case, it was mentioned as a positive effect as it creates a new space. The most popular element in the third animation were flowers along the roadside; landscape is more diverse with accents like tree groups in the landscape. One respondent named traffic that is more intensive as a positive feature. One of respondents noticed disappearance of electricity line as a positive feature.

Twenty–nine percent of respondents named negative features in the first animation, 15 % of respondents in the second animation and one respondent in the third animation. Electricity line was the most popular, followed by bad quality of road surface, cars especially trucks in the first animation, electricity lines, cornfield and a billboard were named as negative features in the last animation.

Billboard with the name of the foreseen café was named as the element that distracts the attention from the road.

Respondents liked the third animation the most, followed by the second the first. The third animation had the highest number of positive elements.

When comparing field edges respondents gave the highest number of points to the road edge with wild flowers, less to a narrow well cut road edge.

Respondents liked the mosaic landscape where fields and meadows are combined with forests the most, forest landscape with closed views and open agriculture landscape the least.

Questionnaire adjustment. The questionnaire was redesigned after the pilot testing and six more animations were added after the pilot testing. The survey consisted of 74 questions. Questions of the online survey translated into English are available in Annex 16. There were seven questions about each road animation. Respondents had to answer three questions using Likert scale (Likert, 1932) with five reply alternatives. There were two closed questions with the possibility to answer yes or no about each animation. These questions were followed by two open questions with a request to name positive and negative landscape elements. Most similar answers and key words from the open question were grouped, counted and used for analysis. Questions were about open and closed views, landscape structure, elements and safety. A separate question asking to compare nine animations was taken out as it can be concluded from the individual questions about each animation. Questions about roadside maintenance and about landscape type preference, reasons of using a car and about respondent's personal data – gender, age group were left unchanged. The open question about profession was changed to respondent's field of work. Six fields, which were connected to road landscape and can influence it, were defined – 1) architecture/construction/real estate, 2) agriculture, 3) forestry,

4) transportation/logistics, 5) tourism/hotels/catering, 6) environmental science/nature protection/landscape architecture. The seventh option was for other fields. Open question asking to name, what should be done in order to improve road landscape quality in Latvia was added at the end, to give respondents the possibility to express their thoughts. Google docs form was not used anymore. Questionnaire was prepared in a web–based format using a survey tool created by the research company SolidData. Google document online form for questionnaires has limited possibilities for question and answer types.

In order to improve animation quality, they were not demonstrated from www.youtube.com. After checking several possibilities, www.vimeo platform was chosen as the best one, which does not reduce the quality of animations. Animations were uploaded quickly enough in the device, where respondents watched them.

3.2.2 Administration of the survey and characteristics of respondents

Web based questionnaire was prepared and carried out using a survey tool created by the research company Solid Data on the Internet. Solid Data maintains a database of respondents in the Baltic States. The company operates in accordance with the principles of quality and data protection of industry–leading research associations ESOMAR and MRS. The company is in the EU and respects the general data protection regulation as defined in the European Union for the acquisition, use and preservation of personal data in the EU Member States. The company sent out an invitation to participate in the questionnaire to persons, who are registered in the respondent database. Respondent database from Latvia was used in this case. Survey was carried out in Latvian among respondents from Latvia, who understand the Latvian language in order to acquire the opinions and experience of local road users. Questionnaire was placed online for two weeks from 8 to 21 April 2019. Data were received in Microsoft Excel format.

Respondents were informed about the data use in the beginning of questionnaire. Data were gathered anonymously. No personal information was collected, and no information could be associated with individual persons. The data from the research company Solid Data uploaded on www.VisiDati.lv is protected according to the requirements of Latvian legislation. By becoming a registered participant of the VisiDati.lv survey, the person agrees to the processing of his/her specified data. The processing of these data is carried out in compliance with the general principles of personal data processing specified in the legislation of the Republic of Latvia (Lietošanas noteikumi…, 2019).

The average road intensity in all case territories is 6194 cars per 24h or 4.3 cars per 1 minute. Questionnaire was filled in by 217 respondents, genders were divided equally – 109 females and 108 males. Each minute of animations was evaluated by 217 persons. The average time of filling in the questionnaire was 24.5 minutes. There was slightly higher number of drivers – 125, than passengers – 92 among the respondents. Most of respondents – sixty two percent, were in the age group from 39 years and more. Sixty five percent of respondents in this group go by car as drivers and fifty nine percent as passengers. Twenty two percent of respondents were in the age group 29 to 38 years. Twenty five percent of respondents in this group go by car as drivers, eighteen percent as passengers. Sixteen percent of respondents were in the age group from 18 to 28 years. Ten percent of respondents in this group go by car as drivers, twenty three percent as passengers (Fig.3.17.).

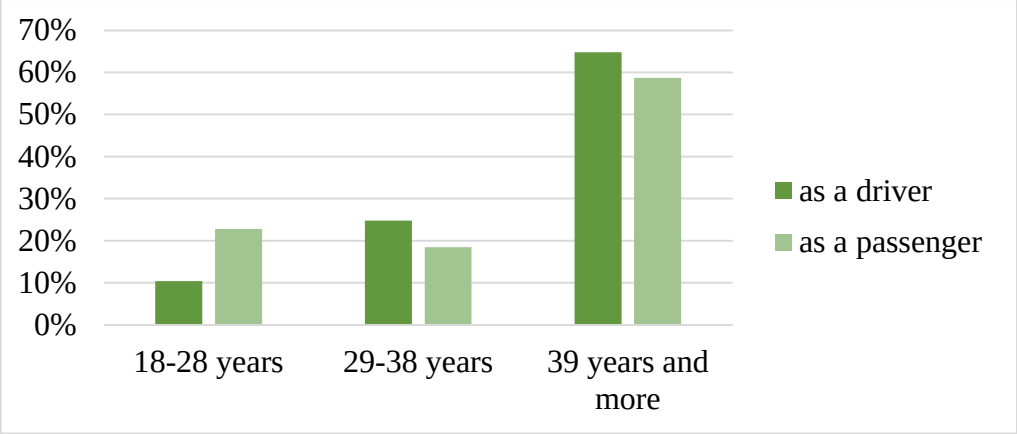


Fig. 3.17. **Distribution of drivers and passengers in the defined age groups**

57.6 % of respondents go by car as drivers and 42.4 % as passengers. Men go by car more often as drivers than women (Fig. 3.18.). 22.1 % of respondents are from six predefined fields, connected with road landscape. The majority – 77.9 % are from other fields (Fig. 3.18.)

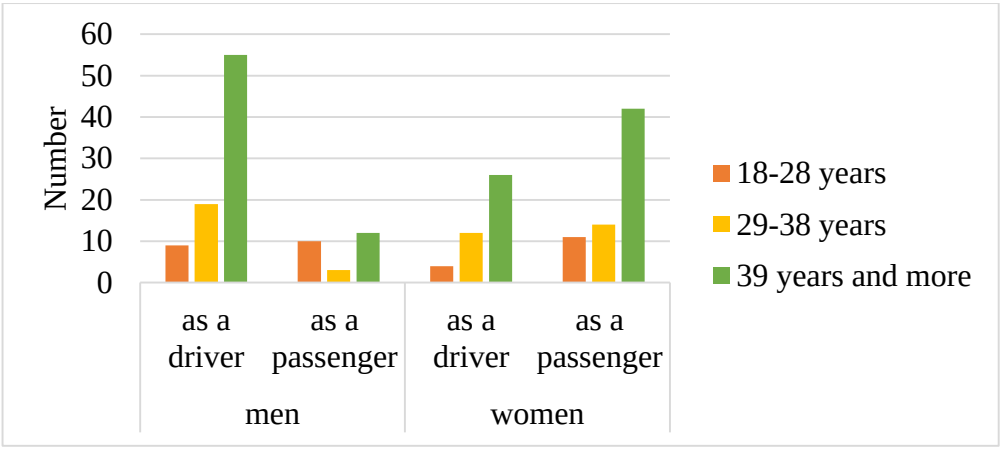


Fig. 3.18. **Characteristics of respondents by age and the way they travel by car**

22.1 % of respondents are from six predefined fields, connected with road landscape. The majority – 77.9 % are from other fields (Fig. 3.19.)

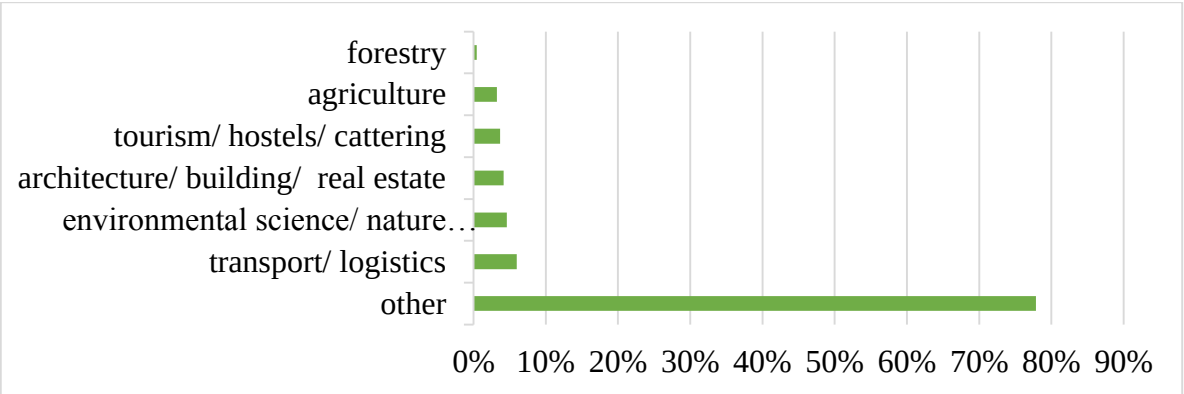


Fig. 3.19. **Fields of work of respondents**

Respondents use car most often for everyday commuting (from home to work, etc.), less often to travel, to go for shopping and the least often for work.

4. RESULTS

Results are described case by case. Results of three scenario preferences, positive and negative road landscape elements in each case are described, followed by the comparison of case results. Results from general questions about road landscape preferences are described next and summary of the results is given at the end of results' section. Discussion about the results is presented afterwards. Statistical data analysis was carried using Microsoft Excel programme. Multi–factor correlation analysis was carried out and it did not show a close correlation among the features, thus showing no interdependence of the results (Annex 15). Table 4.1. shows that the F–value is greater than the F–critical value for the alpha level selected (0.05).

Table 4.1.

ANOVA test results

Source of variation	SS	df	MS	F	P–value	F crit
Among groups	1970135	60	32835.58	584.7486	0	1.319171
Within groups	685070.6	12200	56.15333	–	–	–
Total	2655205	12260	–	–	–	–

Therefore, there is evidence to reject the null hypothesis and say that there are significantly different means. Also, p–value is less than the alpha level selected (which it is, in this case), so the Null Hypothesis can be rejected.

4.1 Results of the first case, the road A7 in Iecava regional community

Respondents evaluated landscape attractiveness in points, where one point represents the the most unattractive and 5 points the most attractive feature. Comparison of three scenarios in agricultural landscape show, that respondents find the landscape of the second scenario the most attractive, the most intensive agriculture (Fig. 4.1.). It was not expected. This scenario has the highest number of positive landscape elements and activities. At the same time the second scenario has the highest number of negative elements named. The lowest number of positive and negative elements is in the third, designed road landscape scenario (Fig. 4.2.).

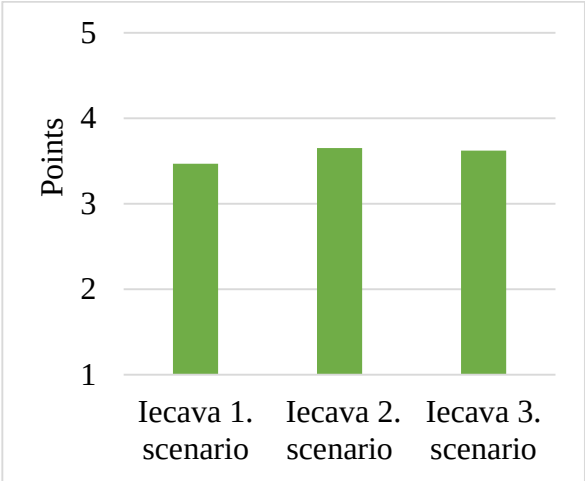


Fig. 4.1 **Attractiveness of the road landscape**

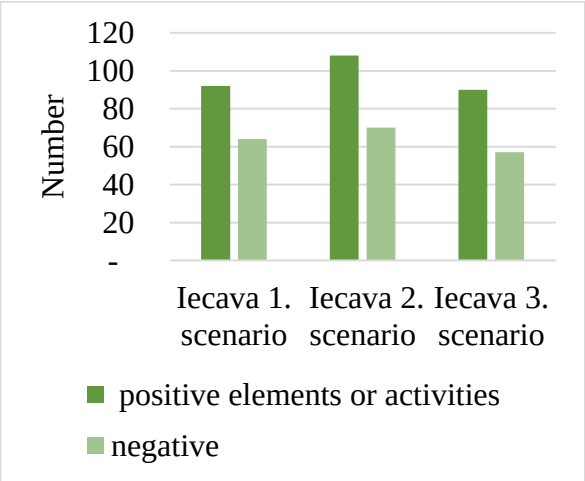


Fig. 4.2 **Positive and negative elements in the road landscape**

Respondents evaluated the degree of openness on a scale from one to five, where 1 is very open and 5 is very closed (Fig.4.3.).

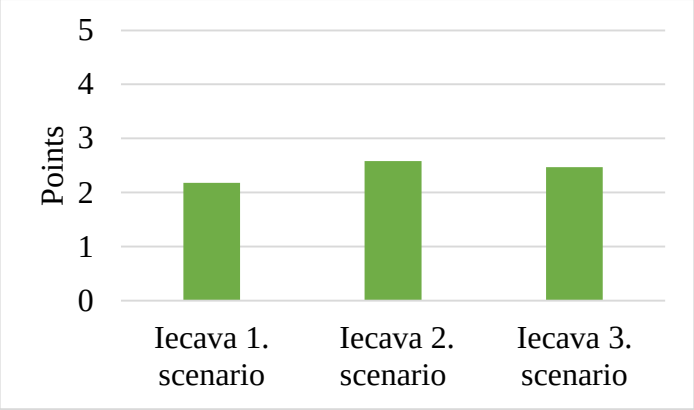


Fig. 4.3. **Landscape structure**

Positive elements mentioned most often in the first scenario of the first case were trees (30 times), followed by agriculture and cultivated fields and meadows (23 times). The third most often mentioned was country house, noting that it is in a good condition (11 times). Good road quality with road marking lines was mentioned 10 times, roadsides with no bushes – 8 times, good visibility and feeling of safety – 7 times, well managed landscape, view to the nature – also 7 times, nature itself – three times, traffic, bushes and wide view were mentioned twice. A bus stop, typical rural landscape, forest in the background, connecting roads, which are in good quality and a nice day were mentioned once by respondents (Fig. 4.4.).

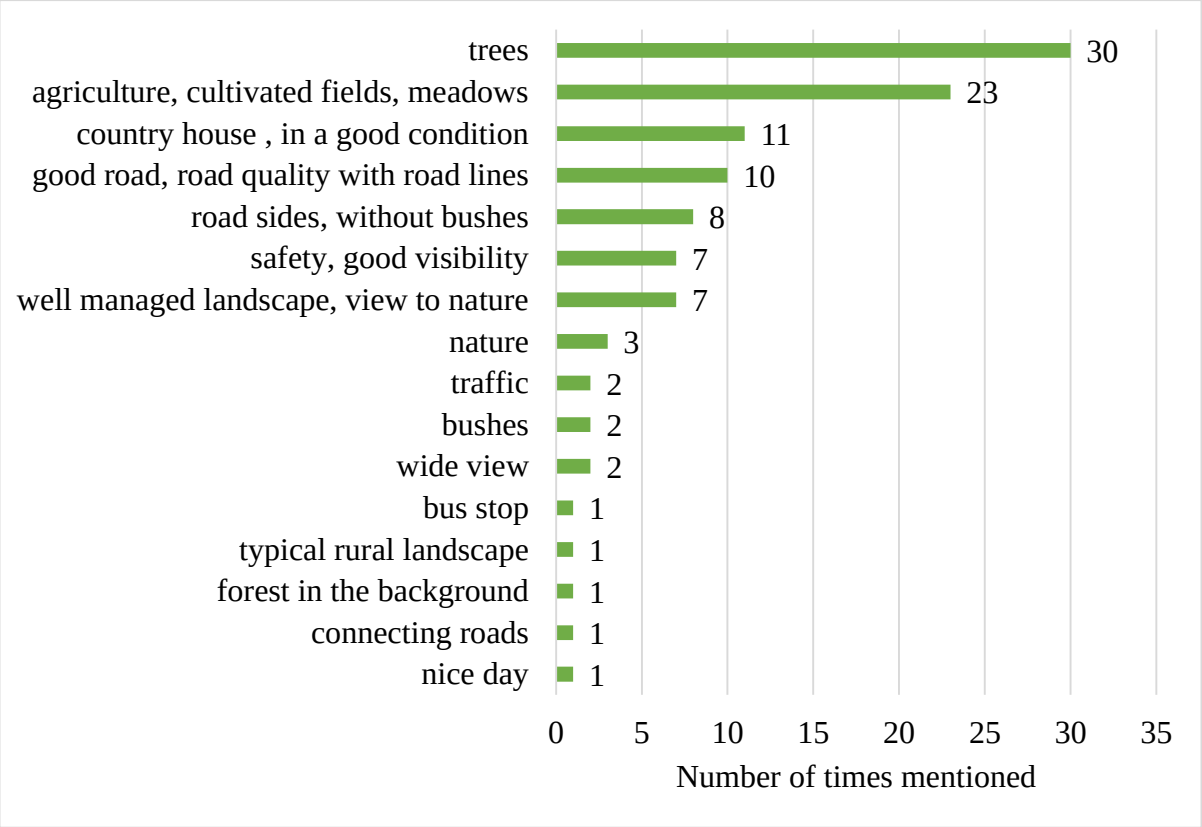


Fig. 4.4. **The first scenario of the first case, positive elements**

The negative element in this animation mentioned most often was asphalt with cracks, bad road quality (17 times), inexpressive, monotonous landscape (13 times), not so well managed road side (9 times), poorly cultivated fields (6 times), electricity line and poles (6 times), trucks on the road (3 times), house too close to the road, which is unsafe, someone can run out on the road (2 times). A bus stop, width of the road as being too narrow were mentioned once and one respondent felt that there were no signs of life (Fig. 4.5.).

Comparing positive and negative elements respondents named roadside management without bushes as a positive element eight times. Roadside management was mentioned as poor nine times. The country house, which is in a good condition, was named eleven times, but twice it was named with negative comments of being unsafe, because of being too close to the road. One respondent named the bus stop as a positive element and one as a negative element.

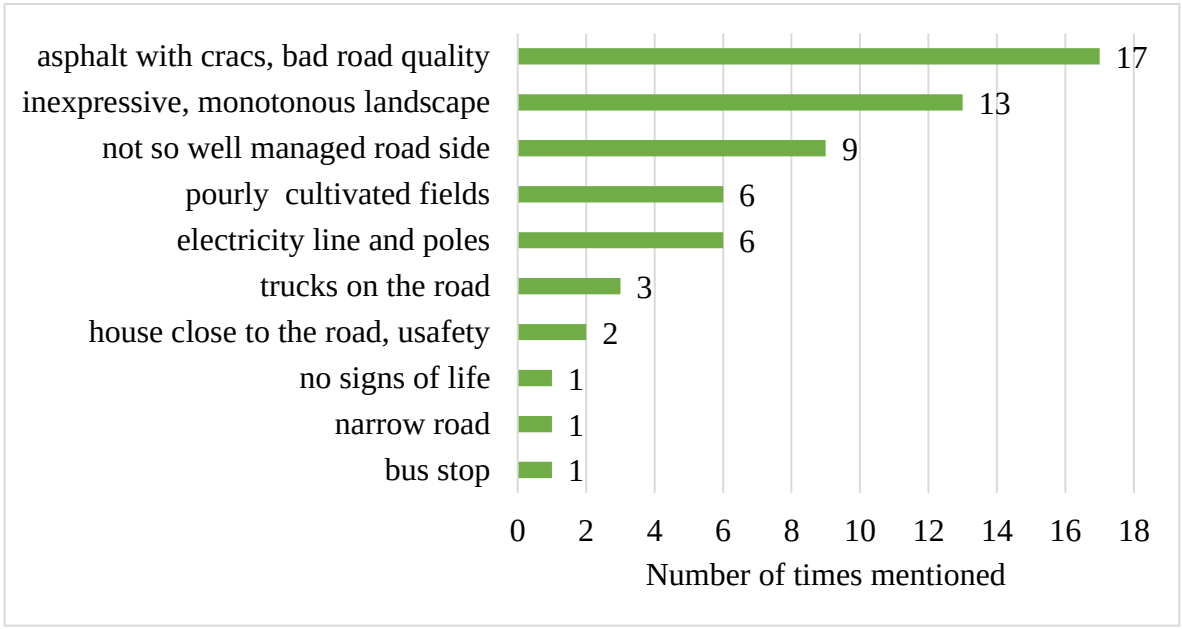


Fig. 4.5. **The first scenario of the first case, negative elements**

Positive element mentioned most often in the second scenario of the first case was orchard, which was nicely planted (36 times), followed by cultivated fields and agriculture (16 times). Trees in general as well as good quality of the road, presence of road lines ranked third (15 times). Nice, well managed environment was mentioned by 11 respondents, well–kept house – 8 times, a corn field – five times and good visibility and openness – four times, followed by the variety of crops, which was mentioned by three respondents (Fig. 4.6.).

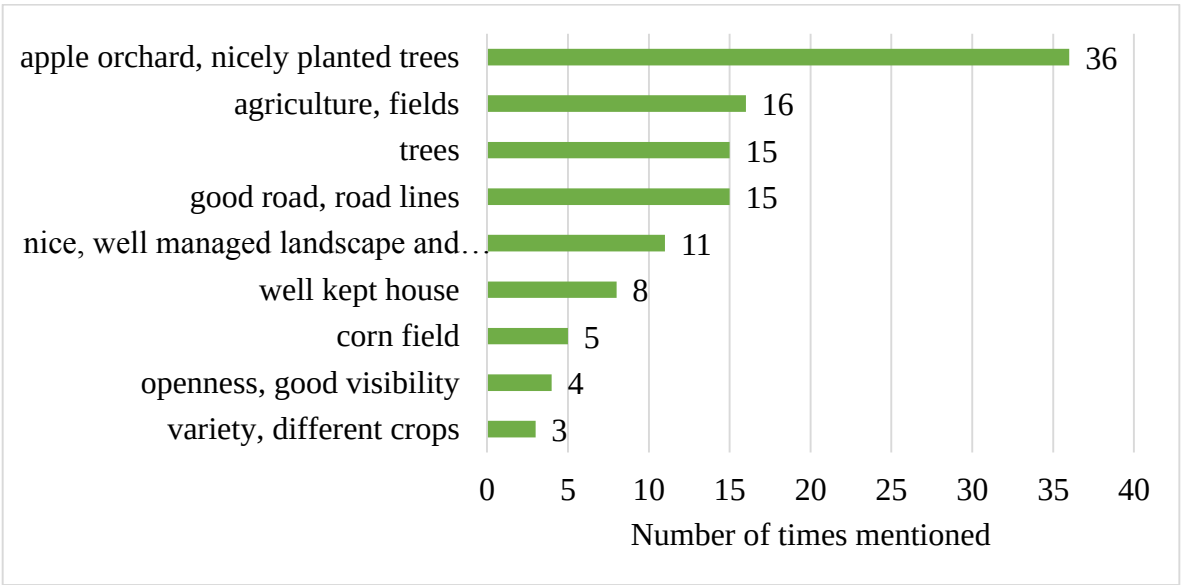


Fig. 4.6. **The second scenario of the first case, positive elements**

The negative elements mentioned most often in this animation were the corn field, which is close to the road, blocks the view and is not safe as wild animals can run out on the road (15 times), many trucks, intensive transport (15 times), electricity line (15 times). Bad road

quality was mentioned by ten respondents, orchard and trees too close to the road (6), absence of ditches along the road (3 times). Boring landscape, that makes a person sleepy, too large fields, monoculture, no trees, no signs, too artificial landscape, flat Zemgale plain, width of the road as being too narrow and only one lane in each direction – all of these qualities were mentioned by one respondent each. One respondent commented that he does not like to look at the industrial agriculture landscapes like in Germany and Poland (Fig. 4.7.)

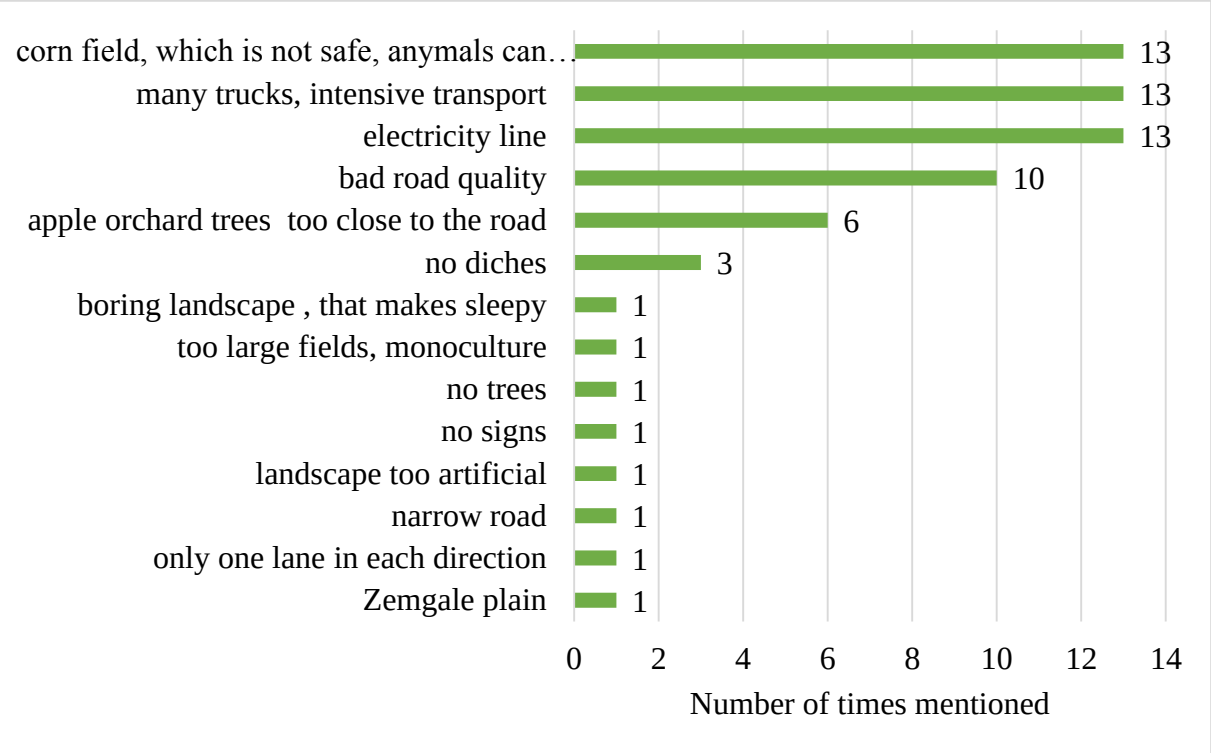


Fig. 4.7. **The second scenario of the first case, negative elements**

Comparing comments about positive and negative elements, apple orchard was named as a positive element for thirty–six times, but six times it was mentioned as a negative element, because it was placed close to the road and respondents saw it as an unsafe situation. Agriculture and cultivated fields were mentioned sixteen times as a positive element and activity, but one respondent commented that fields are too large and monotonous and could make the driver sleepy. The corn field was mentioned five times as a positive element, but thirteen times as a negative element, which blocks the view and can be a hiding place for wild animals, which can run out on the road.

The elements marked as the most positive in the third scenario of the first case were tree groups with bushes along the road and large willow trees (23 times), followed by a café billboard on the left side of the road and wider road edges with flowers and larger biological diversity (8 times). The fact that fields are further away due to the wider road edge was marked six times as well as signs with house names and agriculture, well managed fields. Good visibility in general and at the crossroads, presence of house and design around the bus stop with tress were mentioned five times. More diverse landscape and well managed environment was mentioned three times. Nice landscape, nice views, absence of electricity lines was mentioned twice. Two responded that positive elements were the same as in animation 1 and 2. Cabbage field, more natural looking landscape, calm feeling and possibility to watch the nature, wind protection planting (the large willow trees) were mentioned once. One respondent mentioned the sunny day and one respondent commented that trees looked very real. One respondent was aware that tree groups can help to orientate when approaching from smaller roads. In this case there was a group of trees and shrubs in the T junction (Fig .4.8.).

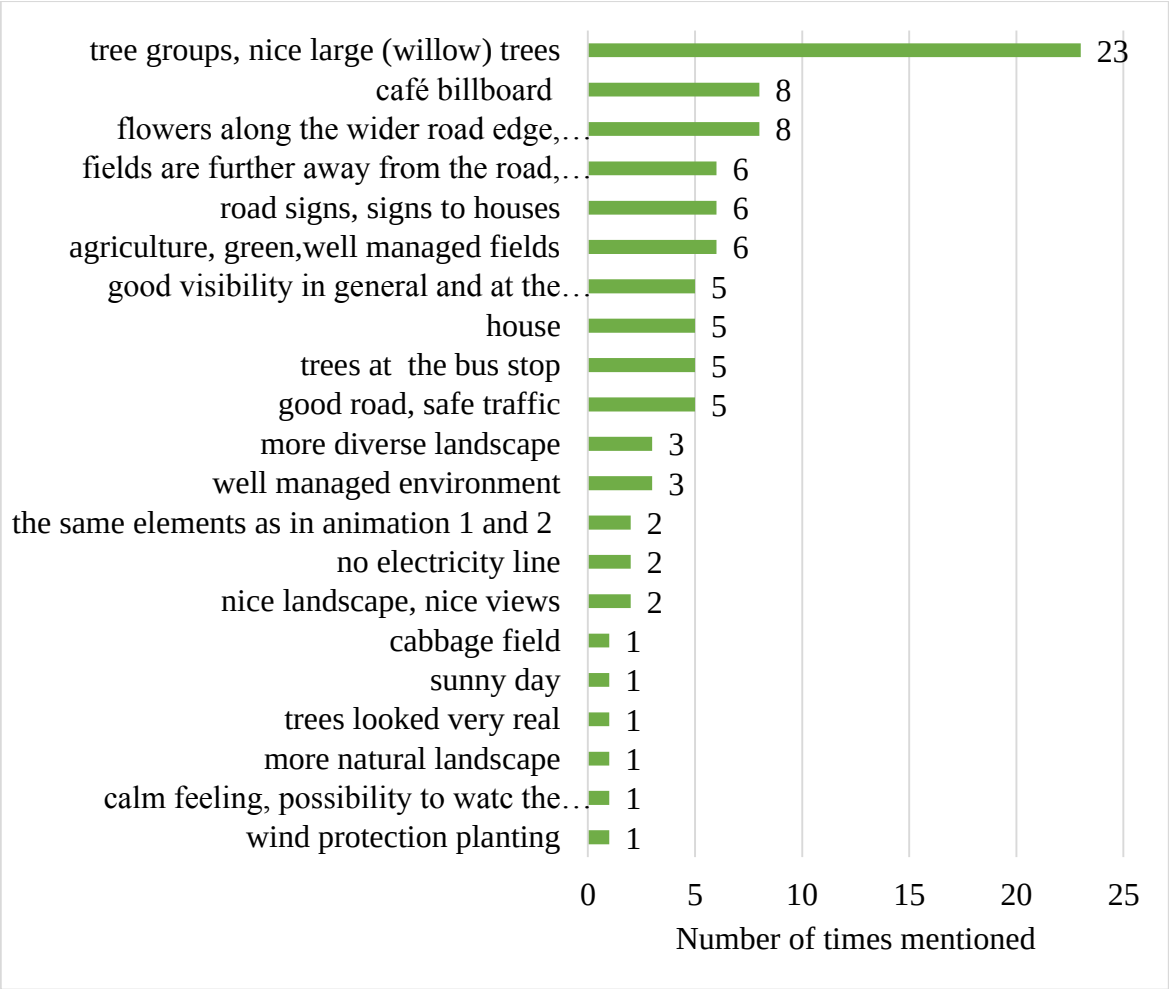


Fig. 4.8. **The third scenario of the first case, positive elements**

The most popular negative element in this animation was the café billboard, it`s size and placement (15 times), followed by the bad quality of the road surface (12 times). Large trees and bushes on the right side close to the road were mentioned nine times with comments regarding safety. Landscape was called monotonous, boring and industrial five times. Many trucks on the road and intensive traffic was mentioned three times. The road was described as narrow with narrow roadsides twice. Safety elements, e.g., bad visibility in some places, house is close to the road, narrow space for cyclists, were mentioned once. One respondent did not see road signs. Poorly managed roadsides, rape fields, which are often fertilised, no trees were mentioned by one respondent each (Fig. 4.9.).

When comparing positive and negative elements, large trees and tree groups were mentioned as a positive element twenty–three times, but as negative – nine times, because of being close to the road and causing feeling of unsafety. Café billboard was mentioned as a positive element eight times, but fifteen times as a negative.

Trees: row of old willow trees, apple orchard and other tree groups along the road were the positive elements mentioned most often in all scenarios in the agriculture landscape. The next positive features noticed and mentioned by respondents in the first two scenarios were cultivated fields and agriculture, which shows that land is used and managed. In the third scenario wider road edge with flowers and larger biological diversity and the café billboard were the second most often mentioned positive element. However, the café billboard was most often named negative element of the third scenario.

Respondents were not asked to evaluate the road quality, but there were many positive and negative comments regarding the quality of road surface, road marking lines, width of the road. In the first scenario, good road quality was mentioned ten times, in the second scenario – fifteen times, the third scenario – five times. Road quality, especially cracks in the road surface

were mentioned as a negative element for seventeen times in the first scenario, ten times in the second and twelve times in the third. As a negative element it was mentioned in thirty–nine comments in total, as a positive element – by thirty respondents.

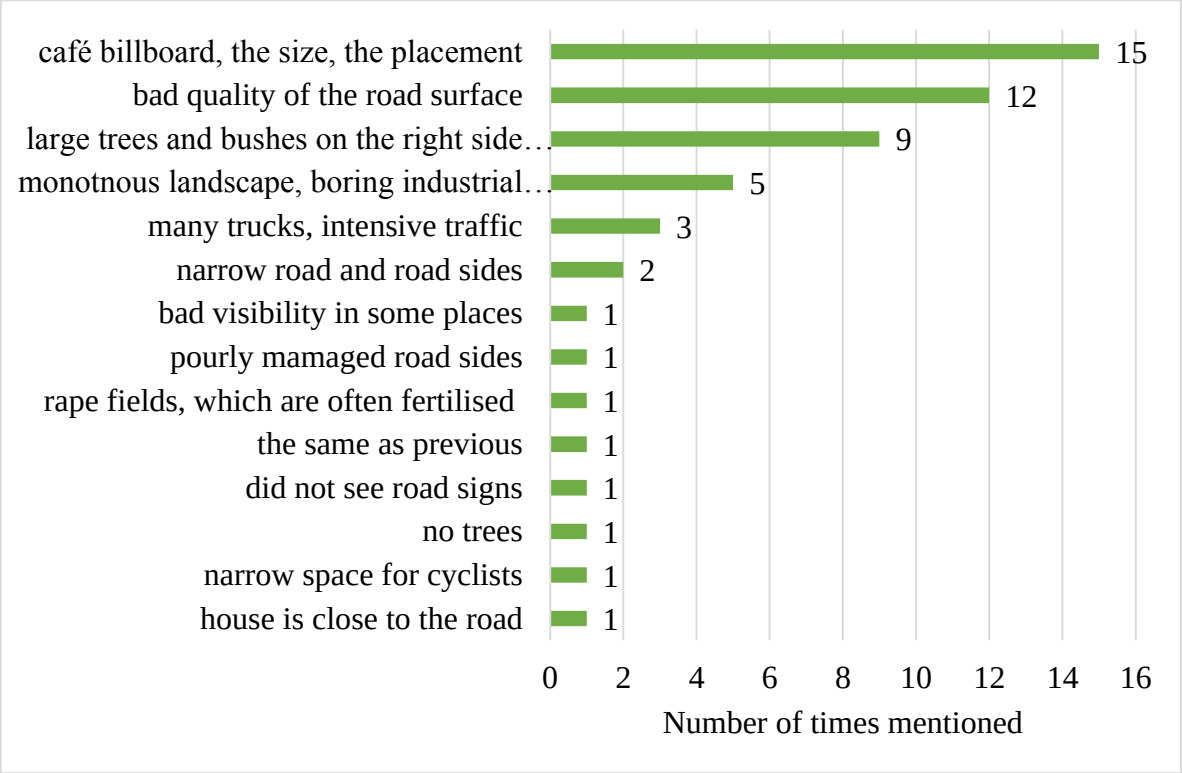


Fig. 4.9. **The third scenario of the first case, negative elements**

Transport was added to animation to show the situation more realistically. The intensity of the transport was not set precisely as it is in current situation. It was not foressen that respondents would comment on transport intensity. Respondents mostly did not like trucks. One respondent mentioned that trucks were a negative element in the video, not in real life.

Several respondents commented that all animations look the same or very similar.

4.2 Results of the second case, the road A3 in Kocēni regional community

Respondents evaluated landscape attractiveness in points, where one point represents the most unattractive and 5 points the most attractive feature. Comparison of three scenarios in mosaic landscape show, that respondents find the landscape of the first scenario, the current situation, the most attractive and landscape of the third scenario with closed views least attactive (Fig. 4.10.). The highest number of positive elements and activities as well as negative elements were named in the second scenario representing the most open landscape, with less forest and trees along the roadsides and with grazing animals in the view. The lowest number of positive and negative elements was in the third scenario representing the most closed landscape with more forest and trees along the roadsides (Fig. 4.11.).

Respondents evaluated the degree of openness on a scale from 1 to 5 where 1 is very open and 5 is very closed. The landscape in the second scenario was named the most open, but the one of the third scenario – the most closed (Fig. 4.12.).

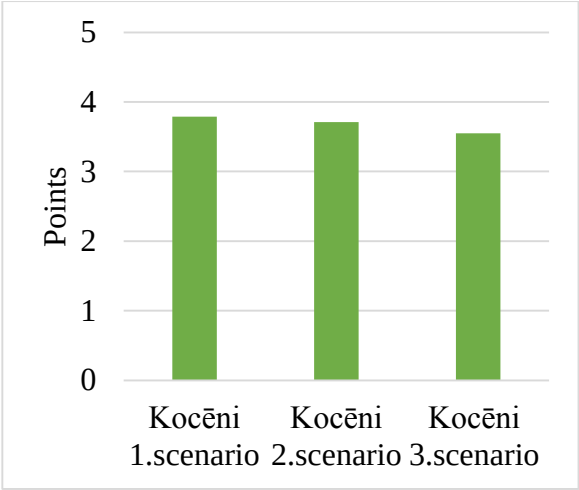


Fig. 4.10. **Attractiveness of the landscape**

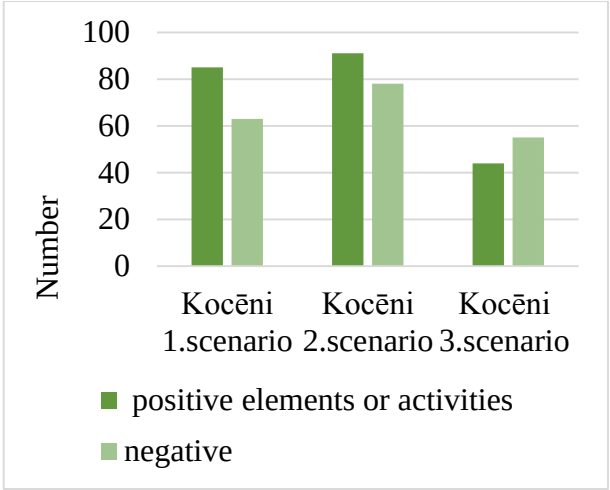


Fig. 4.11. **Positive and negative elements in the road landscape**

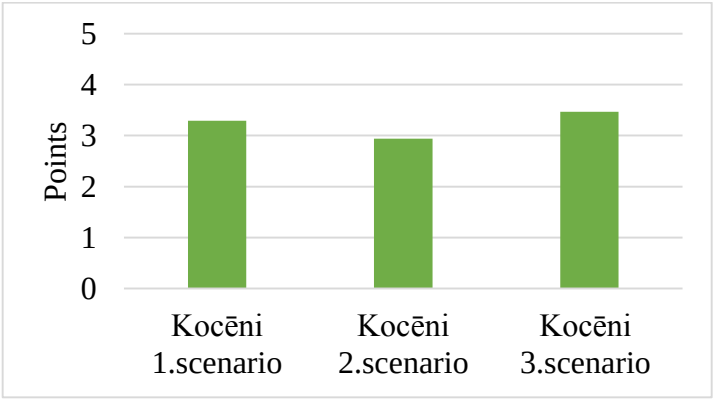


Fig. 4.12. **Landscape structure**

The most popular positive elements in the first scenario of the second case were trees and tree groups (mentioned 21 times), followed by topography and hills (14 times), varied and not so boring landscape (12 times), nice nature and natural landscape (10 times), greenery, bushes (9 times), slopes (6 times), nice forest (5 times), road signs and marking on the road, well managed road sides (4 times). One respondent marked that it is good for CO^2 and dust absorption. Three respondents thought that road is good with smooth surface. Three respondents mentioned that bushes and trees are not too close to the road. The landscape was evaluated as average landscape of Latvia twice, with some nice distant views, not many connecting roads. Bus stop, presence of agriculture and sunny day were mentioned once each animation (Fig. 4.13.).

The most negative elements in this animation were connected with feeling of unsafety, as the road is a road in a trench, there are no barriers, wild animals can run out on the road, low management of road sides with bushes and trees too close to the road (13 times), followed by the electricity line (10 times), poor visibility in some places (8 times), quality of road surface and intensive traffic with trucks (7 times). (Fig. 4.14.).

The road seemed narrow (5 times) with steep slopes (4 times). Hills and trees were mentioned as negative elements twice, absence of ditches, no open views, bus stop as being not nice and a little bit chaotic landscape were mentioned once.

Comparing positive and negative elements, most disagreements were about roadside management. Nine respondents mentioned greenery and bushes along roadside as positive elements and four respondents consider roadside management as good, but thirteen times roadside management was considered as a negative element with bushes and trees too close to the road. Slopes were named six times as a positive element and called steep and mentioned as

a negative element four times. Topography was mostly named as a positive element, but twice it was mentioned as a negative element. Trees were mostly named as positive elements and only twice as negative.

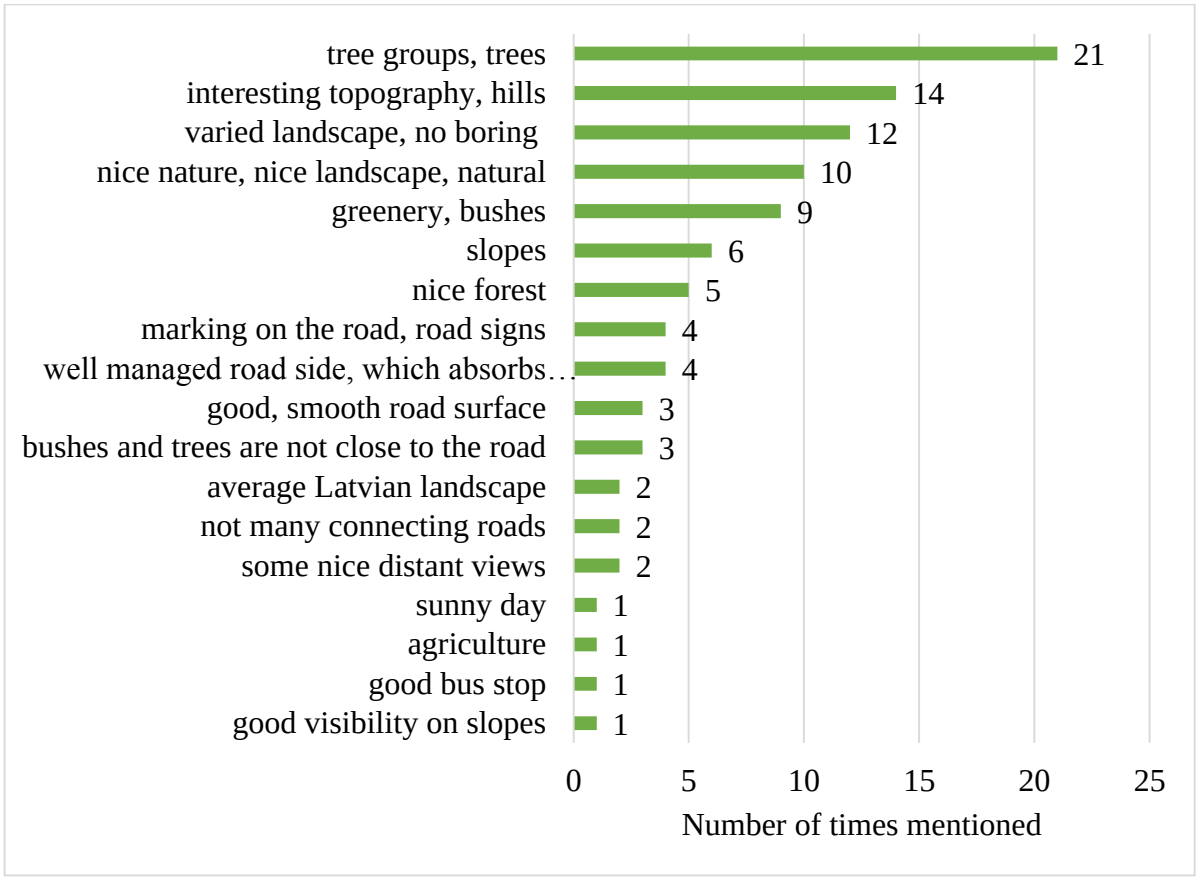


Fig. 4.13. **The first scenario of the second case, positive elements**

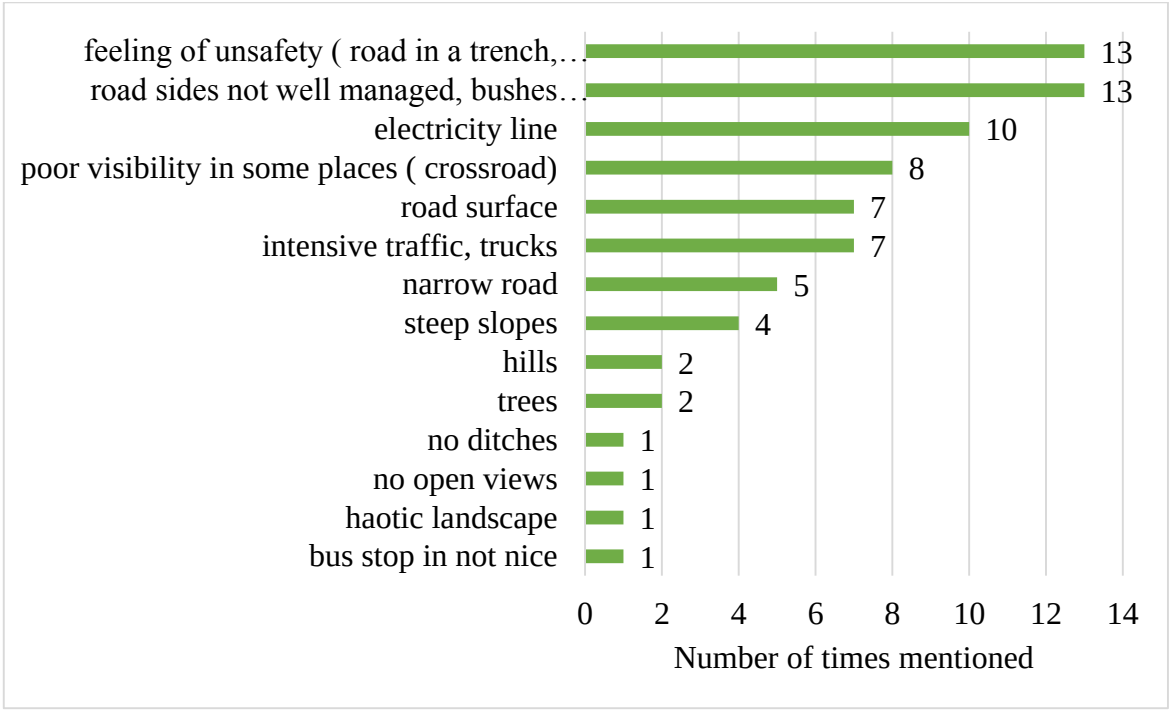


Fig. 4.14. **The first case of the second scenario, negative elements**

The most popular positive elements in the second case second scenario were sheep, grazing on the hills (42 times), followed by hills and topography (14 times). Landscape was

considered more varied and less boring (12 times), respondents liked trees and tree groups (10 times) and roadsides with greenery and bushes (7 times). Smooth road surface was mentioned six times, good visibility and nice nature and landscape three times, a bus stop and hay rolls twice, wide view to horizon, possibility to stop at the road side, well–kept fields, a sunny day, a straight road without curves once (Fig. 4.15.).

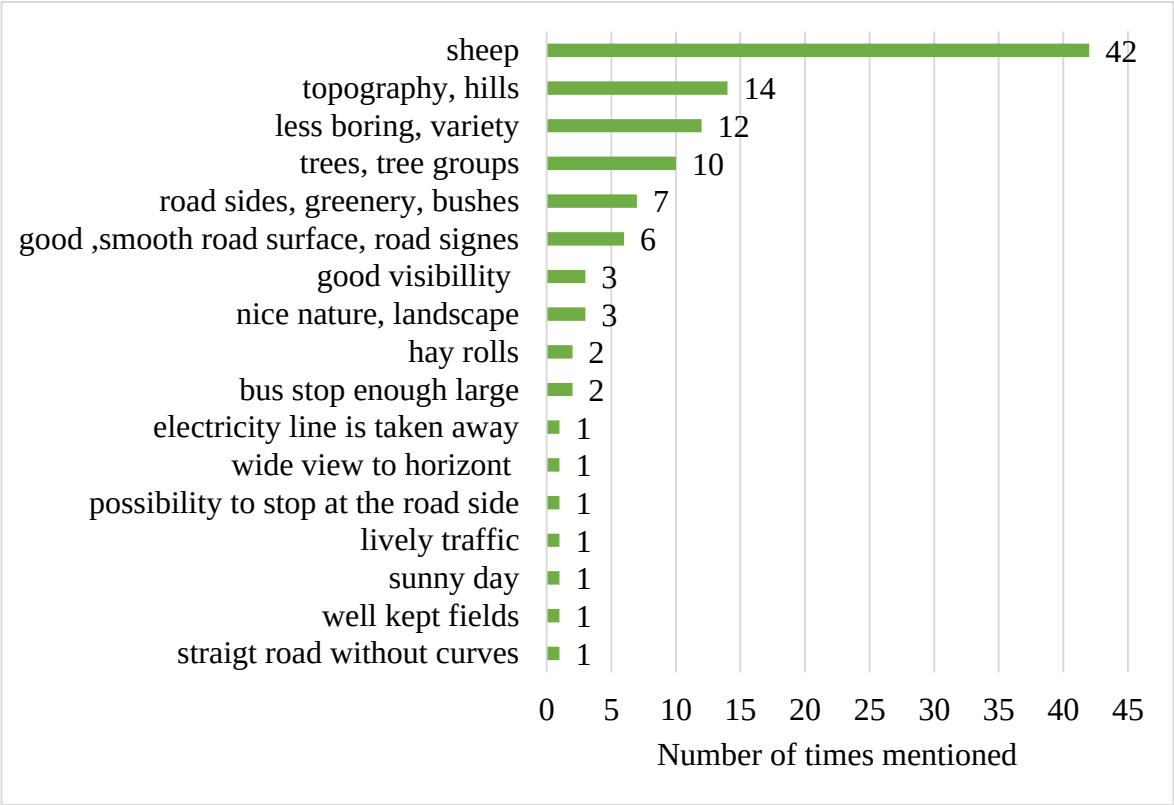


Fig. 4.15. **The second scenario of the second case, positive elements**

Absence or invisibility of fencing for sheep and the fact that sheep were close to the road were mentioned as negative in the second case second scenario most often (42 times). One respondent marked that it is not good for sheep to be so close to the road. The next negative remark was about the width of the road as being too narrow (6 times). Quality of road surface, limited visibility due to hills and slopes and intensive traffic, trucks were mentioned four times. Three respondents thought that roadsides are not well managed, bushes and trees are too close to the road. Hilly landscape without trees looking monotonous, landscape does no look natural, there are not enough traffic signs before the crossroad and signs are too small were mentioned twice each. Two respondents did not like hills and one of them commented that hilly topography creates anxiety of not being able to understand what comes next. It was mentioned once that bus stops have inexpressive design, there are no ditches, angle of connecting roads is not right, amount of trees is small, wild animals from forest can run out on the road and that road is no appropriate for such heavy trucks (Fig. 4.16.).

Comparing positive and negative elements, the largest amount of comments was about sheep. Forty–two respondents mentioned sheep as a positive element, the main negative remark (44 times) was about the absence of a visible fence and sheep being too close to the road. The next most commonly named element both as positive and negative was the quality of road surface. There were more positive remarks (6 times) than negative (4 times) about the road the road quality. Seven respondents marked roadsides with greenery and bushes as a positive element, but three respondents thought that roadsides were not well–managed. Three respondents thought that visibility is good, but four respondents wrote that visibility is not good enough due to the slopes and hills. Three respondents considered landscape and nature as nice,

two respondents thought that landscape does not look natural. Two respondents liked bus stops, but one thought that bus stops have inexpressive design.

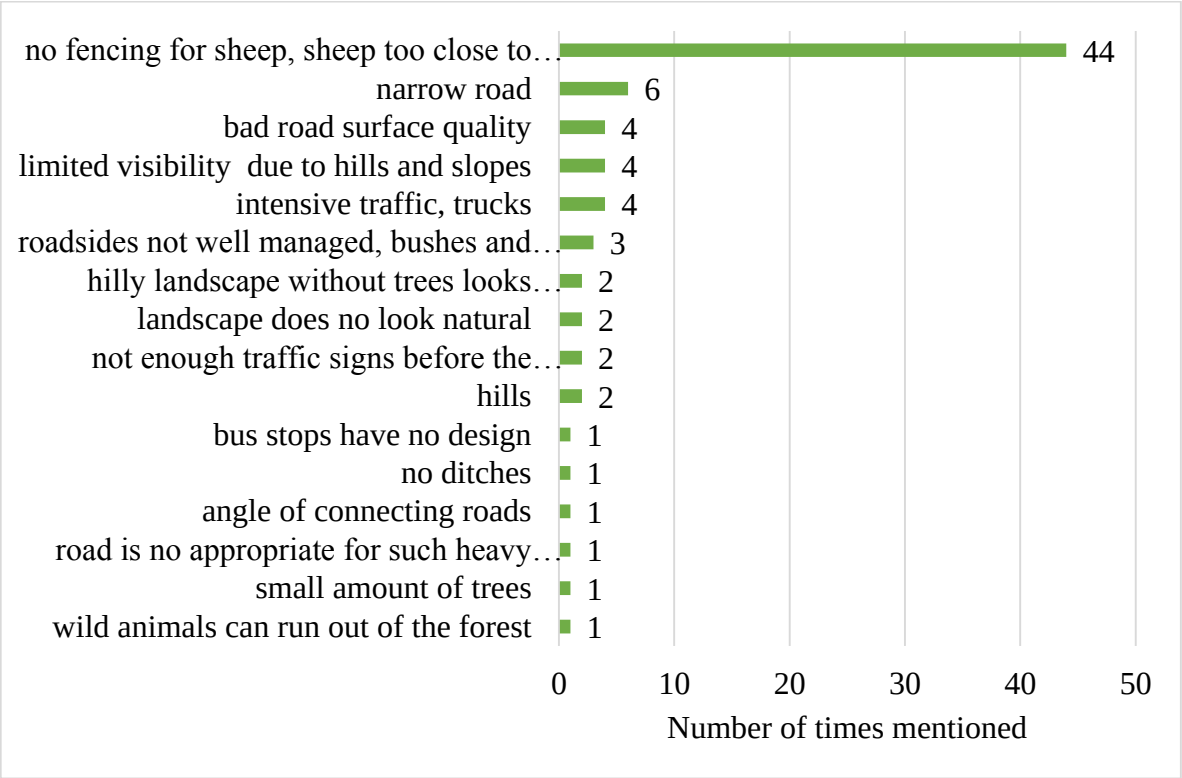


Fig. 4.16. **The second scenario of the second case, negative elements**

The most common positive elements in the second case third scenario were forest, trees and bushes (20 times). The second most often mentioned was nice nature and well–kept environment (10 times), followed by topography and hills (4 times), good road quality with road signs including marking of lanes (3 times). Two respondents liked the open view at the end of animation and one respondent from agriculture field mentioned the wind break of spruce trees as a positive element, having important role in agriculture. One more respondent from an emvironmentel science field noticed the same line of trees and market it as positive elelemnt. Trees not too close to the road, a bus stop, variety in the landscape and sunny day were mentioned once each (Fig. 4.17.).

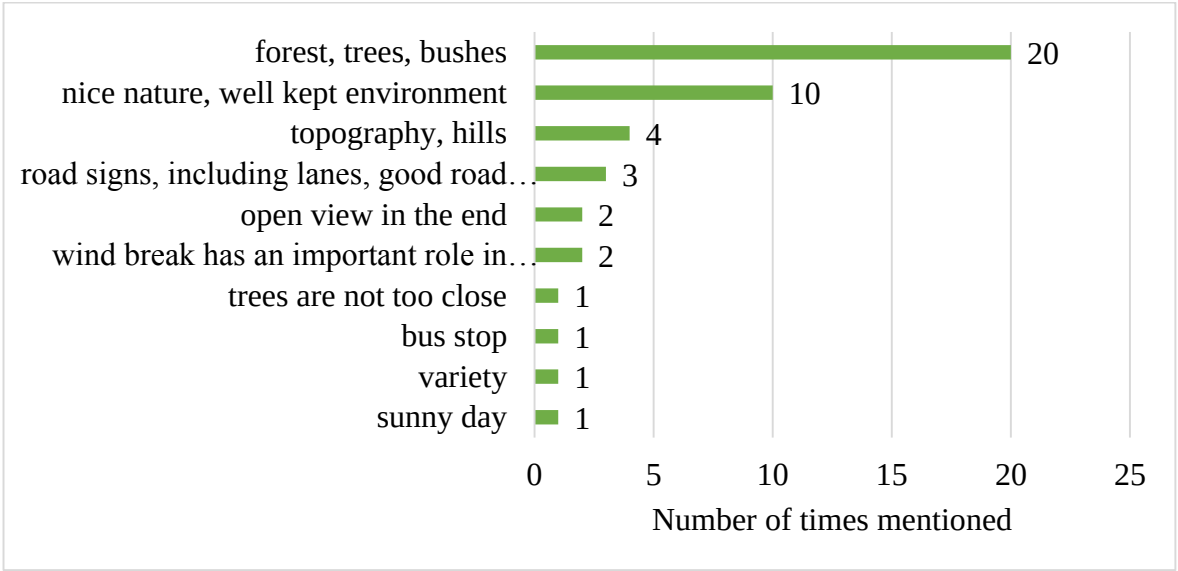


Fig. 4.17. **The third scenario of the second case, positive elements**

Forest and bushes close to the road, which cause danger from wild animals and danger of falling trees on the road were most often mentioned negative elements in the third scenario of the second case (19 times). Landscape was called boring, monotonous, causing depressing feeling eight times. Six respondents marked the limited visibility due to trees and slopes along the road and that the roadsides are not well managed. Bad quality of the road was mentioned four times, the crossroad was considered as not equipped enough and the road was called narrow three times. Two respondents thought that a bus stop without roof in Latvian conditions is not appropriate and traffic was considered too intensive. The landscape in general is not well maintained, the rest area and WC are missing, and no ditches were mentioned once each (Fig. 4.18.).

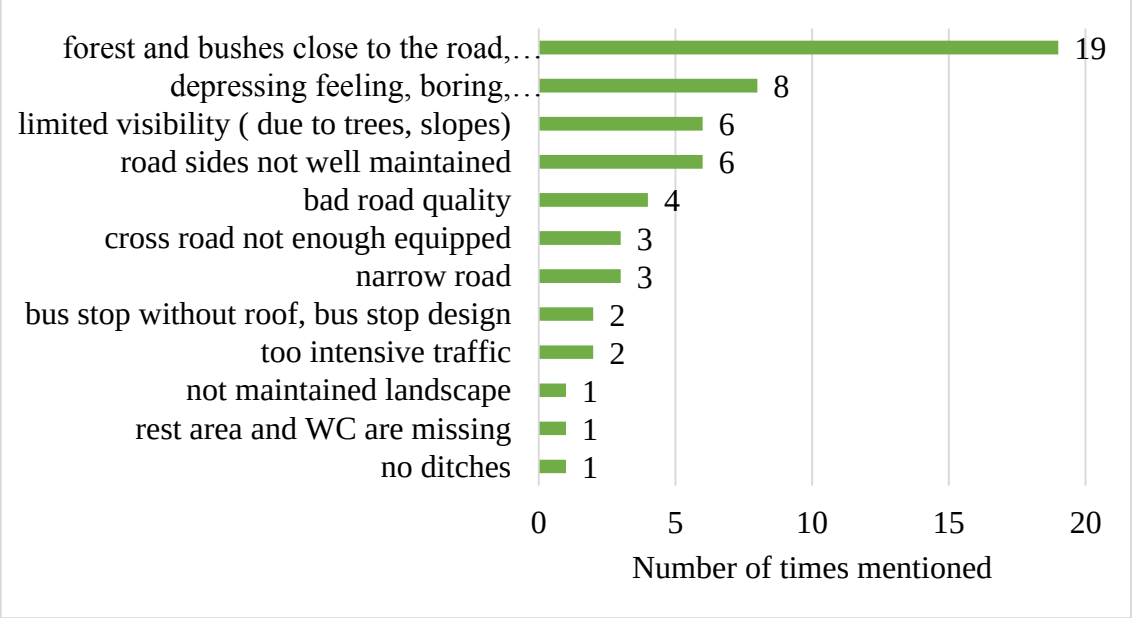


Fig. 4.18. **The third scenario of the second case, negative elements**

Forest and trees were mentioned most often both as positive and as negative elements. The negative remarks were about the forest and trees being too close to the road. Respondents were concerned about the safety, because animals could run out on the road. One respondent thought that trees are in a good distance. Attitude regarding landscape maintenance was different. Ten respondents considered landscape as well maintained, but six considered roadsides not well maintained.

Three respondents thought that road is in good quality, four comments were about the bad quality of the road. One respondent considered the bus stop to be a positive element, but two noted that the bus stop without a roof and in such design is not appropriate for Latvian weather conditions.

4.3 Results of the third case, the road A3 in Strenči regional community

Respondents evaluated landscape attractiveness in points, where one point represents the most unattractive and 5 points the most attractive feature. Comparison of three scenarios in the forest landscape show, that respondents find the landscape of the second scenario, which represents the traditional way of forest management, the most attractive (Fig. 4.19.).

The second scenario has the highest number of positive elements and activities named. The lowest number of comments about positive and negative elements is from the third scenario representing the landscape where forest design principles are applied (Fig. 4.20.).

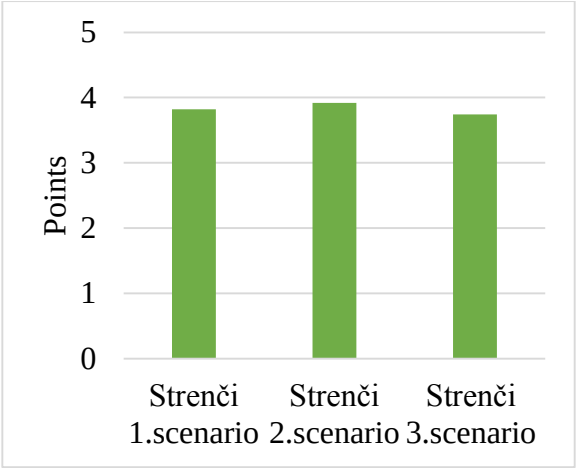


Fig. 4.19. **Landscape attractiveness**

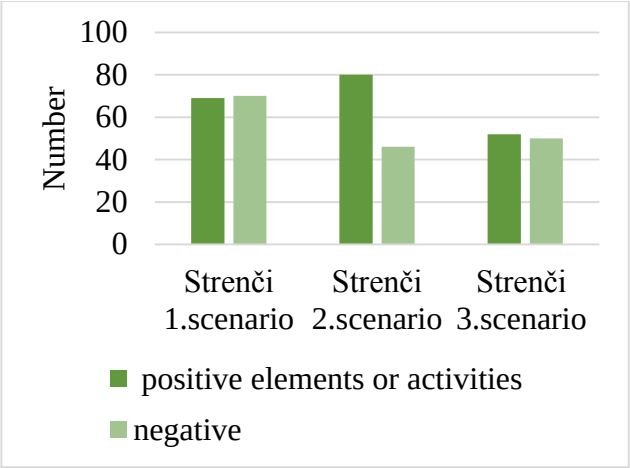


Fig. 4.20. **Positive and negative elements in the road landscape**

Respondents evaluated the degree of openness on a scale from 1 to 5 where 1 is very open and 5 is very closed. The landscape in the second scenario was considered to be the most open and the one of the first scenario – the most closed (Fig. 4.21.).

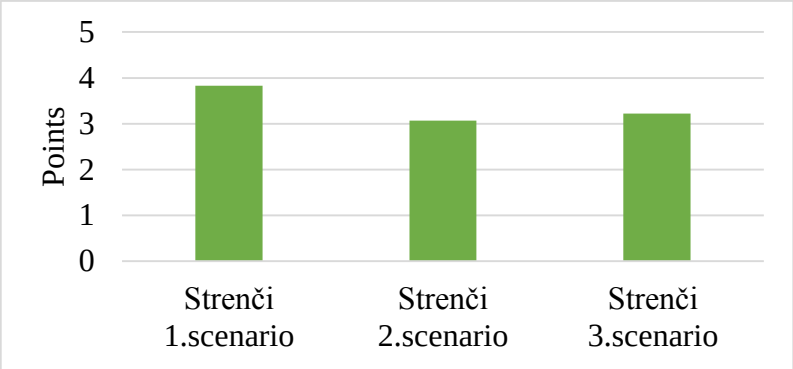


Fig. 4.21. **Landscape structure**

The most popular positive elements in the second case first scenario were nice forest, well maintained forest edge (17 times), followed by trees nearby, large trees, trees in different age, tree groups with bushes (15 times). Respondents named well–maintained roadside 14 times and well–maintained, nice landscape and nature in general – 12 times; comments about the good quality of the road like road signs, poles, junction were made by 8 respondents. The following elements were named twice – country house and meadow next to it at the end of animation; ferns along the forest edge; good visibility, wide roadside; curves and variety (Fig. 4.22.).

Regarding the negative elements, respondents marked that road as too narrow the most (13 times), visibility being bad (10 times) (Fig.4.23.).

Then forest and trees were mentioned, some respondents considered that trees are too high and large trees and forest edge is too dense (9 times). Curves of the road were mentioned as a negative element (9 times), trees and bushes were considered being close to the road (8 times). Road signs too close to the road, not enough signs were named seven times, danger from wild animals and feeling that driving is not safe – five times. Three respondents did not like that there is no fence, three others – that roadsides are not well managed in some places. Absence of safety ditch was mentioned, large billboard at the end of the animation, not many open views, narrow zone between the road and forest and no barriers were all mentioned once.

When comparing positive and negative elements there was some disagreement about the forest and trees. Seventeen respondents liked the forest and fifteen respondents mentioned large trees and tree groups as positive elements, but nine respondents mentioned large trees as a negative element. It may be presumed that one part of respondents look at trees from the point

of view of safety, as nine more respondents consider the trees too close to the road and five times unsafety due to wild animals, which may run out of the dense forest and bushes, is mentioned. Larger number of respondents thought that the roadside is well maintained, only three respondents think that the roadside is not well maintained in some places.

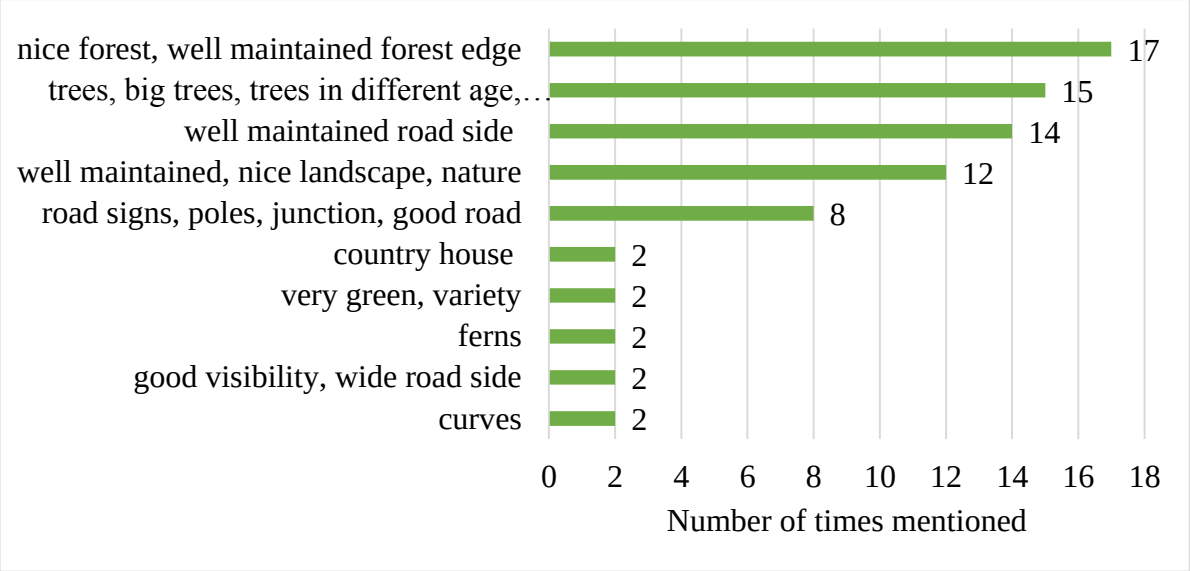


Fig. 4.22. **The first scenario of the third case, positive elements**

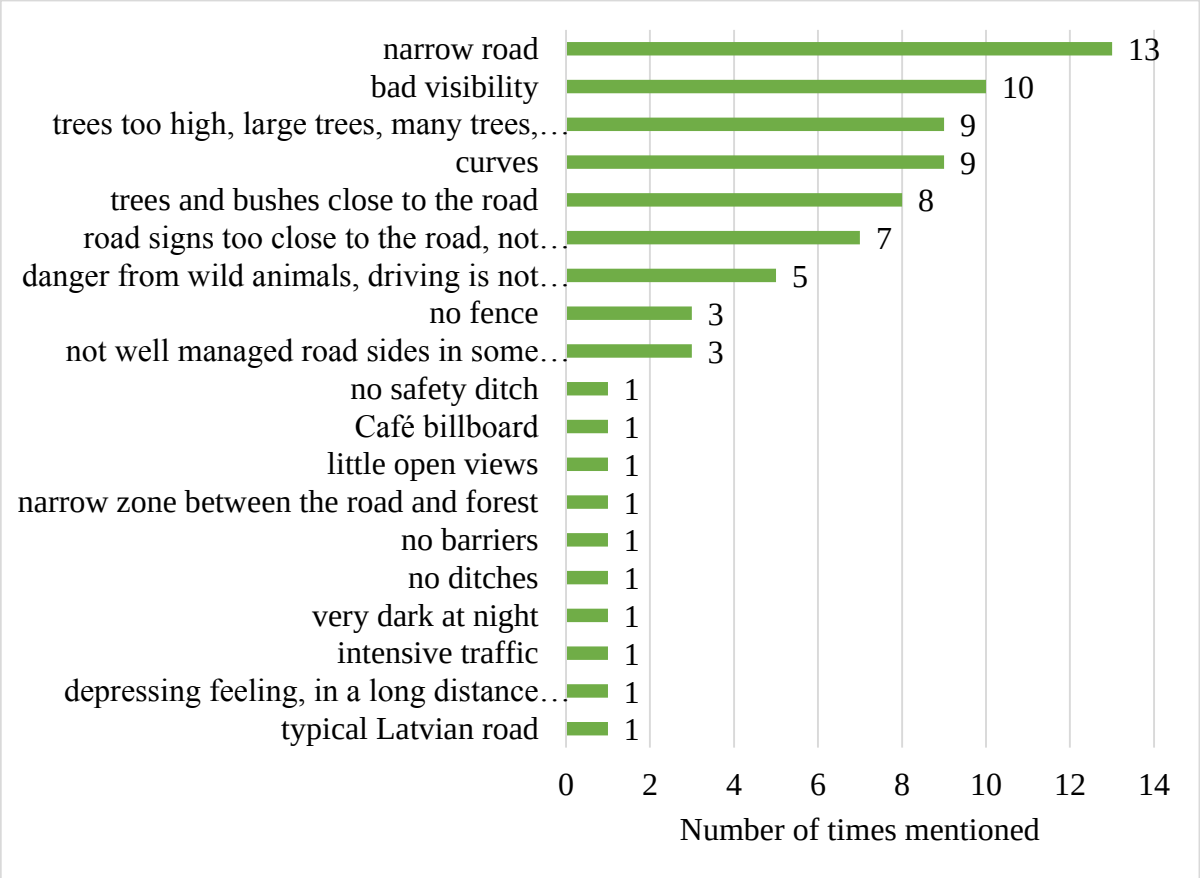


Fig. 4.23. **The first animation of the third scenario, negative elements**

The most positive elements in the second case second scenario were well–maintained forest, large trees and forest being further away from the road (18 times) and more precise comments regarding forest management – thinned forest, feeling of wider space, more safety

and not so claustrophobic, feeling that animals will not run out on the road unnoticed were mentioned 17 times. Better visibility and good visibility in a curve were mentioned seventeen times as well. Well–maintained environment and nice nature were mentioned twelve times, maintained road sides – ten times, wider view, good and well maintained road – six times, variety – five times, young forest plantation – four times, road signs and marking – three times, gradual placement of bushes and trees – twice, connecting road once and sunny day – once (Fig. 4.24.).

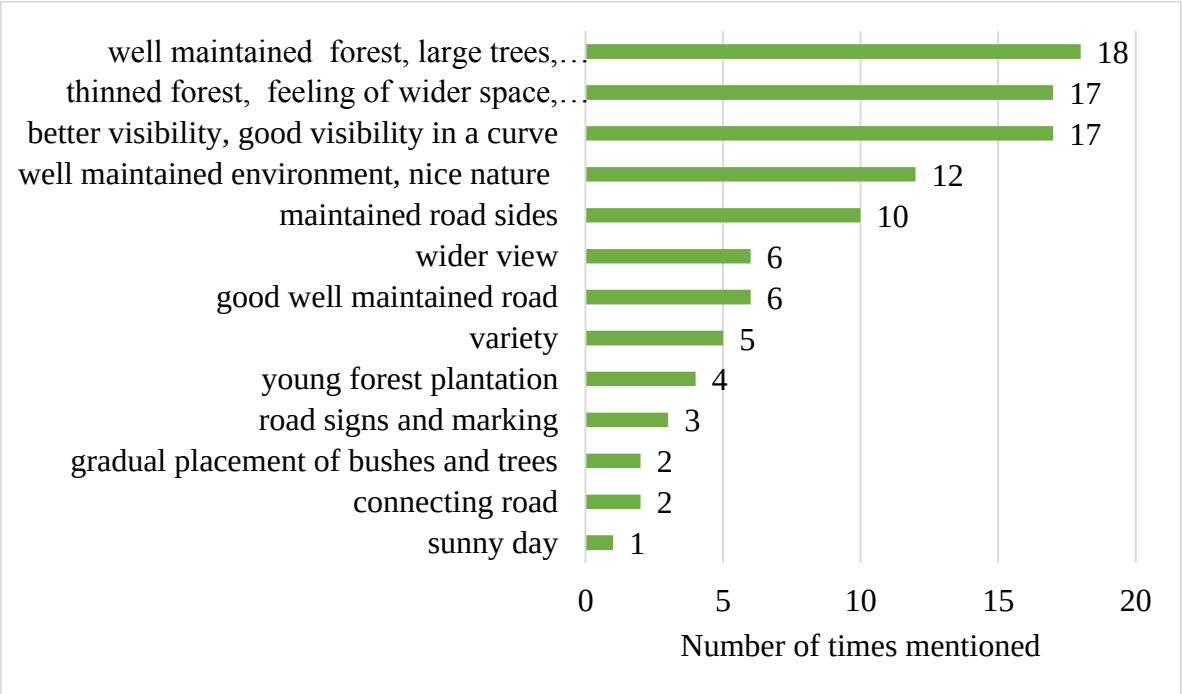


Fig. 4.24. **The second scenario of the third case, positive elements**

Regarding the negative elements, respondents marked that road is too narrow and road lanes could be wider most often (13 times). No variety, trees looking the same age, too artificial landscape and forest thinned too extensively were marked eight times. Six comments were given about the road infrastructure like road signs too close to the road, unreadability of signs. Four respondents mentioned that trees and bushes are close to the road in some places. Three times curve and not enough visibility in the curve were mentioned. Two respondents commented on the absence of fence and danger from wild animals. Large billboard, absence of ditches, feeling that visibility through the forest takes away attention from the road, landscape on the right side of the road looking more natural than on the left side, bicycle lane were mentioned once. One respondent marked that tree plantation creates monotonous feeling and one respondent commented that he does not like such roadside (Fig.4.25.).

Comparing positive and negative elements there was some disagreement about the forest management. Seventeen respondents liked the thinned forest. It gives the feeling of wider space, is not so claustrophobic, feels safer, animals will not run out on the road unnoticed, but eight respondents do not like that there is no variety, trees look the same age, too artificial, too thin for the forest. Most of the comments regarding the visibility were positive, but three respondents thought that visibility in the curve is not good enough. One respondent mentioned that thinned forest with better visibility is negative as it takes away the attention from the road. Six respondents mentioned variety in the landscape as positive, eight respondents did not like that there is no variety in trees in the forest. Four times forest plantation was considered as a positive element, but one respondent thought that it creates monotonous feeling.

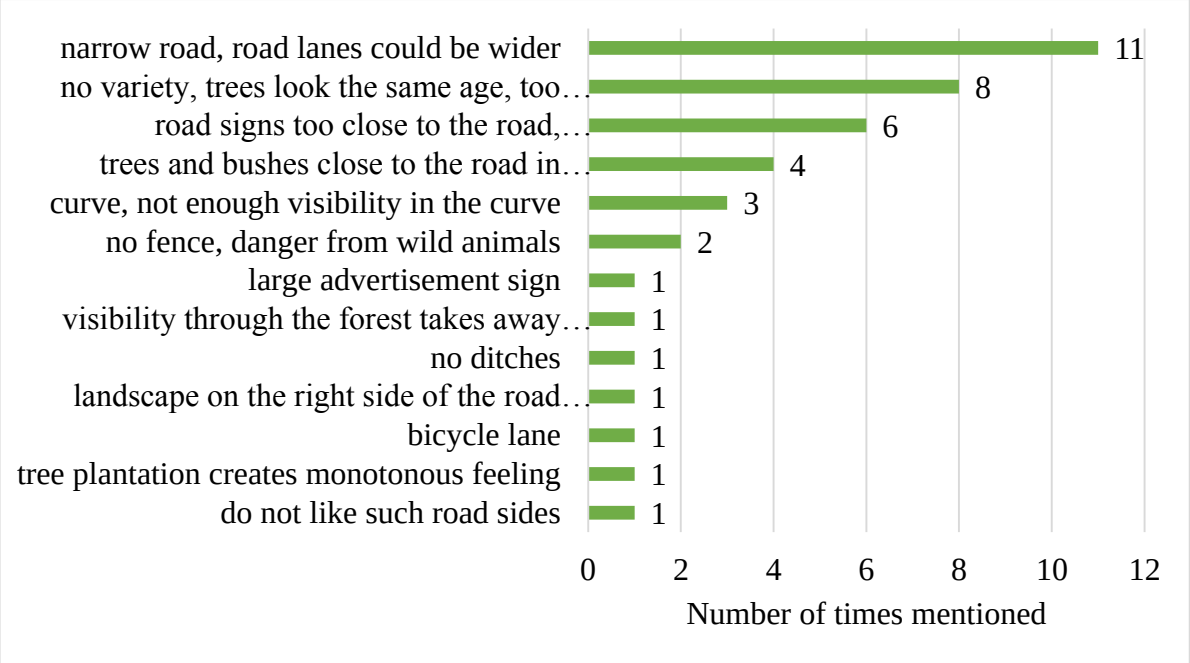


Fig. 4.25. **The second scenario of the third case, negative elements**

The most positive elements in the second scenario of the second case were well–maintained environment, nice nature and landscape in general (13 times), followed by trees, nice forest, cut and transparent forest undergrowth (10 times). Five respondents mentioned view to the river; variety and tree groups of different age, partly open and open views; good road quality. Four mentioned wider and well–maintained roadside, road signs and marking, road poles, nice well–maintained forest landscape on the right side of the road with open views, good visibility. Good solution for the connecting road from the left, triangle was remarked twice. Curving road, vitality of the place, wide view to the landscape, young forest stand on the left side were mentioned by one respondent each (Fig.4.26.).

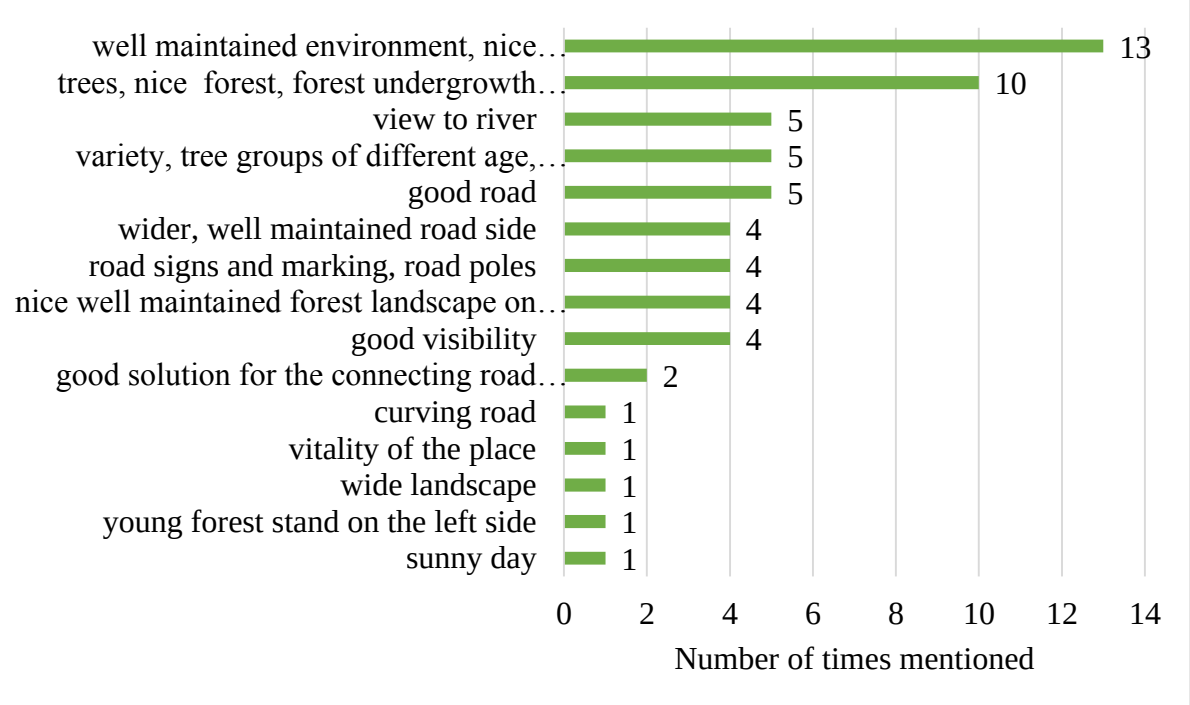


Fig. 4.26. **The third scenario of the third case, positive elements**

Large trees and bushes to close to the road in some places, limited visibility in the curve were mentioned nine times as the most negative features. Respondents considered road as narrow (6 times) and one respondent added a comment about lack of places to stop. Dense forest with bushes on the left side of the road was mentioned by six respondents. Three times comments were made about the absence of fencing, threat from wild animals on the road, bad visibility, especially at the crossroad. Two respondents noted that there are too many bushes, there is only forest and trees. Trees are too far from the road, there are many road signs, large billboard at the end of the animation, absence of ditches, little forest, curves were mentioned once (Fig.4.27.).

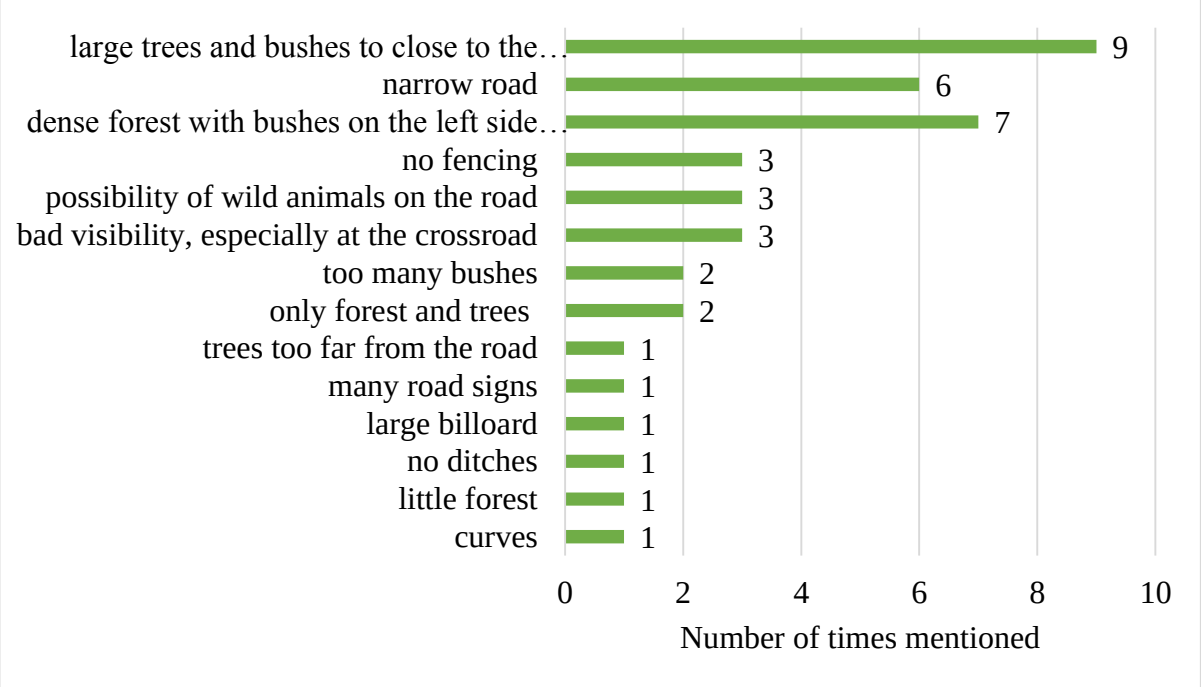


Fig. 4.27. **The third scenario of the third case, negative elements**

Comparing positive and negative elements, the main disagreements were about forest and trees, mainly connected to their placement. Ten respondents named trees, nice forest, and cut and transparent forest undergrowth as a positive element. Nine respondents thought that large trees and bushes are too close to the road in some places and limit visibility. Six respondents thought that forest on the left side is dense.

4.4 Comparison between cases and results from general questions

Comparison between the cases. The landscape in the first scenario of the first case was named as the most open, but the third case of the first scenario as the most closed. Feeling of safety of respondents is connected to landscape structure.

Comparing the feeling of safety in each scenario on a scale from 1 to 5, where 1 is very unsafe and 5 is very safe, respondents felt most safe in a current agriculture landscape and the most unsafe in the third scenario of forest landscape where forest was close to the road in some places.

Comparison of landscape attractiveness among cases, were 1 point is very unattractive landscape and 5 points is very attractive landscape, shows that respondents find the second scenario of traditionally managed forest landscape with clear cuts, where new trees are planted along the road, open roadsides, regularly thinned forest in Strenči regional municipality the most attractive. The second most attractive is current situation of the same case forest landscape with rather closed views. Kocēni current situation with mosaic landscape is in the third place.

Respondents found the current situation of agriculture landscape in Iecava regional community the most unattractive, but it felt the safest. The slightest differences between the attractiveness and the safety were found in agricultural landscape. Most differences between attractiveness and safety were found in the forest landscape, especially in the third scenario of the third case, which was the design version of the forest landscape (Fig.4.28.).

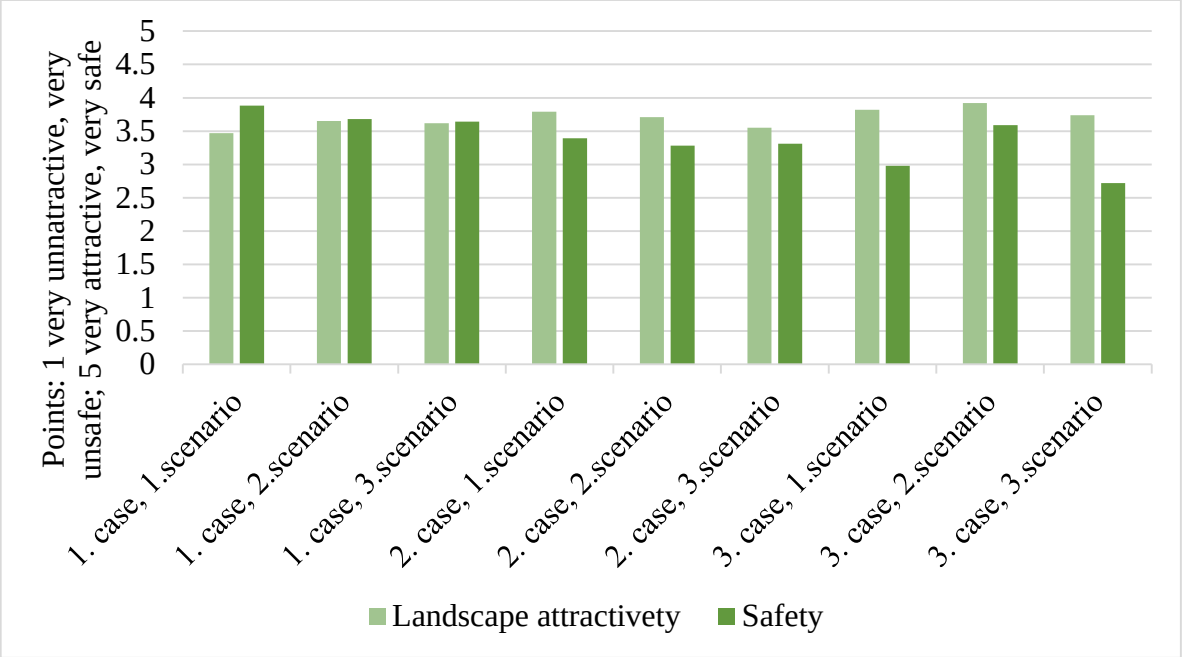


Fig. 4.28. **Road landscape attractiveness and feeling of safety in each scenario**

Comparison of safety feeling between drivers and passengers showed little differences in the first case – agriculture and the second case – mosaic landscape and there were more differences in the third case – forest landscape. Drivers felt less safe than passengers did in the third case (Fig. 4.29.).

Comparison of landscape attractiveness and landscape structure where 1 point was given to very closed landscape and 5 to very open landscape shows some connection between landscape openness and attractiveness. Very open agriculture landscape like in the first case is considered less attractive (Fig.4.30.) Landscape with more closed structure was considered more attractive; reasons will be discussed in the next chapter.

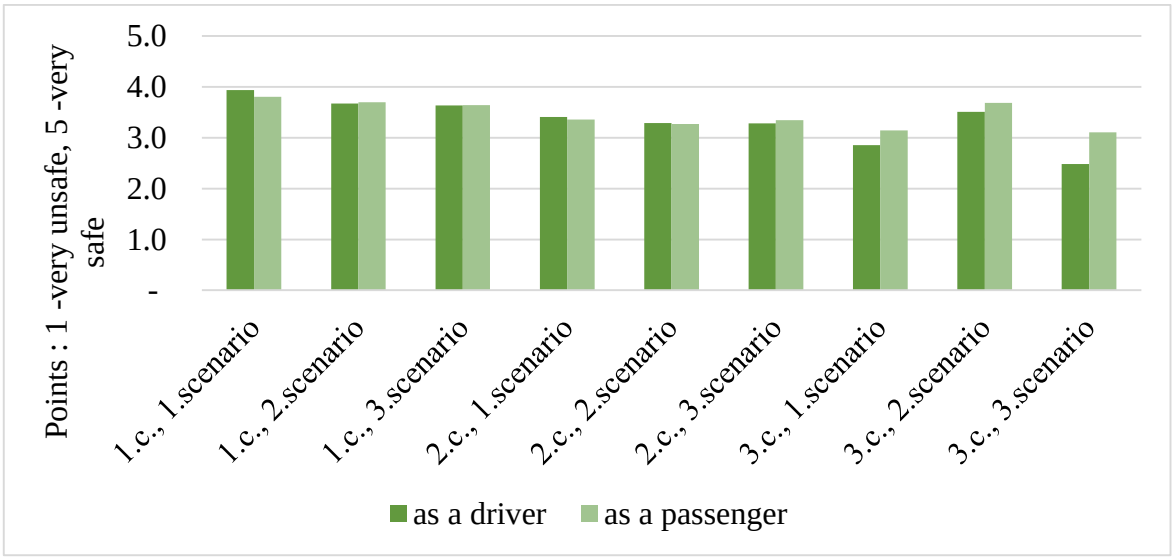


Fig. 4.29. **Feeling of safety between passengers and drivers**

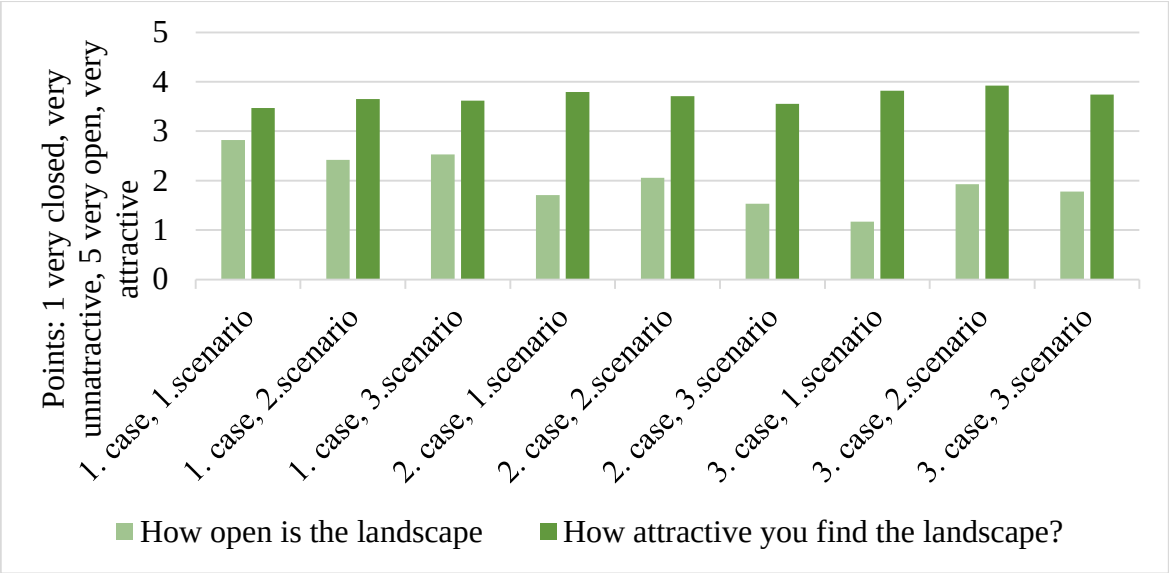


Fig. 4.30. **Comparison of landscape struture and landscape attractrivenes**

Respondents named positive elements 705 times and negative elements 549 times in all scenarios together. Some respondents named only one element each time, but some respondents named several elements each time. Highest number of positive elements and activities was named in the second scenario of the first case area representing intensive agricultural scenario. The lowest number of positive elements was in the third scenario of the second case, which represented afforested mosaic landscape. The highest number of negative elements was mentioned in the second scenario of the second case, representing more open mosaic landscape, and the lowest number of negative elements was in the second scenario of the third case representing the traditional way of forest management (Fig.4.31.). The most mentioned positive elements were trees, tree groups and bushes. The highest positive evaluation of trees was in an open agriculture landscape. In the second scenario of the second case in a mosaic landscape, the most popular positive element was appearance of grazing sheep. Due to the open landscape, topography became more obvious and was marked as a positive feature. The most named negative elements were the ones, which can cause unsafety on the road, like bad or limited visibility due to trees and bushes close to the road.

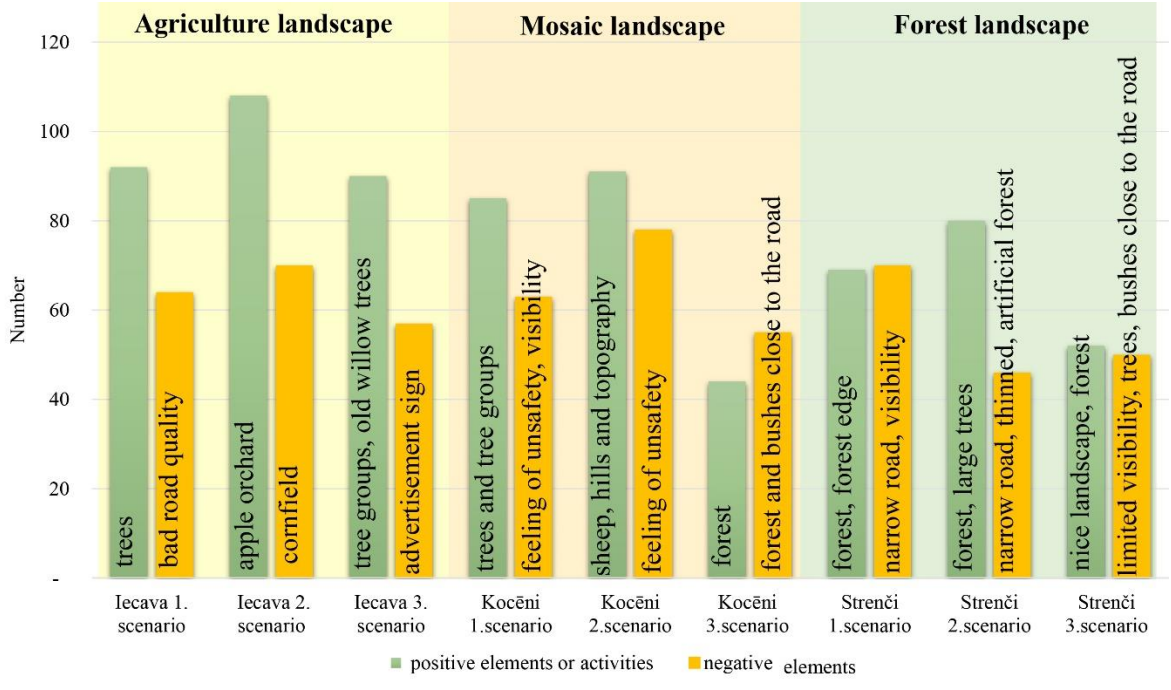


Fig. 4.31. **Positive and negative elements in all scenario animations**

Only few respondents noticed when some of negative elements disappeared, like electricity line in the first and second case. In the comments about positive and negative landscape elements respondents compared road landscapes in animations to landscapes they had seen, when driving in Poland, Germany, and Wales. Landscapes from other countries were always mentioned as negative examples. There is a tendency of less comments towards the end of the questionnaire. It can be explained by the length of the questionnaire. It is possible that respondents became tired towards the end of the questionnaire.

Results from general questions. Respondents evaluated how important is the landscape they see when travelling along the road. The answers given on a scale from 1 (not important at all) to 5 (very important) gave average number 3.92, which shows that road landscape is important. Landscape is almost of the same importance for both genders. Landscape is not important at all to 2 % of men, not important to 4 % of women and 8 % of men, neither unimportant nor important to 21 % of women and to 22 % of men, important to 41 % of woman and 44 % of men, very important to 34 % of women and 23 % of men (Fig.4.32).

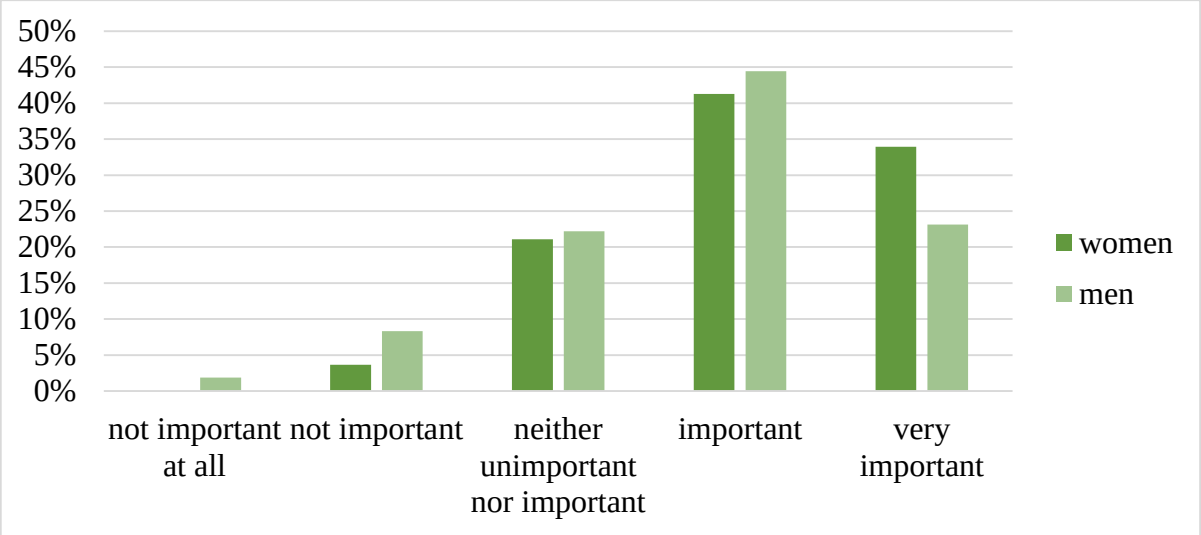


Fig. 4.32. **Importance of the road landscape by gender**

Landscape is more important to passengers than drivers. It is very important to 41 % of passengers and to 19 % of drivers, important to 39 % of passengers and 46 % of drivers, neither important nor unimportant to 14% of passengers and 27 % of drivers, not important to 5 % of passengers and 7 % of drivers, not important at all for 1 % of passengers and 1 % of drivers. (Fig. 4.33., Fig. 4.34.).

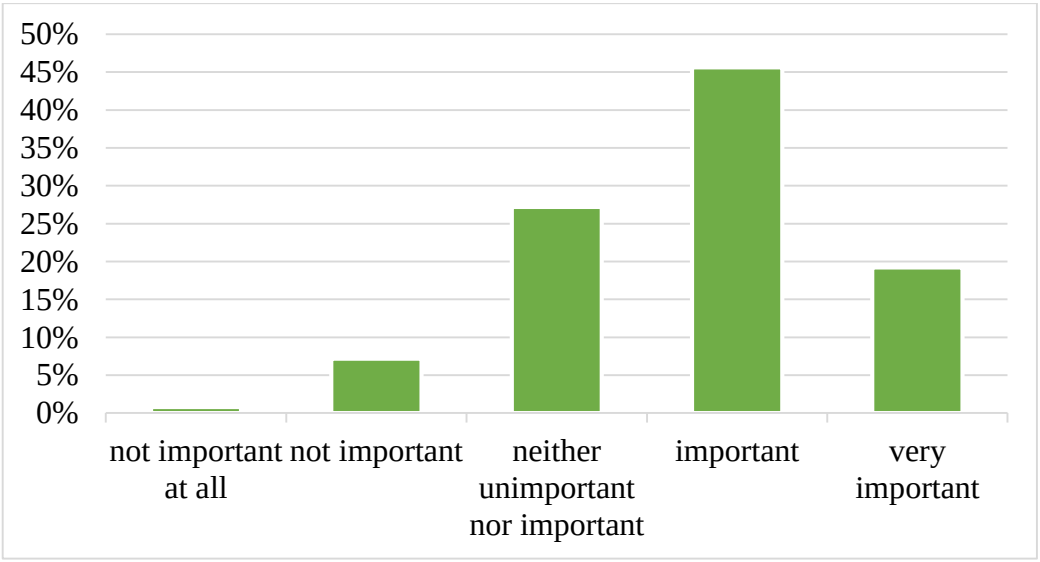


Fig. 4.33. **Importance of the road landscape to drivers**

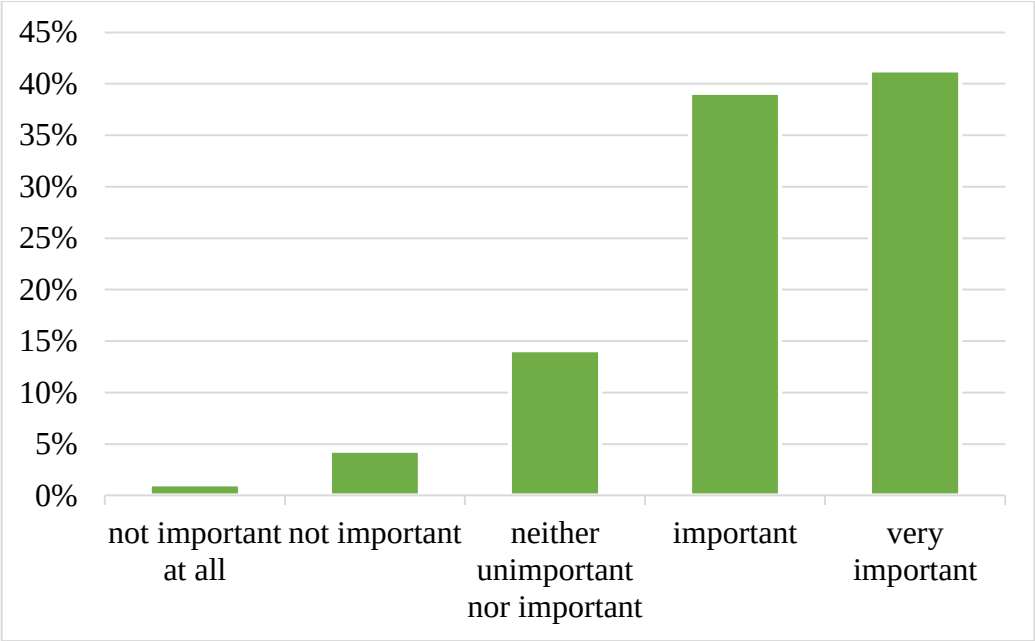


Fig. 4.34. **Importance of the road landscape to passengers**

Division of landscape importance to the defined age groups is presented in figure 4.35. Landscape is more important for travellers in age group 18–28.

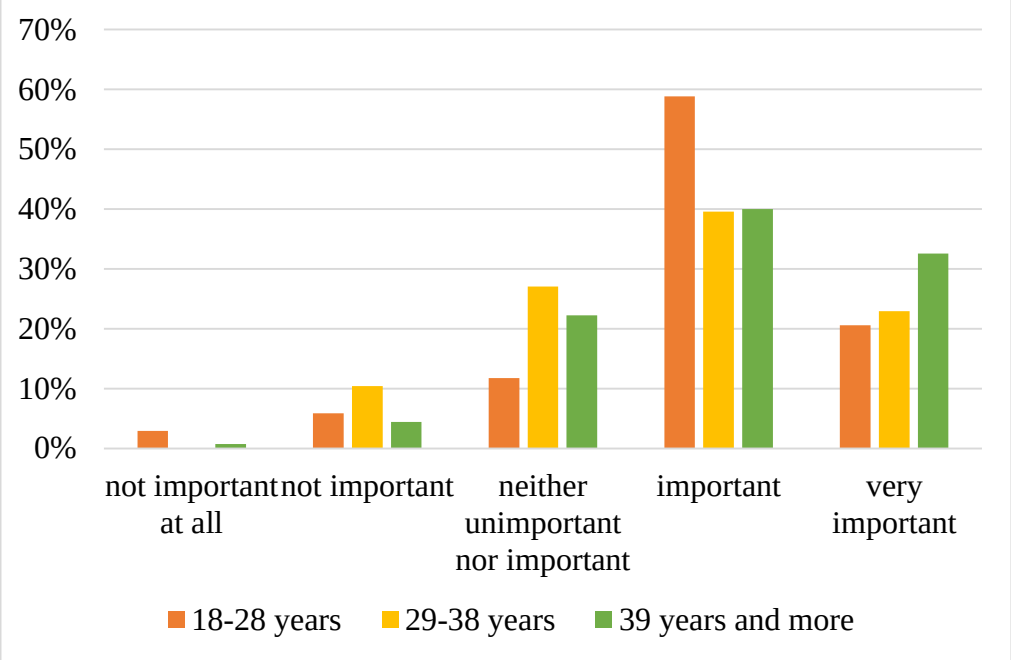


Fig. 4.35. **Importance of landscape depending on travellers age**

Respondents ordered their preferences regarding landscape type from the first to the third place. From the respondents ranking of landscapes according to the description, mosaic landscape, where forests change with fields and meadows, was the most preferred among three defined landscape types. The second preference was for agriculture landscape with long and open view perspectives and the last one was forest landscape with closed views. Mosaic landscape was the most preferred by older travellers in the age group 39 years and more. Agriculture landscape was more preferred by travellers in the age group 18 to 28. Forest landscape was the last preferred by older travellers in the age group 39 years and more (Fig. 4.36.).

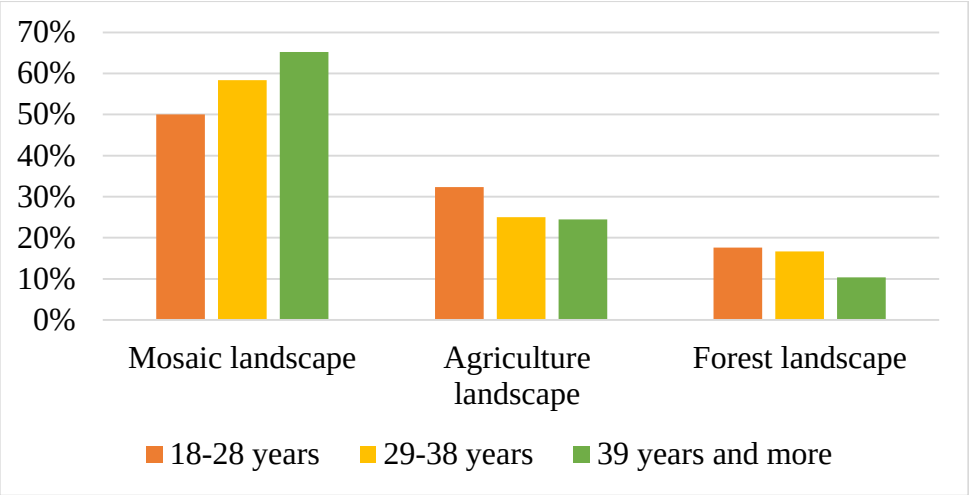


Fig. 4.36. **Landscape type preference**

Respondents evaluated different roadside maintenance options. Answers given on a scale from 1 to 5 about the road edge show that the road side with flowers is the most preffered (3.77 points on average) (Fig. 4.37.), followed by narrow well–maintained road edge with grass (3.39 points in average) (Fig.4.38.) and the least preferred – road side with cut grass, but bushes growing in the ditches (3.03 points on average) (Fig.4.39.). There are some differences between drivers and passengers regarding preferences in roadside management. In all three options there are more passengers than drivers who have chosen the highest evaluation on a scale from 1 to 5.

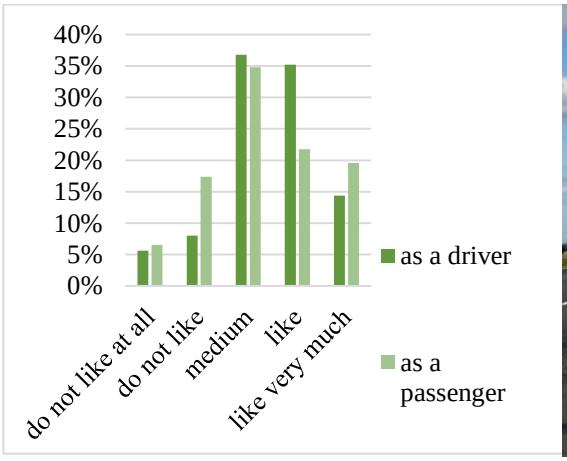


Fig. 4.37. **Narrow road side with regularly cut grass**

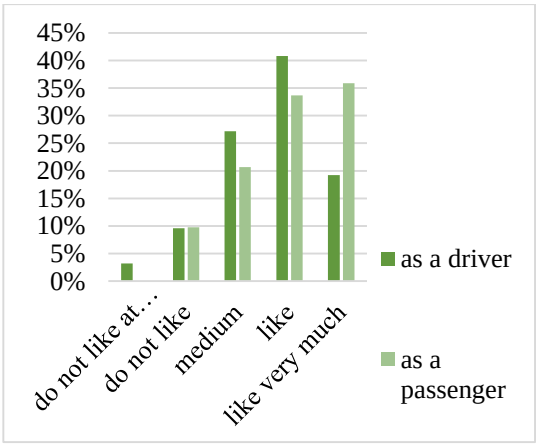


Fig. 4.38. **Road side with flowers**

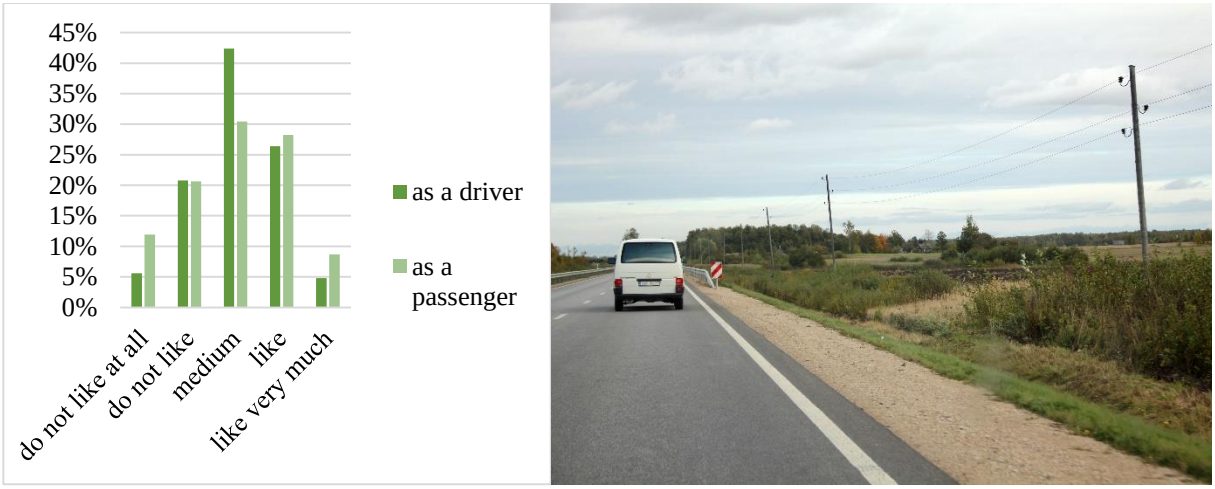


Fig. 4.39. **Partly maintained road side**

Respondents were asked to express their suggestions, what should be improved in the road landscape (Fig.4.40.). Roadside maintenance, which includes regular grass cutting, cutting of bushes in the ditches, picking up garbage, was mentioned most often. The next important issue for road users is road quality. Many respondents complained about the quality of road surface. Part of respondents said, that they have no time to look at the landscape because of the bad road quality.

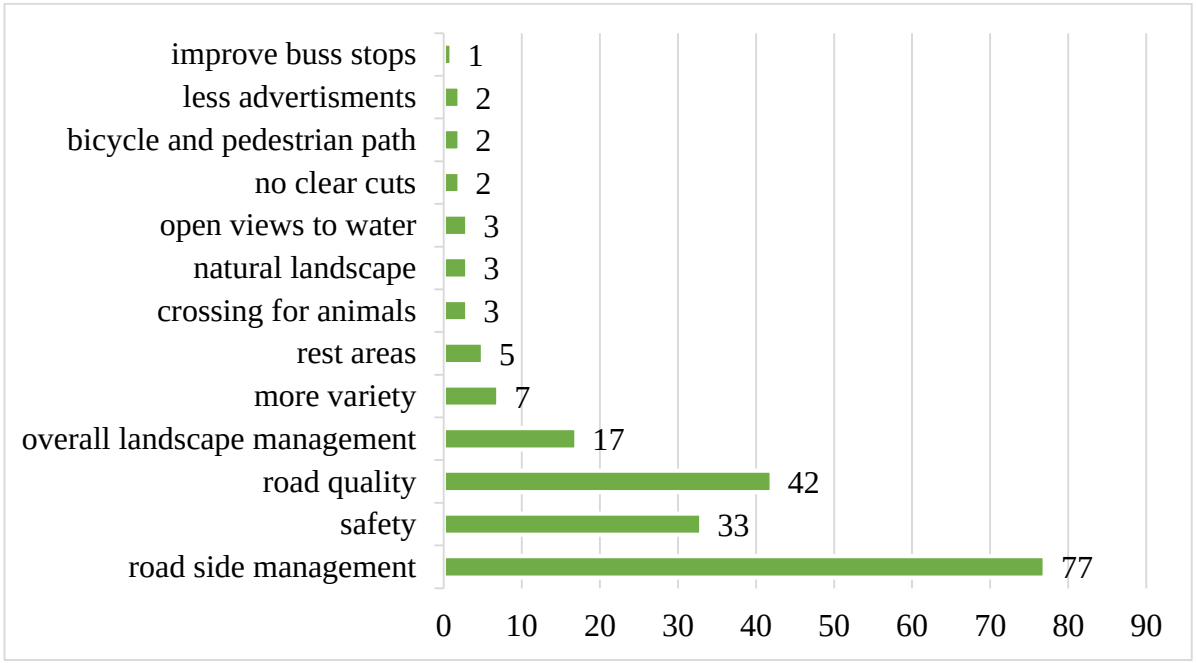


Fig. 4.40. **Suggestions for road landscape improvement by respondents**

The third important issue is road safety. That includes good visibility, enough wide visibility zone along the road, road barriers, lighting, road signs. Safety regarding wild animals was also mentioned quite often. Respondents asked for better visibility in order to see animals approaching the road, fences and animal bridges over the road. Overall landscape management, taking care of dead wood, taking down old abandoned buildings was mentioned 17 times. Seven respondents asked for higher landscape variety, mentioning that it could help to reduce fatigue. Five respondents would like to have more and better–quality rest areas, which are well equipped and managed. There were several respondents, who thought that landscape quality is fine, or they are not interested in the landscape and highlighted the road quality and safety.

5. DISCUSSION

The purpose of the study was to provide a greater understanding of how Latvian travellers perceive road landscapes. The research was carried out using four visual characteristics of road related to traveller's movement along the road – variety, aesthetic of flow, legibility and orientation (Blumentrath, Tveit, 2014) and the fifth feature – vividness, that Clay and Smidt have identified as significant in the perception of road landscapes (Clay, Smidt, 2004) is taken into account. After comparison of these characteristics and results of respondent's survey, it can be concluded that road user evaluation of landscape elements and spatial composition generally is in line with visually aesthetic road design principles, but there are also some differences, which will be discussed further.

Road landscape characteristics

1) Variety is facilitated by the diversity of landscape elements and activities, varied and long-enough views, sequences, creating and highlighting landmarks, temporary effects, road art (Blumentrath, Tveit, 2014). Variety is identified as a key concept of the visual quality of the road landscape, it enhances the attractiveness of roads, reduces fatigue (Tveit et al., 2006; Clay, Smidt, 2004). The variety was noticed and mentioned by respondents as a positive feature. Respondents mentioned a variety of views in the first two animations of the second case mosaic landscape and the third case forest landscape, second and third animations. When the landscape was fully open (as in the first case) or views were closed (as in the second case, third animation by depicting forest), the landscape was called boring.

Landscape elements in the foreground and middle ground, which contribute to variety, were noticed. Some respondents mentioned the forest in the background of the first and third scenario. Trees and tree groups, which can attract the view, farmstead, flowers along the roadsides, information signs were mentioned as positive elements. There were many positive comments about the animals in the landscape, sheep in the second case. There were many negative comments about animals as well, mainly regarding their distance from the road and safety. Respondents were afraid that animals were too close to the road and could endanger travellers' safety by running out on the road.

Negative elements, which do not contribute to the variety, but cause visual clutter, were noticed as well. Respondents named electricity line in the first and second case as a disturbing visual element. Electricity lines close to the road destroy the visual quality of the landscape not only by their presence as such, but also by the practice of cutting branches of trees close to the lines. Billboard of the café, which appeared in the first case's third animation and third case animations got both positive and negative comments, the latter prevailing. Large signs are not preferred in roadside views, which corresponds to the studies of public preferences by K.Wolf (2003). Utility poles, overhead wires, and signage degrade perceived visual quality, create chaos and reduce preferences. A positive remark must be made about the regulations on the placement of advertisement signs in Latvia, described in the overview of normative documents.

Topography in the first and second animation of the second case, where it was possible to see the hills, was noted as a positive feature contributing to the variety. Opening the view to topography in the second case and the view to the river Gauja in the third case was considered as highlighting landmarks and respondents marked these changes as positive.

Variety is considered to be important particularly for drivers in driving safety by avoiding monotony and reducing fatigue (Blumentrath, Tveit, 2014). Monotony was noted by many respondents as a negative aspect in agriculture landscape animations and animation with a forest close to the road. Road users evaluated large, monotonous fields of agricultural land with open views negatively. As described in the literature review, such landscapes can provoke over speeding and cause dangerous situations. In the case of agriculture landscape, it is confirmed by statistical data about road accidents, described in chapter 2.2. It is possible to reduce

monotony in the agricultural landscape by placing tree groups (Дзенис, Реинфелд, 1968) and using other possibilities of road design in order to increase variety, which affects driving safety.

One-kilometre lengths of the road sections limited possibilities to include sequences in all animations. Changes of landscape structure in the second case mosaic landscape and last animation of the third case forest landscape were considered as sequences, but it was not separately noted by respondents.

Respondents were not asked to evaluate temporary effects in the landscape, as the landscape was demonstrated only in summer, but they could have used their imagination and mention positive or negative features connected with seasonality. One of the respondents did it by naming the corn field in the agriculture landscape as a feature limiting visibility in summer. Seasonality is a very important aspect in the road landscape, as mentioned in the literature review. It is a separate theme, which was not considered more in this research, but could be conducted in another study.

Road art was not considered appropriate in the case areas. Placement of road art elements and landmarks is described in the literature review.

2) Aesthetics of flow is supported by design, which follows one principal idea, facilitating varied and long enough views, sequences, good road alignment, scale and details adapted to place (Blumentrath, Tveit, 2014). From these characteristics, respondents noticed varied and long enough views, as described above. Aesthetics of the flow is also connected to the movement, which influences landscape perception. As the view to the water is important for the public (Steinitz, 1990) an open view to the Gauja river in the forest landscape was planned in the third case of the third scenario. Regulations about tree cutting in the forest allow to design "landscape felling" (Noteikumi par..., 2013), but in a limited area of 0.2 ha. It can be too little to achieve a good result. In this case, forest width from the road to the Gauja river to the road was 60 m. There were no trees in the protected zone of 10 m from the river. The possible allowed length of the clear cut would be 40 m. In order to notice the opening and see it for 5 seconds, the length of the opening should be at least 120 m according to the theory described in the literature review. The opening for the view to the river, in this case, was designed 120 m long, but it still was noticed by a low number of respondents, only by five from 217. It can be explained by the fact that the view was in the inner bend of the curve. According to the theory, travellers tend to look at the outside bend of the curve. Openings in the roadside should be designed considering road geometry, travellers' perception and placed on the outside of the curve.

In all animations, scale and general details were considered as adapted to the place by the author, except the design of the bus stop in the second case animations. The architecture of elements along the road was not changed. As described in the preliminary research, there is a tendency to replace the Soviet time bus stops with new ones during the road reconstruction. It does not happen in all cases but can be noticed often along the newly reconstructed roads in rural areas. New bus stops have very minimal facilities, they consist of a platform, bench without a roof, garbage bin and information sign, like in the second case animations. The bus stop in the second case had three positive remarks about its design and two negative remarks. Both passengers and drivers gave positive remarks. Negative remarks came from those respondents, who travel as passengers. They mentioned, that bus stops with a roof and the possibility to hide from the wind, would be more suitable for Latvian weather conditions. The bus stop in the first case, with a roof and the back wall described in chapter 2.2.1. It had both – positive and negative comments from passengers. The design of a bus stop in the current situation is as the ones designed by Road and Transport Design institute "Ceļuprojekts" in the sixties. It has both – historical value and good design for passengers. The negative remark was given by a passenger in the age group from 18 to 28. It could be explained by a negative attitude to everything that is not modern architecture.

3) Legibility is facilitated by visual guidance, good road alignment, simplicity in design, as little equipment as possible, lighting and bright colors. Results from the survey conform with the theory, that bad legibility is typical for curved roads as the next stretch is hidden behind a bend or the top of a hill. The road over the hill in a trench in the second case and road curve in the third case were noted as negative factors by road users. At the same time too long, straight stretches of the road are unsafe according to the theory, discussed in the literature review. In Latvian road planning practice, the length of straight stretches of the road often was planned not longer than 2 – 3 kilometres (Дзенис, Реинфелд, 1968). Drivers are accelerating speed on long straight roads.

Signs, road lighting, tree rows along the road enhance visual guidance according to the literature and can help to improve legibility. One driver commented the first animation of the third case of a forest landscape negatively as being very dark at night. Road lighting is not necessary everywhere, but it should be taken into account in areas where the legibility of the road needs to be improved.

Results show road users pay much attention to road signs. Presence of road signs and adding new information signs with house names in the first case were evaluated as positive in all cases. The placement of information signs is also important for the tourism development.

A row of old willow trees along the road in agriculture was mentioned as positive element by many respondents and negative by some respondents. Negative remarks were made regarding safety about tree being too close to the road. Unfortunately, the present tendency in road reconstruction is to take down tree rows, as they are considered dangerous. Foreign research shows that tree rows have a speed decelerating effect and drivers tend to drive slower when the trees are present (Clavi, 2015). This is a very important issue, which must be considered and checked in each case of road reconstruction.

Bright colors are considered to improve road legibility. One of the respondents is his recommendations on how to improve the road landscape asked for more colors in the road landscape. As the roadside architecture was not changed in animations, there were not many options to include bright colors in the road landscape. In the countryside, bright colors can appear in the landscape seasonally with some crops and broad leave trees, in architecture and road art. They have to be in line with building regulations of each area.

4) Orientation in space is facilitated by designing varied and long enough views, sequences, creating and highlighting landmarks and road art. All these characteristics were discussed above.

5) Vividness. Road landscapes of case areas do not stand out with any special remarkable features, which would make an immediate and lasting impression on the viewer, that characterises vividness (see literature review) except a panoramic view at the end of the current situation's animation of the second case, mosaic landscape (Fig.2.8.). This panorama was noticed by some respondents and should be preserved in the future. In the second and third animation of the second case, the view is not so impressive due to the designed changes. In the second animation, the surprise of sudden opening of the wide view is missing. When the trees from hills on the sides of the road are taken down in the second animation, the surprise of opening the view is gone. In the third animation, the view is partly blocked by wind protection row of spruce trees on the right side of the road.

Other landscapes of the current situation in all animations were characterised by respondents as regular Latvian landscapes where nothing special stands out. The vividness of landscapes can be improved by adding variety, where it is possible. Experience of other countries, e.g. the Netherlands (Piek et al., 2011), can be used in order to establish and protect panoramic views, which would increase the vividness of the road landscape.

Road landscape qualities

From the road landscape qualities reviewed in the literature – archaeological, cultural, historical, natural, recreational and scenic quality (Kelley, 2004) road users gave positive

comments to natural, scenic and cultural quality. They prefer the presence of nature along the road. It conforms with other studies that naturalness positively correlates with landscape preferences (Antonson et al., 2009; Steinitz, 1990). Also, it is obvious from environmental psychology research that the individual's visual experiences of nature are often more appreciated than those of the built city (Kaplan and Kaplan, 1989).

All elements of the landscape – landform, water, vegetation, which were in the middle ground, not too close to the road, were evaluated as positive, contributing to the scenic quality of the road. Respondents noticed features of the cultural environment like farmsteads, traditional way of land use. Literature review and the preliminary study show, that historic roadside elements like old trees, rows of trees, historical buildings are still present in the landscape. In the case study territories, there were few of these elements present like a row of old willow trees, and a bus stop in the first case area. Both were noted by respondents as positive elements showing that public notices these elements, maybe even not knowing about their history. It is necessary to evaluate all elements in the road landscape before making any decisions for changes. Historical buildings and other elements improve the orientation and can serve as landmarks. Traditional land use adds identity to the road landscape.

Some respondents noted that there were no places to stop or asked for rest areas along the road. It would increase the recreational quality of the road, like in Norway, where rest stop design adds extra value to the tourist routes (Carter, 2017). The individual design of rest areas can contribute to the road landscape variety, orientation and improve the safety by offering the possibility to rest. Problems of the present state of rest areas were displayed in chapter 1.5.

Road landscape elements

Trees and tree groups were most often mentioned positive elements in all questionnaire. The highest number of positive comments about trees was in open agriculture landscape, where they stand out. Trees in agriculture landscape have the highest visual. Positive evaluation of trees is consistent with research on public evaluations of other landscape settings. Trees and especially large trees have been found to have a high positive influence on user preferences (Wolf, 2006). In the first case area, the presence of old willow trees along the road was noted positively. More transparent forest in the second animation of the third case was noticed and positively evaluated by respondents and it conforms with studies of Kaplan (1985). There were also comments that such a forest does not look natural. Society still needs to be educated about the ecological value of diverse forest with trees of different age.

The existing regulations "On Tree Felling Outside Forest Requirements" require assessment of the ecological, visual, cultural and historical quality and safety of trees, tree groups, rows and alleys in the road protection zone. Methodology and better procedure of tree assessment for municipalities should be developed to avoid misunderstandings as it has happened in some cases e.g., in Bukaiši, Tērvete municipality in 2018, when large trees along the roadsides were cut down.

The next highest number of positive comments was about animals in the landscape, the possibility to see topography, which was discussed above.

Presence of traditional farmsteads was evaluated positively in the first and third case. There were no bridges, no industrial buildings, nor any large modern or such old historic buildings as churches in the case areas. In order to evaluate the attitude of road users towards such roadside elements, research of other case areas should be carried out.

There were comments about the absence of ditches along the roads. In the first two cases there were ditches, but according to the topography they were very shallow, and it was not possible to notice them. In the third case, in forest area, there were no ditches in the current situation. In cases when territory next to the road is well ameliorated, ditches are not necessary, but in other cases they are mostly necessary.

Answers to the questions about roadside verge type showed that respondents prefer roadside vegetation with meadow flowers better than regularly cut grass. It conforms with the study from northern England about the assessment of scenic beauty of the roadside (Akbar et al., 2003), where respondents showed a positive attitude towards establishing a variety of vegetation types instead of a uniform seed mixture. Grass swards with flowering herbs near the road and trees further away were the most preferred combination of plant types for revegetation of road verges. Urban meadows as an alternative to short-mown grassland are gaining its importance in England. Recent research suggests diversification of urban greenspace by planting urban meadows in the place of some mown-amenity grassland. It has several benefits, including economic aspects of roadside maintenance. Native perennial meadow plantings can produce biologically diverse grasslands that support richer and more abundant invertebrate communities, and restructure plant, invertebrate and soil microbial communities compared with short-mown grassland (Norton et al., 2019). Flower meadows are already appearing in Nottinghamshire, Derbyshire, Birmingham, Newcastle and Sheffield along city roads according to BBC News (Heath, Bevis, 2019). It could be considered as an alternative in agriculture areas in the countryside as well, like it was designed in the third animation of the first case. Respondents perceived flowers along the roadside as a positive element.

Negative elements – utility poles, overhead wires, and signage were discussed above. The rest of the negative comments were about elements, which were too close to the road in users' opinion and endangered traffic safety. So many concerns about the safety were not expected.

Safety

It is a very important issue for all travellers and findings of this research prove it. Most of negative remarks about the animations were concerning safety issues. Respondents from transport field were concerned mostly about safety, visibility and road quality and most of them recommended to take care of roadside management to improve visibility. Respondents from other fields commented on safety as well.

Research proves that landscape affects road safety. The findings of studies by Mok et al. (2005) show a significant decrease in crash rate after landscape improvements were implemented at the 95% confidence level on 10 urban arterial or highway sites in Texas.

Safety is connected to elements along the road, landscape structure and road maintenance. Travellers felt safer in open agriculture landscape with wide and open roadsides, good visibility and less safe in closed forest landscape, which corresponds to the findings by Antoson et al. (2009) in the study about the surrounding landscape's effect on driving behaviour in Swedish landscapes. In the open landscape, subjects drove faster, did not drive as close to the centre of the road, and grasped the steering wheel more often while simultaneously experiencing less stress. Landscape appeared to be relevant to traffic safety. Research on the effects of roadside vegetation on driving performance on a two-lane rural road by Calvi (2015) demonstrated that the distance of trees from the road affects the drivers' performance. Drivers balanced with the useful guidance information that roadside trees provided the risk associated with the presence of trees: when trees were far away, the sense of guidance was predominant, and drivers adopted higher speeds; when trees were closer, drivers saw the trees as a risk, slowed down, and moved further away from them.

In the second animation of the third case of this research, when the forest edge was moved away from the road, the forest was thinned so increasing visibility, respondents felt safer as well. Research about the clear zone width and forest structure suggest that, while the increased roadside vegetation density does not necessarily result in reduced driver speeds or deviated lateral positioning, the manipulation of the roadside clear zone width does provide tangible benefits to safe driver behavior (Fitzpatrick et al., 2016). For forested landscapes, Finder et al.

(1999) found that the distance to forest cover is an important deer-vehicle accident predictor (Finder et al., 1999), and Seiler (2005) noted that an increased distance of 100 m between forest cover and road might significantly reduce collisions with moose. In Latvia, where forest covers 50.9 % of the country's territory according to the State Forest Service's data, it is very important to pay attention to the road landscape design in forest areas.

Some respondents marked that there were no safety fences in the forest landscape and asked for animal overpasses. Everyone including animals should be protected from dangerous situations on the roads. The study about driver behavior on the road with and without safety fences by Antonson et al. (2015) using driving simulator shows that in general, game fence and vegetation does not affect driving speed, speed variability, lateral position or visual scanning. However, when the moose appeared in the landscape the drivers slowed down earlier and their speed was more significantly reduced when no game fence was present. Game fencing was perceived as one reason for the drivers to feel at ease when driving. Fencing is not the only solution, which can guarantee 100% safety on the road, but the question about the animals on the road needs to be addressed.

Respondents identified the curved road in the third case as dangerous. There were some positive comments about curves, which make the road more interesting, but most comments were negative. People's perception should be considered, but their assumptions about safe roads can be wrong. Real driving safety should be distinguished from a feeling of safety. Haynes et al. (2007) studied road curvature and its association with traffic accidents at a district's level in England and Wales. Their study developed several measures for road curvature and found that at a district's level, road curvature is a protective factor meaning that more curved roads in an area result in fewer road accidents. Curvature may be risky considering its engineering effect; however, from the behavioral aspect, drivers may drive more slowly and cautiously on curved roads. On straight roads drivers are more likely to fall asleep or feel bored (physiological theory). The overall safety effect of road curvature (compared to straight roads) is likely to be mixed (Wang et al., 2013). Nature and landscape experts in Latvia try to educate society about different landscape elements including curves in the projects "Ainavas runā (Landscapes talk)" (Ainavas runā, n.d).

Landscape structure

As studies targeted at the view from the road (e.g. Antonson et al., 2009; Clay, Smidt, 2004), show, vividness and openness are important indicators for the attractiveness of views, it was expected by the author that agriculture landscape due to open views would be evaluated higher than the forest landscape. Forest landscape is closed and there are few open views. Results are different. Respondents rated three landscape types according to their preferences and results show that the most preferred landscape type is mosaic landscape, followed by the agricultural landscape and forest landscape, as it was expected by the author on the basis of the literature review. But answers to the previous question do not match with responses to the question were respondents had to rate the attractiveness of each scenario separately. Scenarios represent the same three landscape types. According to the results, the second scenario of the third case of a forest landscape with intensive clear cuts, thinned forest, and newly planted trees was evaluated as the most attractive. The second highest rating of attractiveness was given to the current situation of a forest landscape, with few openings and many old trees. Current situation of the mosaic landscape was only the third. This was unexpected. It was assumed that respondents would give a higher evaluation to the mosaic landscape.

High evaluation of landscape attractivity of the forest landscape animation with clear cuts can be explained by its similarity to the mosaic landscape. Edge of the grown-up forest was moved back from the road due to the clear cuts, there were more open views and better visibility. Landscape in this scenario was well maintained, the grass was neatly mown, there were no shrubs and bushes near the road. Many respondents evaluate the landscape, which looks well-maintained. It corresponds to the research in a wider field of landscape quality assessment

studies, which have shown increased preferences for perceived stewardship (synonymous with a sense upkeep maintenance) (Tveit, et al., 2006).

This forest animation had a number of negative comments as well, saying that there was no variety, trees look the same age, the forest looks too artificial, too thin. It was also concluded that too much and too little maintenance are both valued negatively. Too much maintenance is seen as artificial (Coeterier, 1996), because ‘‘too much maintenance is artificial, sterile, everything is programmed, there are no degrees of freedom in one’s behaviour, one cannot do anything. Too little maintenance looks shabby; one does not want to do anything’’.

According to the research by other authors, people in different age groups have different views about the landscape and it`s unique and characteristic features (Peneze, 2009). The landscape is changing over time. Before the First World War and between the First and Second World War the agricultural landscape dominated in Latvia. In 1929, forest land was only 25.5% from the State territory. Today forests cover 50.9 % of the country’s territory. People identify and value landscape elements with which they have grown up. It could be that younger persons who have grown up with more forest present evaluate forest landscape differently than older people, who have grown up in a more open landscape. This is a subject for more research in Latvia.

Landscape maintenance

It is important to many respondents. There were many positive comments about the fact that landscape is used, well maintained as well as negative comments about the lack of maintenance mainly in animations of the current state of case areas. Most of the answers on the question of what should be improved in the road landscape were about better maintenance of the roadsides. The problems in the road landscape foreground like overgrown ditches, which often limit visibility and possibility to see the middle ground, were described in the preliminary study as well. Review of normative documents shows that roadside maintenance regulations exist on all roads. Maintenance of less important roads, like local municipality roads, depends on the decisions and financing of municipalities. There are rules for operation and maintenance of drainage systems (Meliorācijas sitēmas …, 2010), which regulate maintenance of ditches, including roadside ditches. But it should be checked how these rules are taken into consideration in real life and it is a tool for local municipalities to improve the visibility and aesthetics of the roadside landscape.

Overall road landscape would improve in the case of better roadside management by the state and landowners of the territories next to the road and through better communication and cooperation. As the protection zone of major roads is 100 m, it should be possible to influence landowners by normative documents to take better care of the roadsides by cutting down the fringe of bushes on the borders of properties.

All road landscape corridor can be improved through planning and better management.

Legal framework of the road landscape

As described in the literature review, the road landscape is affected by new road planning, road reconstruction and maintenance. There are standards and regulations for these actions, but the term “road landscape” is little mentioned in normative documents. Publicly accessible viewing points, perspectives, scenic roads may be included in the thematic Landscape plan according to the Spatial Development Planning Law (Teritorijas attīstības plānošanas…, 2014). Present situation and problems of scenic road designation and development have been described in the literature review.

Analysis of normative documents was carried out with the aim to understand the current state of “road landscape”. In order to give any suggestions for improvement of the situation, more detailed analysis, not only of normative documents, but also of the current structure of road management system, should be carried out. As the road landscape is influenced by many fields (Fig. 1.13), the Ministry of Transportation, which is responsible for the development of

transport infrastructure, has to cooperate with specialists from other fields. Examples of positive experience from other countries, where transport agencies or departments are considering road landscape in road infrastructure development can help to develop such cooperation. Our neighboring country Lithuania, which has been under the same Soviet system as Latvia, has developed Landscape Design Guidelines for the state roads and railways at the end of 2013 (Braga et al., 2013). It can serve as a good example. Besides, we should look back in history, where we have a positive experience of including road landscape into road infrastructure development, through the projects and theory developed by V. Reinfelde. In Soviet time, roads had road passports, described in the literature review. It was a good practice, that could be renewed today.

Study shows that there are more options for landscape changes in mosaic and especially forest landscape. Considering that forest area in Latvia is 52 % and 49 % of the forest belongs to the state, there is a possibility to develop road landscape design policy along the roads in the state forests in accordance with road landscape design principles.

Currently, roads in Latvia are classified according to their importance. Planning regions and regional communities have defined scenic roads in their documents. There are the first attempts to develop touristic routes by the professional rural tourism association "Lauku ceļotājs" (Lauku ceļotājs, 2018). Overall road landscape development policy, defining road categories according to their importance and users, setting goals for road landscape development for each road category with clear design guidelines should be developed as it is in other countries, where road landscape design principles are applied.

Unexpected results

It was not defined in the beginning of the questionnaire, what should be considered as road landscape. It was done intentionally, in order not to influence respondents and to see what they perceive and notice. Respondents were asked to evaluate road landscape, not the road itself, but there were many comments about the road quality, road infrastructure, connecting roads, organization of junctions, traffic intensity, type of cars and the way cars are driving. That was an unexpected result. It shows the current problems connected to the road quality and importance of road improvement to the society. Lack of finances for road infrastructure improvement was described in the literature review.

The survey was conducted in April, just after winter, when roads have not yet been repaired after the winter and the quality of roads is a more sensitive issue than in other seasons. It might have influenced respondents and could explain the high amount of comments on the road quality as well.

Limitations of the research

Animation method has some limitations. There were many comments about roads being too narrow. The view of the road on a computer screen is perceived differently than on a real road. It might be that they looked too narrow due to the way animations are perceived. The same conclusion can be made about the comments on the objects in the foreground and road surface. Studies show that car drivers see the elements in the foreground only for a short time, and the elements in the middle plan play a greater role, drivers and passengers focus more ahead. In the modelled situation one looks at the foreground more. This is limitation compared to the traffic simulator, which resembles real life situation, with a possibility to change the focus and angle where one looks better. In animations people might focus on some things which they do not notice in real life.

Use of animations in a web–based survey limits the length of road section to study. Animations cannot be too long in order not to lose the attention of respondents. There are technical limitations of models being too large to demonstrate them online ofr a web–based survey. Web–based survey method has limitations, which could have influenced the results. It was recommended at the beginning of the questionnaire to look at the animations on a computer

in a full-screen mode, but it is possible that respondents filled it in on a mobile phone or a tablet with a small screen, where it is harder to notice differences in the animation design. There were some comments that animations look the same.

The road section of 1 km length is appropriate for landscape assessment using an animation method. It was possible to evaluate most of the characteristic features of the road except sequences and road alignment. For these characteristics, road section should be longer. It is essential in road landscape planning to look at the whole route as the road landscape is perceived as one "story" during the whole drive. Road landscape can be designed for short sections only after analysis and development plan or general guidelines of the whole route have been carried out.

Further research

Findings of the research show that the landscape is important for travellers in Latvia. Next step in the research would be to find out tourists' and experts' view on road landscapes of the same animations, and compare how they see and evaluate road landscape elements, to find what the differences between experts, tourists and non-experts are. Tourists' view would help to recognize what the special features of Latvian landscape they notice are, and what should be more highlighted in our road landscape.

CONCLUSIONS AND RECCOMENDATIONS

The aim of the research is achieved by answering to the research questions.

1. **What elements or features of the road landscape are the most important contributors to the travellers' experience?**

- **Good road quality**. According to the results of the road user survey, the quality of the travellers' experience is closely related to the quality of the road. Currently, the quality of the road surface is one of the most important factors ensuring the quality of travelling. The condition of the road surface and other elements of the road infrastructure e.g., road marking, signs, safety barriers, ditches, lighting, and other engineering equipment is important to road users and need to be improved and maintained. The role of a landscape architect is to involve in the design or choose the most suitable road infrastructure elements, respecting the landscape and type of the road.
- **Driving safety.** Safety is highly important for travellers. The most important landscape elements that affect the road user's sense of safety during the trip are those that are close to the road in the foreground, as they affect visibility. Their distance from the road needs to be carefully assessed and considered in the road landscape design, and they should be used to enhance driving safety. The road landscape should be designed in order to provide good visibility of the road and roadsides. Use of tall, cultivated plants should be avoided in the foreground in the agricultural landscape in order not to limit the visibility and distant views. In the forest landscape, the edge of the forest should be kept in a distance from the road. Experience from other country road landscape design principles can be used here.

Landscape structure affects the driving safety and feeling of safety. Travellers feel safer in open agriculture landscape and less safe in a closed forest landscape. It can be enhanced by applying road landscape design principles and by road landscape maintenance in all types of landscapes. The Ministry of transport, as a decision making body, is advised to pay attention to the impact of the road landscape on road safety in its road safety plan.

From the safety point of view, important elements of road landscape are rest areas, which provide the opportunity to stop and relax in a suitable and equipped area. It is recommended to improve the recreation facilities along the state roads, which is the responsibility of the state company "Latvian State Roads", and to evaluate the need for new resting places.

- **Variety**. Roadside elements, which enhance variety and scenic qualities of the road, are important to the travellers. The most important positively valued landscape elements are trees and tree groups. The guidelines and methodology in assessment of trees, tree groups, rows and alleys in the road protection zone should be developed for local municipalities. A landscape architect should be involved in this procedure. Trees need to be regularly monitored and preserved for future generations. New trees and tree groups should be planned according to the principles of road landscape design.
- **Landscape maintenance.** Routine maintenance of the roadsides is an essential factor in creating a visually aesthetic landscape for road users. The foreground of the road landscape should be maintained in all landscape types and provide good visibility and views to the middle ground of the landscape in agricultural and mosaic landscapes. Existing rules for operation and maintenance of drainage systems should be considered and municipalities should persist on their application.

Roadside edges in the foreground in agricultural landscapes could be diversified by use of local meadow plants along road verges. Special attention is necessary along the borders of the state land and landowners of adjacent territories in the road landscape corridor. Better communication and clear regulations regarding the maintenance of borders need to be developed.

Derelict buildings and other elements lowering the visual quality of the landscape should be taken down or reconstructed. Road landscape corridor management plans are necessary for all roads according to their type.

2. What spatial characteristics are dominant in forming a legible and coherent travelling experience?

- **Road alignment in the landscape.** Road alignment influences the aesthetics of flow and road legibility. In cases of new road construction and road reconstruction, depending on the road status, a landscape architect should be involved in the road design process in order to evaluate the possible views, find the best setting in the landscape thus increasing the overall road quality.

In cases of long, straight road sections, landscape design principles should be applied to improve the safety and travelling experience. In curving roads, special attention needs to be paid to the visibility, especially in forest areas by moving and designing the forest edge in order to improve visibility.

The topography of the landscape should be highlighted through road landscape design. In places where the road is in a trench or embankment, use of landscape design principles on slopes should be used to improve their scenic quality. Topography in combination with the landscape structure should be used in the design of panoramic views along the road.

- **Mosaic landscape.** Spatially diverse mosaic landscape with changing landscape structure increases the quality of travelling experience. Fully open agricultural landscapes are perceived as monotonous and boring and have a negative impact on traffic safety. Enclosed forest landscape is perceived as unsafe and dull.

Variety in open agriculture landscapes and closed forest landscapes can be increased by using road landscape design principles. In the agriculture landscape trees and tree groups, diversity of crops and planning of field placement in the road landscape corridor, wider uncultivated roadside edges can help to increase variety and landscape quality.

In the forest landscape, monotonous and long stretches of forest can be diversified by openings in the landscape and planning of clear cuts along the roads. As the territories adjacent to roads belong to different owners this planning should be carried out by "Latvian State Roads" involving landowners. "Latvian State Forests" as owners of 49% of forests can contribute to the road landscape quality, by applying road landscape design principles along the roads in the state forests.

Land use changes in mosaic landscapes should be planned carefully, in order to preserve the mosaic structure of the landscape, keeping the balance between open and closed views.

- **Diversity of views.** Diversity of views increases the interest and influences the route choice, which is important for tourism development. Views to traditional and characteristic elements like farmsteads, churches, traditional land use, rivers, etc. of road landscape should be designed and kept open. In the forest landscape, openings should be created, thus increasing the variety, clear–cuts should be designed in accordance with the principles of forest design, keeping groups of trees and planning borders of the clear cuts according to the topography. Special attention should be paid to the design of the forest edge, its density, and composition of trees. Opening of views in the forest and mosaic landscapes should be planned, considering the travelling speed. Scenic panoramas should be identified and measures for their protection set in the spatial plan of the territory or a thematic landscape plan.

3. What kind of Latvian landscape is the most preferred by road users?

Road users prefer maintained, mosaic countryside landscapes. When driving out of the city, road users like to feel safe, see diverse landscapes, where nature is in harmony with the presence of the people, who use the land, where agriculture land is cultivated respecting the biological diversity, forests are managed, and houses are inhabited.

Implications for planning, design and management

- Further research is needed to create a safe and scenic road landscape.
- It is necessary to work out the road landscape development policy, set goals for different road types depending on their significance, location and primary users. It is recommended that

the Ministry of transport, as a policymaker in the transport sector, takes the initiative in developing the road landscape policy, integrates it into transport planning and in cooperation with the Ministry of Environmental Protection and Regional Development integrates it in the spatial planning to reach the local municipality level.

- Road landscape assessment methodology, guidelines for road landscape planning and management need to be developed, using experience and design principles pioneered by V. Reinfelde and P. Dzenis and other countries in the road landscape planning and design. Landowners and the public should be included in the road landscape assessment.

REFERENCES

1. **Al–Kodmany K.** (2001).Visualization tools and methods for participatory planning and design. *Journal of Urban Technology*, Vol. 8, p. 1–37.
2. **Akalin K. B.** Bilgiç Ş Kara Ç (2016). Visual Landscape Assessments in Road Project. *International Journal of Interdisciplinarity in the Theory and Practice*, Vol. 10. p. 66–72.
3. **Akbar K. F., Hale W. H. G., Headley A. D.** (2003). Assessment of scenic beauty of the roadside vegetation in northern England. *Landscape and Urban Planning*, Vol. 63, No. 3, p. 139–144.
4. **Andrejsons V.** (2004). *Laikmeti un ceļi*. Latvijas autoceļu nozare vēsturiskā skatījumā. Rīga: AGB. 112 lpp.
5. **Andrejsons V. (**2009). *Ceļi Latvijā*. Rīga: VAS Latvijas Valsts ceļi, SIA Apgāds Imanta. 252 lpp. ISBN 9789984397658.
6. **Andrejsons V., Sviķis H.** (2016). *Latvijas zemes ceļi un autoceļi 1940-1990*. Rīga: SIA DUE. 410 lpp.
7. **Antonson H., Ahlström C., Mårdh S., Blomqvist G., Wiklund M.** (2014). Landscape heritage objects' effect on driving: A combined driving simulator and questionnaire study. *Accident Analysis and Prevention*, Vol. 62, p. 168–177.
8. **Antonson H., Ahlstrom C., Wiklund M., Blomqvist G., Mårdh S.** (2013). Crash barriers and driver behaviour: A simulator study. *Traffic Injury Prevention*, Vol. 14, No. 8, p. 874–880.
9. **Antonson H., Jägerbrand A., Ahlström C.** (2015). Experiencing moose and landscape while driving: A simulator and questionnaire study. *Journal of Environmental Psychology*, Vol. 41, No. 3, p. 91–100.
10. **Antonson H., Mårdh S., Wiklund M., Blomqvist G.** *(*2009). Effect of surrounding landscape on driving behaviour: a driving simulator study. *Journal of Environmental Psychology*, Vol. 29, p. 493–502.
11. **Anund A., Kecklund G., Peters B., Forsman Å., Åkerstedt T**. (2008). Driver impairment during night and the relation with physiological sleepiness. *Scandinavian Journal of Work, Environment and Health*, Vol. 34, No. 2, p. 142–150
12. **Appleton K. J., Lovett A. A.** (2003). GIS-based visualisation of rural landscapes: defining 'sufficient' realism for environmental decision-making. *Landscape and Urban Planning*, Vol. 65, p. 117–131.
13. **Appleton K., Lovett A., Sünnenberg G., Dockerty T.** (2002). Rural landscape visualization from GIS databases: A comparison of approaches, options and problems. Computers. *Environment and Urban Systems*, Vol. 26, p. 141–162.
14. **Appleyard D., Lynch K., Myer J. R.** (1964). *The View from the Road.* Cambridge: MIT Press. 64 p.
15. *Latvijas Lauksaimniecība* (2018). Agriculture of Latvia. Collection of Statistics. Central statistical bureau of Latvia. Riga. 65 p. ISBN 978-9984-06-521-2
16. *Beautiful Roads – A Handbook of Road Architecture*. (2002). Danish Road Directorate, Copenhagen, Denmark. 63 p.
17. **Bell D. S. A.** (2003). Mythscapes: memory, mythology, and national Identity. *British Journal of Sociology*, Vol. 54, No. 1, p. 63–81.
18. **Bell S.** (2012). *Landscape Pattern, Perception and Process.* London: Routledge. 340 p.
19. **Bell S.** *Design for Outdoor Recration.* 2nd Edition. London, UK: Spon Press, 2008. 261p.
20. **Bell S., Nikodemus O.** (2000) *Rokasgrāmata meža ainavas plānošanai un dizainam.* Valsts meža dienests. Rīga: LTS International Ltd. 75 lpp. ISBN 9984-528-78-2
21. **Bell S., Penēze Z., Nikodemus O., Montarzino A., Grīne I.** (2007). The value of Latvian rural landscape. In: *European Landscapes and Lifestyles: The Mediterranean and beyond.* Edicoed Universitarias, Lusofonas. Lisbon, p. 347-362.

22. **Bishop I., Lange E.** (2005). Visualization in Landscape and Environmental Planning. London: Taylor & Francis. 296 p.
23. **Bishop I.D**. (1997) Testing perceived colour difference using the internet. *Landscape and Urban Planning*, Vol. 37, No. 3–4, p. 187–196.
24. **Bishop P., Hines A., Collins T.** (2007). The current state of scenario development: an overview of techniques. *Foresight*, Vol. 9, No. 1, p. 5–25.
25. **Blumentrath C., Tveit M. S.** (2014). Visual characteristics of roads: A literature review of people's perception and Norwegian design practice. *Transportation Research Part A: Policy and Practice*, Vol. 59, p. 58–71.
26. **Bradfield R., Wright G., Burt G., Cairns G., Van Der Heijden K.** (2005). The origins and evolution of scenario techniques in long range business planning. *Futures*, Vol. 37, No. 8, p. 795–812.
27. **Braga A., Bugeniene S., Godiene G., Kamičaityte – Virbašiene J., Matijošaitiene I., Nemanuūte – Gužiene J., Radvilavičius R., Samuchoviene O., Vitkiene J.** (2013). *Kraštovaizdžio formavimo gaires valstybiniams keliams ir geležinkeliams*. Kaunas. 135p.
28. **Brink van den A., Bruns D., Tobi H., Bell S.** (2017). *Research in Landscape Architecture. Methods and methodology*. London and New York: Routledge, p. 105–118
29. **Brown G.** (2003). A method for assessing highway qualities to integrate values in highway planning. *Journal of Transport Geography*, Vol. 11, No. 4, p. 271–283.
30. **Brown S.** (1968). Scenarios in systems analysis. In: E.S. Quade, W.I. Boucher (Eds.). *Systems Analysis and Policy Planning: Applications in Defence.* New York: American Elsevier Publishing Co., p. 298-323.
31. **Brush R., Chenoweth R. E., Barman T.** (2000). Group differences in the enjoy ability of driving through rural landscapes. *Landscape and Urban Planning*, Vol. 47, p. 39–45.
32. **Calvi A.** (2015). Does roadside vegetation affect driving performance ? Driving simulator study on the effects of trees on drivers' speed and lateral position. Transportation research record. *Journal of the Transportation Research Board*, Vol. 25, No. 18, p. 1–8.
33. **Chamberlain B. C., Liu R., Canfield J.** (2016). Using Landscape Visualization to Inform Streetscape Design. *Journal of Digital Landscape Architecture*, p. 84–91. https://doi.org/10.14627/537612010
34. **Charlton S. G., Mackie H. W., Baas P. H., Hay K., Menezes M., Dixon C.** (2010). Using endemic road features to create self-explaining roads and reduce vehicle speeds. *Accident Analysis and Prevention*, Vol. 42, No. 6, p. 1989–1998.
35. **Chase A. F., Chase D. Z., Weishampel J. F., Drake J. B., Shrestha R. L., Slatton K. C., Carter W. E.** (2011). Airborne LiDAR, archaeology, and the ancient Maya landscape at Caracol, Belize. *Journal of Archaeological Science*, Vol. 38, No. 2, p. 387–398.
36. **Clay G. R., Smidt R. K.** (2004). Assessing the validity and reliability of descriptor variables used in scenic highway analysis. *Landscape and Urban Planning*, Vol. 66, No. 4, p. 239–255.
37. **Coeterier J.F.** (1996). Dominant attributes in the perception and evaluation of the Dutch landscape. *Landscape and Urban Planning*, Vol. 34, p. 27–44
38. **Creswell J.W.** (2014). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*, Los Angeles, CA: Sage, 273 p.
39. Danish Road Directorate (2002) *Beautiful Roads – A Handbook of Road Architecture*. Copenhagen: Danish Road Directorate. 63 p.
40. **Davis T**. (2008). The rise and decline of American Parkways. In: Mauch C., Zeller T. *The World Beyond the Windshield: Roads and Landscapes in the United States and Europe*. Ohio: Ohio University Press, p. 35–59.
41. **Deming M.E., Swaffield S.** (2011). Landscape Architecture Research: Inquiry, Strategy and Design, Hoboken, NJ: John Wiley & Sons. 272 p.
42. **Denstadli J.M., Jacobsen S.Kr.J.** (2011). The long and winding roads: Perceived quality of scenic tourism routes. *Tourism Management*, Vol. 32, No. 4, p. 780–789.

43. **Dewan T.** J. (2008). *Scenic Assessment Handbook 2008*. Maine State Planning Office Main Coastal Program. 43 p.
44. **Draper R., Petty K.** (2001). The national scenic byways program: on the road to recreation. *Journal of Physical Education, Recreation and Dance*, Vol. 72, No. 1, p.27–31.
45. **Dripe J.** (1940). *Latvijas zemes ceļi un tūrisms*. *Ceļš un satiksme*, Nr. 13.
46. **Eby D. W., Molnar L. J.** (2001). Vehicle route guidance preferences of driving tourists. *ITS Journal – Intelligent Transportation Systems Journal*, Vol. 6, No. 3, p. 261–279.
47. **Echániz I.E.** (2007). *Infrastructure and landscape: roads*. Meeting of the Council of Europe on "the European Landscape Convention". Spatial Planning and Landscape Division Directorate of Culture and Cultural and Natural Heritage. 65 p.
48. **Efthymiou D., Antoniou C.** (2013). How do transport infrastructure and policies affect house prices and rents? Evidence from Athens, Greece. *Transportation Research Part A: Policy and Practice*, Vol. 52, p. 1–22.
49. **Eleksis K., Sviķis H., Vikmanis E.** (1967). *Automobiļu ceļu remonts un uzturēšana*. Rīga: Liesma, 236.–237. lpp.
50. **Elliott M.A., McColl V.A., Kennedy J.V.** (2003). *Road Design Measures to Reduce Drivers' Speed via 'Psychological' Processes: A Literature Review (TRL Report TRL564).* Transport Research Laboratory, Crowthorne, Berkshire, UK. 30 p.
51. **Españo L., Echaniz I.** (2013). Infrastructure networks in the landscape. Landscape and Infrastructures for Society. In: *Proceedings of 9th Meeting of the Workshops of the Council of Europe for the Implementation of the European Landscape Convention and Third International Congress on Landscape and Infrastructures*, Cordoba, Spain, 15-16 April 2010. Council of Europe, p. 30–36.
52. **Finder R. A., Roseberry J. L., Woolf A.** (1999). Site and landscape condition at white-tailed deer/vehicle collision locations in Illinois. *Landscape and Urban Planning*, Vol. 44, p. 77–85.
53. **Fitzpatrick C. D., Samuel S., Knodler M. A.** (2016). Evaluating the effect of vegetation and clear zone width on driver behavior using a driving simulator. *Transportation Research Part F: Psychology and Behaviour*, Vol. 42, p. 80–89.
54. **Forsyth A., Jacobsen J., Thering K.** (2007). *Moving Design: Spaces of Transportation.* Centre for Transportation Studies, University of Minnesota, Minneapolis. 42 p.
55. **Francis M.** (1999). A case study method for landscape architecture. *Landscape Journal*, No. 20, issue 1, p. 1–19.
56. **Garré S., Meeus S., Gulinck H.** (2009). The dual role of roads in the visual landscape: A case-study in the area around Mechelen (Belgium). *Landscape and Urban Planning*, Vol. 92, No. 2, p. 125–135.
57. **Gibson E. J., Gibson J. J., Smith O. W., Flock H.** (1959). Motion parallax as a determinant of perceived depth. *Journal of Experimental Psychology*, Vol. 58, No. 1, p. 40–51.
58. **Grahn P., Stigsdotter U.** (2003). Landscape planning and stress. *Urban Forestry and Urban Greening*, Vol. 2, p. 1–18.
59. **Grauda D., Stramkale V., Miķelsone A., Rashal I.** (2008). Evaluation and utilisation of Latvian flax genetic resources in breeding. *Latvian Journal of Agronomy*, No.10, LLU, p. 112–116.
60. **Grazuleviciute-Vileniske I., Matijosaitiene I.** (2010). Cultural heritage of roads and road landscapes: classification and insights on valuation. *Landscape Research*, Vol. 35, No. 4, p. 391–413.
61. **Harsema H., Cusveller Sj., Bijhouwer R., van Bolhuis P., van Keulen N., Meyer F.** (2000). *Landscaps architectuur en stedebouw in Nederland (Landscape Architecture and Town planning in the Netherlands)* Bussum, Thoth, p. 97–99.

62. **Harsema H., van der Bijl R., Mutsaers F.** (1991). *Landschap van wegen en kanalen – 75 jaar adviezen van de afdeling Verkeerswegen van het ministerie van LNV aan Rijkswaterstaat,* Utrecht. Wageningen : Veenman. 99 p.
63. **Hassan R., Hansen T. B., Nordh H.** (2014). Visualizations in the planning process. Rethinking comprehensive design: speculative counterculture. In: *Proceedings of the 19th International Conference on Computer–Aided Architectural Design Research in Asia*, CAADRIA, 2014, p. 65–74. March 1, 2018. [Accessed 14 May 2018]. Available at: https://www.scopus.com/inward/record.uri?eid=2-s2.0-84904600819&partnerID=40&md5=21a86c813a663032418e43da00eaf187.
64. **Haynes R., Jones A., Kennedy V., Harvey I., Jewell T.** (2007). District variations inroad curvature in England and Wales and their association with road-traffic crashes. *Environment and Planning*, Vol. A 39, No. 5, p. 1222–1237.
65. **Henningsson M., Blicharska M., Antonson H., Mikusiński G., Göransson G., Angelstam, P., Folkesnon L., Jönsson S.** (2015). Perceived landscape values and public participation in a road-planning process – a case study in Sweden. *Journal of Environmental Planning and Management*, Vol. 58, No. 4, p. 631–653.
66. Highways Agency (2007). *Assessing the Effect of Road Schemes on Historic Landscape Character*. Bristol: Halcrow Group Limited. 64 p.
67. **Hill J.D., Boyle L.N.** (2007). Driver stress as influenced by driving maneuvers and roadway conditions. *Transportation Research. Part F. Traffic Psychology and Behaviour*, Vol. 10, No. 3, p. 177–186.
68. **Horberry T., Edquist J.** (2009). Distractions outside the vehicle. In: Regan M.A., Lee J.D., Young K.K. (Eds.). *Driver Distraction: Theory, Effects and Mitigation*. USA: CRC Press, Press, FL, p. 215–227.
69. **Jaal Z., Abdullah J.** (2012). User's preferences of highway landscapes in Malaysia: A Review and analysis of the literature. *Procedia - Social and Behavioral Sciences*, Vol. 36, p. 265–272.
70. **Jacobsen J. K. S., Antonson H.** (2017). Motivational segments for trips along the high coast byway of Sweden: a study of local leisure excursions and domestic holidaymaking. *Scandinavian Journal of Hospitality and Tourism*, Vol. 17, No. 2, p.177–193.
71. **Jeļinskis P.** (2010). Achievements and development problems of Latvian national road safety programme for years 2007–2013. In: *Proceedings of 20th Canadian Multidisciplinary Road Safety Conference*, June 6-9, 2010, Niagara Falls, Ontario, p.12–13.
72. **Jiang L., Kang, J. Schroth, O.** (2015). Prediction of the visual impact of motorways using GIS. *Environmental Impact Assessment Review*, Vol. 55, p. 59–73.
73. **Jick T.D.** (1979). Mixing qualitative and quantitative methods: Triangulation in action. *Administrative Science Quarterly*, Vol. 24 p. 602–611.
74. Junta de Andalucia. (2009). *Roads in the Landscape. Criteria for their Planning, Layout and Project Design.* Conserejeria de Obras Publicas. 443 p. ISBN: 978-84-8095-559-1
75. **Kaplan R**. (1985). The analysis of perception via preference: A strategy for studying how the environment is experienced. *Landscape Planning*, Vol. 12, p. 161–176.
76. **Kaplan R., Kaplan S.** (1989). *The Experience of Nature: a Psychological Perspective*. Cambridge: Cambridge University Press. 340 p.
77. **Kearney A. R., Bradley G. A., Petrich C. H., Kaplan R., Kaplan S., Simpson-Colebank D.** (2008). Public perception as support for scenic quality regulation in a nationally treasured landscape. *Landscape and Urban Planning*, Vol. 87, No. 2, p. 117–128.
78. **Kelley W.** (2004). National scenic byways: diversity contributes to success. *Transportation Research Record*, Vol. 1880, p. 174–180.
79. **Kent R. L.** (1993). Determining scenic quality along highways: a cognitive approach.

Landscape and Urban Planning, Vol. 27, p. 29–45.
80. **Kļaviņš M., Nikodemus O., Segloņš V., Melecis V., Vircavs M., Āboliņa K**. (2008). *Vides zinātne.* Latvijas Universitāte, 454–477.lpp. ISBN 978-9984-825-09-4.
81. **Komlajeva L., Adamovics A.** (2012). Evaluation of flax (Linum usitatissimum L.) quality parameters for bioenergy production. In: *11th International Scientific Conference "Engineering for Rural Development"*: proceedings, Jelgava, Latvia, May 24-25, 2012 [elektroniskais resurss].Latvia University of Agriculture. Faculty of Engineering. Jelgava, p. 490-495.
82. **Kučan A.** (2007). Constructing Landscape Conceptions. *Journal of Landscape Architecture*, Vol. 2, No. 1, p. 30–41.
83. **Kwartler M.** (2005). Visualization in support of public participation. In: *Visualization in Landscape and Enviromental Planning: Technology and Applications*. I.D. Bishop, E. Lange (Eds.). London: Taylor & Francis, p. 251–260.
84. **Lange E.** (1990). Vista Management in Acadia National Park. *Landscape and Urban Planning*, Vol. 19, p. 353–376.
85. **Lange E.** (2001). The limits of realism: perceptions of virtual landscapes *Landscape and Urban Planning*, Vol. 54, p. 163–182.
86. **Lange E.** (2002). Visualization in landscape architecture and planning: Where we have been , where we are now and where we might go from here. *Landscape Architecture*, Vol. 1803, p. 1–11.
87. **Larsen J.K.** (2016). Curating views: the Norwegian tourist route project. In: Hvattum M., Larsen J. K., Brenna B., Elvebakk B. *Routes, Roads and Landscapes*. New York: Routledge, p. 191–201.
88. **Latkovskis P.** (2013). *Ainavu ekoloģiskā plānošana un tās metodoloģiskie risinājumi mozaīkveida ainavās*. Promocijas darbs. Rīga: LU. 156 lpp.
89. *Latvijas Lauksaimniecība* (2018). Agriculture of Latvia. Collection of Statistics. Central statistical bureau of Latvia. Riga. 65 p. ISBN 978-9984-06-521-2
90. Latvijas valsts standarts LVS 190-1:2000. *Ceļu projektēšanas noteikumi. Ceļa trase*. SIA Standartizācijas, akreditācijas un metroloģijas centrs, Standartizācijas birojs. 2000, 26.–40.lpp.
91. Latvijas valsts standarts LVS 190–2:2007. *Ceļu projektēšanas noteikumi. Normālprofili.* SIA Standartizācijas, akreditācijas un metroloģijas centrs, Standartizācijas birojs. Rīga: 2007, 19.-31. lpp.
92. **Lieplapa L.** (2013). *Autoceļu ietekmes uz vidi novērtējuma metodika*. Promocijas darbs. Rīga: RTU. 100 lpp.
93. **Likert R.** (1932) A Technique for the measurement of attitudes. *Archives of Psychology*, No. 14, 55 p.
94. **Lippold C., Dietze M., Krüger H.-P., Scheuchenpflug R.,** (2006). Einfluß der Straßenbepflanzung und Seitenraumgestaltung auf das Verhalten der Verkehrsteil-nehmer und auf die Sicherheit im Straßenverkehr. *Straße & Autobahn,* Vol. 11, S. 670–678.
95. **Lovett A., Appleton K., Warren-Kretzschmar B., Von Haaren C.** (2015). Using 3D visualization methods in landscape planning: An evaluation of options and practical issues. *Landscape and Urban Planning*, Vol. 142, p. 85–94.
96. **Lovett A., Appleton K.J., Jones A.P.** (2009). Using 3D visualization methods in landscape planning: An evaluation of options and practical issues. *Landscape and Urban Planning*, Vol. 142, p. 85–94.
97. **Lynch K.** (1965). The view from the road. *Economic Geography,* Vol. 42, No. 3, p. 276-277. DOI http://doi.org/10.2307/142014
98. **Marriott P. D.** (1998). *Saving Historic Roads. Design and Policy Guidelines*. New York: John Wiley and Sons. 240 p.
99. **Martín B., Arce R., Oter, I., Loro M.** (2018). Visual landscape quality as viewed from motorways in Spain. *Sustainability (Switzerland)*, Vol. 10, No. 8, p. 1–13.

100. **Martín B., Ortega E., Otero I., Arce R. M**. (2016). Landscape character assessment with GIS using map-based indicators and photographs in the relationship between landscape and roads. *Journal of Environmental Management*, Vol. 180, p. 324–334.
101. **Matijošaitienė I., Stankevičė I.** (2014). Road landscape as a product: does it satisfy consumers' aesthetic needs? *The Baltic Journal of Road and Bridge Engineering*, Vol. 9, No. 4, p. 297–305.
102. **Matijošaitienė I.** (2010). Identification of hedonomic road landscape in Lithuania. *Environmental Research, Engineering and Managemenet*, Vol. 4, No. 4, p. 72–78.
103. **Matijošaitienė I., Navickaitė K.** (2012). Aesthetics and safety of road landscape : are they related ? *Journal of Sustainable Architecture and Civil Engineering* Vol. 1, No. 1. p.20–25.
104. **Matijošaitienė I., Navickaitė K.** (2012). Aesthetics and safety of road landscape : are they related ?, Vol. 1, No. 1, p. 20–25.
105. **Matijošaitienė I., Navick K.** (2012). Aesthetics and safety of road landscape: are they related? *Journal of Sustainable Architecture and Civil Engineering*, Vol. 1, No. 1, p.20–25.
106. **Mauch C., Zeller T**. (2008). *The World Beyond the Windshield: Roads and Landscapes in the United States and Europe*. Ohio: University Press. 275 p.
107. **Melluma A.** (1994). Metamorphoses of Latvian landscapes during fifty years of Soviet rule. *GeoJournal*, Vol. 33, No. 1, p. 55–62.
108. **Melluma A., Leinerte M.** (1992). *Ainava un cilvēks*. Rīga: Avots. 176 lpp.
109. **Merriman P.** (2006). A new look at the English landscape: landscape architecture, movement and the aesthetics of motorways in early postwar Britain. *Cultural Geographies*, Vo. 13, No. 1, p. 78–105.
110. **Mitchell R., Hall C.M.,** (2006). Wine tourism research: the state of play. *Tourism Review International*, Vol. 9, No. 4, p. 307–332.
111. **Mok J.-H., Landphair H.C., Naderi J.R.** (2006). Landscape improvement on roadside safety in Texas. *Landscape and Urban Planning*, Vol. 78, p. 263–274.
112. **Mount N., Harvey G., Aplin P, Priestnall G.** (Eds.) (2009). *Representing, Modelling and Visualizing the Natural Environment*. Boca Raton, FL: CRC Press, p. 287–309.
113. **Mourant R. R., Rockwell T. H.** (1970). Mapping eye–movement patterns to the visual scene in driving: An exploratory study. *Human Factors: The Journal of Human Factors and Ergonomics Society*, Vol. 12, No. 1, p. 81–87.
114. **Murtha T., Golden C., Cyphers A., Klippel A., Flohr T.** (2018). Beyond inventory and mapping : LIDAR, landscape and digital landscape architecture. *Journal of Digital Landscape Architecture*, Vol. *3*, p. 249–259.
115. **Nassauer J.I.** (1983). Framing the landscape in photographic simulation. *Journal of Environmental Management*, Vol. 17, p. 1–16.
116. **Niedola I., Averjanovs D.** (2011). Transporta infrastruktūras attīstības nozīme teritorijas resursu izmantošanā. *Ilgtspējīga Telpiskā Attīstība*. Nr. 3, 20.–25. lpp. ISSN 1691-6174.
117. **Ņitavska N**. (2014). *Baltijas jūras piekrastes ainavu identitāte Latvijā*. Promocijas darbs. Jelgava: LLU. 216 lpp.
118. **Nitavska N., Zigmunde D**. (2017). Legislative framework for landscape planning in Latvia. In: *IOP Conference Series: Materials Science and Engineering*. - Vol. 245(6): 2rd World Multidisciplinary Civil Engineering - Architecture - Urban Planning Symposium WMCAUS 2017; Session 4: Theories and Methods in Civil Engineering and Architecture, BIM, Mathematical and Statistical Methods, Risk Management, Regional Planning, Sustainable Urban Development, Urban Sociology, Economics and Politics, GIS-Based Modelling and Planning, Computer Aided Design. Article number 062033.
119. **Norton B., Bending G., Clark R., Corstanje R., Dunnett N., EvansK., Grafius D., Gravestock E., Grice S., Harris J., Hilton S., Hoyle H., Lim E., Mercer T., Pawlett**

M., Pescott O., Richards P., Southon G., Warren P. (2019). Urban meadows as an alternative to short mown grassland: effects of composition and height on biodiversity. Ecological applications. *Ecological Society of America.* Accepted for publication 2019. doi: 10.1002/eap.1946. Article e01946

120. **Nye D. E**. (2016). Redefining the American sublime, from open road to interstate. In: Hvattum M., Larsen J. K., Brenna B., Elvebakk B. *Routes, Roads and Landscapes*. New York: Routledge, p. 99–113.
121. **Olwig K. R.** (2005). Liminality, seasonality and landscape. *Landscape Research,* Vol. 30, No. 2, p. 259–271.
122. **Oppenheim A.N.** (1992). *Questionnaire Design, Interviewing and Attitude Measurement.* 2nd ed. London: Printer. 303 p.
123. **Palmer J. F.** (2001). Whither scenic beauty? Visual landscape quality assessment in the 21st century. *Landscape and Urban Planning*, Vol. 54 (1–4), p. 267–281.
124. **Parsons R., Tassinary L. G., Ulrich R. S., Hebl M. R., Grossman-Alexander M.** (1998). The view from the road : implications for stress recovery. *Journal of Environmental Psychology*, Vol. 18, p. 113–139.
125. **Parsons R., Tassinary L.G., Ulrich R.S, Hebl M.R., Grossman-Alexander M.** (1998). The view from the road: implications for stress recovery and immunization. *Journal of Environmental Psychology*, Vol. 18, No. 2, p. 113–140.
126. **Penēze Z.** (2009). *Latvijas lauku ainavas izmaiņas 20. un 21. gadsimtā: cēloņi, procesi un tendences*. Promocijas darbs, Latvijas Universitāte. Rīga. 255 lpp. ISBN 978-9984-45-109-1
127. **Petraglia L., Weisbrod G.** (2001). *A Review of Impact Studies Related to Scenic Byway Designation*. National Scenic Byways Resource Center. University of Minnesota. Duluth. 45 p.
128. **Piek M., Sorel N., Middelkoop M.** (2011). Preserving panoramic views along motorways through policy. In: *Research in Urbanism Series*. Ed. by S. Nijhuis, R. Lammeren, F. Hoeven. Amsterdam, Netherlands: IOS Press BV, p. 261–277.
129. **Piek M., Sorel N., Middelkoop, van M. (** 2011) Preserving panoramic views along motorways through policy. In: Nijhuis E., Lammeren van R., Hoeven van den R. *Exploring the Visual Landscape*. Advances in physiognomic landscape research in the Netherlands. Research in urbanism series. Volume 2. IOS Press, p. 261–277.
130. **Poisa L., Adamovics A**. (2010). Hemp (Cannabis sativa L.) as an environmentally friendly energy plant. *Scientific Journal of Riga Technical University. Environmental and Climate Technologies*, Vol. 5, p. 80–85.
131. **Potoglou D., Maoh H., Wang Y., Orford S.** (2019). The Impact of Public Transport Infrastructure on Residential Land Value: Using Spatial Analysis to Uncover Policy-Relevant Processes. In: *The Practice of Spatial Analysis*. Ed. by H. Briassoulis, D. Kavroudakis, N. Soulakellis. Cham: Springer, p. 275–293.
132. **Pozuelo Meño I**. (2013). Networks and landscape in planning. Landscape and Infrastructures for Society. In: *Proceedings of 9th meeting of the Workshops of the Council of Europe for the implementation of the European Landscape Convention and Third International Congress on Landscape and infrastructures*, Cordoba, Spain, 15-16 April 2010. Council of Europe, p. 50-54.
133. **Pradines C.** (2009). *Road Infrastructures: Tree Avenues in the Landscape*. 5th Council of Europe Conference on the European Landscape Convention. 64 p. Available at: http://www.historicroads.org/documents/CEP-CDPATEP-2009-15-TreeAvenues_en.pdf, 9 March 2013.
134. **Prat F., Gras M. E., Planes M., Font-Mayolas S., Sullman M. J. M.** (2017). Driving distractions: An insight gained from roadside interviews on their prevalence and factors associated with driver distraction. *Transportation Research Part F: Traffic Psychology and Behaviour*, Vol. 45, p. 194–207.

135. *Projektēšanas un būvniecības vadlīnijas. Ūdens novade*. (2018). Latvijas Valsts ceļi, AS "Ceļuprojekts". Rīga. 135 lpp.
136. **Qin X., Meitner M. J., Chamberlaiz B. C., Zhang X., Centre F. S**. (2013). *Estimating Visual Quality of Scenic Highway using GIS and Landscape Visualizations*. 10 p.
137. **Raitz K.** (1998). American roads, roadside America. *Geographical Review,* Vol. 88, No. 3, p. 363–398.
138. **Ramírez Á., Ayuga-Téllez E., Gallego E., Fuentes J.M., García A.I.** (2011). A simplified model to assess landscape quality from rural roads in Spain. *Agriculture, Ecosystems and Environment*, Vol. 142, No. 3-4, p. 205–212.
139. **Reinfelde V.** (1972). Atpūtas vietu izbūve. *Autoceļi,* Nr. 1, 28.–31. lpp.
140. **Rekittke J., Paar P.** (2008). Real-time collage in landscape architecture. In: *Digital Design in Landscape Architecture 2008.* Ed. by E. Buhmann, M. Pietsch, M. Heins. Heidelberg: Wichmann, p. 88–95.
141. **Roth M.** (2006). Validating the use of internet survey techniques in visual landscape assessment – an empirical study from Germany. *Landscape and Urban Planning*, Vol. 78, No. 3, p. 179–192.
142. **Ruskule A., Nikodemus O., Kasparinska Z., Kasparinskis R., Brūmelis G**. (2012). Patterns of afforestation on abandoned agriculture land in Latvia. *Agroforestry Systems*, Vol. 85, No.2, p. 215–231.
143. **Russ P., Louis T., Roger U., Michelle H., Michele G.-A**. (1998). The view from the road: Implications for stress recovery and immunization. *Journal of Environmental Psychology*, Vol. 18, p. 113–139.
144. **Schroeder P., Meyers M., Kostyniuk L.** (2013). *National Survey on Distracted Driving Attitudes and Behaviors – 2012*. Report No. DOT HS 811 729. Washington, DC: National Highway Traffic Safety Administration. 194 p.
145. Schutt J. R., Phillips K. L., Landphair H. C. (2001). *Guidelines for Aesthetic Design in Highway Corridors: Tools and Treatments for Texas Highways College Station Texas*. Technical report. Texas Transportation Institute. 94 p.
146. **Seiler A.** (2005). Predicting locations of moose-vehicle collision in Sweden. *Journal of Applied Ecology*, Vol. 42, p. 371–382.
147. **Shearer A. W.** (2005). Approaching scenario-based studies: Three perceptions about the future and considerations for landscape planning. *Environment and Planning B: Planning and Design*, Vol. 32, No. 1, p. 67–87.
148. **Sheppard S. R. J.,** (2000). *Visualisation Software: Bringing GIS Applications to Life*. GEOEurope 2000, p. 28–30.
149. **Sieber S. D.** (2002). The integration of fieldwork and survey methods. *American Journal of Sociology*, Vol. 78, No. 6, p. 1335–1359.
150. **Silenieks, A.** (1930). Ka apstādāmi zemes ceļi. *Ceļš un Satiksme: neoficiālā daļa*, Nr. 1.
151. **Slēde E., Vikmanis E.** (1980). *Latvijas PSR autoceļu būves pieredze*. Rīga: Avots. 173 lpp.
152. **Smirnovs J.** (2008). *Transports un vide*. *Autoceļu labiekārtošana.* Rīga: RTU. 88 lpp.
153. **Smirnovs J., Naudžuns J., Lāma A.** (2007). Effectiveness of the 2000–2006 national road traffic safety programme implementation in Latvia. *The Baltic Journal of Road and Bridge Engineering*, Vol. 2, No.1, p. 13–20.
154. **Smith B. L., Smith W. L.** (1992). Scenic byways: their selection and designation. *Transportation Research Record*, No. 1363, p. 5–13.
155. **Spraggins H. B., Mitchell M. C.** (1996). Scenic byways planning. *Transportation Quarterly*, Vol. 50, No. 3, p. 95–112.
156. **Steinitz C.** (1990). Toward a sustainable landscape with high visual preference and high ecological integrity: the loop road in Acadia National Park, U.S.A. *Landscape and Urban Planning*, Vol. 19, No. 3, p. 213–250.

157. **Stūre I.** (2004). *Kultūras un dabas mantojuma aizsardzība un attīstības plānošana*. Rīga: LU Akadēmiskais apgāds. 194 lpp. ISBN 9984770451
158. **Sutton C. R.** (1947). Essential factors in the design of wayside areas. Highway research abstracts. *Highway Research Board,* No. 140, p. 20–21.
159. **Sviķis H., Andrejsons V.** (2013). *Latvijas zemes ceļi 1919-1940*. Rīga: Latvijas Valsts ceļi. 223 lpp. Latvijas ceļu nozarei 100. ISBN 978-9984-49-802-7
160. **Sviķis H., Andrejsons V.** (2016). *Latvijas zemes ceļi un autoceļi 1940-1990*. Rīga: Latvijas Valsts ceļi. 415 lpp. Latvijas ceļu nozarei 100. ISBN 978-9934-14-874-3
161. **Sviķis H., Andrejsons V.** (2018). *Latvijas autoceļi 1990–2019.* Rīga: Latvijas Valsts ceļi. 415 lpp. Latvijas ceļu nozarei 100. ISBN 978-9934-8807-0-4
162. **Swafield S.** (2017). Case studies. In: *Research in Landscape Architecture: Methods and Methodology.* Ed. by A. Brink, D. Bruns, H. Tobi, S. Bell. New York, NY: Routledge, p. 105–120.
163. **Taubenbergs F**. (1972). Autoceļu apstādījumi šodien un rīt. *Autoceļi,* Nr. 2, 15.-19.lpp.
164. **Theeuwes J.** (1998). Selfexplaining roads: subjective categorization of road environments. In: *Vision in Vehicles VI.* Ed. by A. Gale. Amsterdam: North Holland, p. 279–288.
165. **Theeuwes J., Horst van der R., Kuiken M.** (2012). Designing safe road systems : a human factors perspective. Ashgate Publishing 175.
166. **Tyrrell, T. J., Devitt, M. F.** 1999 Valuing changes to scenic byways. In: Pizam A., Mansfeld Y. (Eds.) *Consumer Behaviour in Travel and Tourism*. Binghamton, The Haworth Hospitality Press.
167. **Toorn M. Van Den.** (2006). *Design of infralandscapes. Towards a new space typology in landscape architecture*. Wageningen University and Research (WUR). 8 p.
168. **Toorn M. Van Den**. (2005). Design in a culture of mobility. Towards a new space typology in landscape architecture. In: *WSEAS International Conference on Environment, Ecosystems and Development,* Venice, Italy, November 2-4, p. 291–298.
169. *Transport and Main roads*. (2013). Road Landscape Manual. A Guide to the Planning, Design, Operation and Maintenance of Road Landscape Infrastructure. State of Queensland. 415 p.
170. *Transporta attīstības pamatnostādņu 2014. – 2020. gadam stratēģiskais ietekmes uz vidi novērtējums* (2013). Vides pārskats. Rīga, SIA Estonian, Latvian and Lithuanian Environment. 71 lpp.
171. **Tress B., Tress G.** (2003). Scenario visualisation for participatory landscape planning – a study from Denmark. *Landscape and Urban Planning*, Vol. 64, p.161–178.
172. **Tunnard C., Pushkarev B.** (1963). *Man-Made America: Chaos or Control*? An Inquiry into Selected Problems of Design in the Urbanized Landscape. 1st edition. Yale: Yale University Press. 479 p.
173. **Tveit M., Ode Å., Fry G.** (2006). Key concepts in a framework for analysing visual landscape character. *Landscape Research*, Vol. 31, No. 3, p. 229–255.
174. **Vahrenkamp R.** (2010). *The German Autobahn, 1920-1945: Hafraba Visions and Mega Projects.* BoD. 266 p.
175. Valsts ražošanas apvienība Latvijas autoceļi (1988). *Latvijas ceļu zaļā rota*. Teksta autors K. Kaugurs; sastādītāja R. Kārkliņa. Rīga: Valsts ražošanas apvienība "Latvijas autoceļi". 38 lpp.
176. **Veeneklaas F.R., Berg L.M van den** (1995). Scenario building: art, craft or just a fashionable whim? In: *Scenario Studies for the Rural Environment*. Ed. by J.F.T. Schoute, P.A. Finke, F.R Veeneklaas, H.P. Wolfert. Dodrecht: Kluwer Academic Publishers, p. 11–13.
177. Vermont Agency of Transportation (2000) *Vermont Byways Program*. Program manual. Mantpelier. Vermont. 18 p.

178. Vides aizsardzības un reģionālās attīstības ministrija. *Ainavu aizsardzība*. Nozares pārskats rajona plānojuma izstrādāšanai. Rīga: Jumava. 91 lpp. ISBN 9984-05-338-5
179. **Vouligny É., Domon G., Ruiz J.** (2009). An assessment of ordinary landscapes by an expert and by its residents: landscape values in areas of intensive agricultural use. *Land Use Policy*, Vol. 26, No. 4, p. 890-900.
180. **Vugule K.** (2013). The Latvian landscape as seen from the road. In: *Research for Rural Development 2013: Annual 19th International Scientific Conference Proceedings*, Vol. 2, p. 120–127.
181. **Vugule K., Bell S., Stokmane I**. (2014a). Road landscape development in Latvia up to the 21st century. *Landscape Architecture and Art*. Scientific journal of Latvia University of Agriculture. Jelgava: Latvia University of Agriculture, Vol. 4, No. 4, p. 10–16.
182. **Vugule K., Ieviņa D., Stokmane I.** (2014b). The road landscape in Latvian laws and regulations. *Landscape Architecture and Art*. Scientific journal of Latvia University of Agriculture. Jelgava: Latvia University of Agriculture, Vol. 5, No. 5, p. 102-108.
183. **Vugule K., Mengots A., Stokmane I.** (2018a). Road landscape modelling. *Research for Rural Development 2018: annual 24th International scientific conference proceedings.* Latvia University of Life Sciences and Technologies. Jelgava, Vol. 1, p. 163–168. ISSN 2255–923X.
184. **Vugule K., Stokmane I., Bell S., Ile U.** (2018b). Public participation in the road landscape planning. In: *Landscapes of Conflict: ECLAS Conference 2018:* book of proceedings. University College Ghent School of Arts, Landscape and Garden Architecture and Landscape Development. Ghent, p. 537–544. ISBN 9789491564130.
185. **Vugule K., Turlaja R.** (2016). Scenic roads in Latvia. *Research for Rural Development 2016: annual 22nd International Scientific Conference Proceedings*, Vol. 1, p. 182–188.
186. **Wang C., Quddus M. A., Iso, S. G.** (2013). The effect of traffic and road characteristics on road safety: A review and future research direction. *Safety Science*, Vol. 57, p. 264–275.
187. **Weber F., Kowarik I., Säumel I.** (2014). Urban forestry and urban greening a walk on the wild side. *Perceptions of Roadside Vegetation Beyond Trees*, Vol. 13, p. 205–212.
188. **Wherrett J. R.** (1999). Issues in using the internet as a medium for landscape preference research. *Landscape and Urban Planning*, Vol. 45, p. 209–217.
189. **Wherrett J. R.** (2000). Creating landscape preference models using internet survey techniques. *Landscape Research*, Vol. *25*, No. 1, p. 79–96.
190. **Williams K., Olsen M. J., Roe G. V., Glennie C.** (2013). Synthesis of transportation applications of mobile LIDAR. *Remote Sensing*, Vol. 5, p. 4652–4692.
191. **Wolf K. L.** (2003). Freeway roadside management: The urban forest beyond the white line. *Journal of Arboriculture*, Vol. 29, No. 3, p. 127–136.
192. **Wolf K. L.** (2006). Assessing public response to freeway roadsides. Urban Forestry and context-sensitive solutions. *Journal of the Transportation Research Board*, No. p.102–111.
193. **Xiao R.-M., Yun W.-G., Xu T.-B.** (2007). Driving safety on long-even-straight-line road on highland. *Journal of Chang'an University. Natural Science Edition,* Vol. 27, No. 3, p. 76–79. [Chinese with English abstract].
194. **Yin R. F.** *Applications of Case Study Research.* Thousand Oaks, CA: Sage Publications, 2011. 264 p.
195. **Zariņš A., Smirnovs J.** (2013). Ceļa telpiskā risinājuma uztveres novērtējums. No: *Vietējo resursu (zemes dzīļu, meža, pārtikas un transporta) ilgtspējīga izmantošana – jauni produkti un tehnoloģijas (NatRes).* Rakstu krājums 2010-2013. Rīga, 278.–282.lpp.
196. **Zeller T.** (2007). Driving Germany: *The Landscape of the German Autobahn, 1930-1970*. Washington: D.C. Berghahn books. 281 p.

197. **Zeller T.** (2016) Staging the Driving Experience: Parkways in Germany and the United States. In: *Routes, Roads and Landscapes*. Ed. by M. Hvattum, J. K. Larsen, B. Brenna, B. Elvebakk. New York: Routledge, p. 125–138.
198. **Zheng Y.-T., Yan S., Zha Z.-J., Li Y., Zhou X., Chua T.-S., Jain R**. (2013). GPSView. *ACM Transactions on Multimedia Computing, Communications, and Applications,* Vol. 9, No. 1, p. 1–18.
199. **Ziemelniece A.** (2011). The transformation processes and the protection of the rural cultural landscape. In: *The 5th International Scientific Conference "Rural Development 2011":* proceedings, 24–25 November, 2011, Kaunas: Akademija, Vol. 5, No. 2, p. 480–484.
200. **Ziemelniece A**. (2016). The preservation of the uniqueness of the cultural landscape in farmsteads of Zemgale. *Landscape Architecture and Art.* Scientific journal of Latvia University of Agriculture. Jelgava: Latvia University of Agriculture, Vol. 9, No. 9, p. 57–66.
201. **Zigmunde D.** (2010). Traditional rural landscape identity preservation as an integrative tool for new suburbs in Latvia. In: *Landscape Legacy: Landscape Architecture and Planning Between art and Science: International Conference*. Maastricht, the Netherlands, ISOMUL, CELA. Wageningen, p. 116–117.
202. **Zigmunde D., Jankevica M., Vugule K.** (2015). The influencing factors of landscape aesthetics in Latvian rural areas. In: *Nordic View to Sustainable Rural Development: Proceedings of the 25th NJF Congress.* Riga: NJF Latvia, p. 406–411.
203. **Zigmunde D., Nitavska N., Markova M., Rubene S**. (2015). Enhancing spatial perception ability by using landscape modelling approach. In: *ECLAS Conference 2015: Landscapes in Flux:* Book of Proceedings, Tartu, Estonia, September 20-23, 2015. Tartu: Estonian University of Life Sciences. Department of Landscape Architecture, p.31–34.
204. **Zigmunde D., Ņitavska N., Vugule K., Storie J., Katlapa A., Kalniņa A., Mengots A.** (2016). Landscape cognition. *Landscape Architecture and Art*. Scientific journal of Latvia University of Agriculture, Vol. 8, No. 8, p. 31–42.
205. **Zube E. H.** (1987). Perceived land use patterns and landscape values. *Landscape Ecology*, Vol. 1, No. 1, p. 37–45.
206. **Zube E. H., Simcox D. E., Law C. S.** (1987). Perceptual Landscape Simulations: History and Prospect. *Landscape Journal*, Vol. 6, No. 1, p. 62–80.
207. **Бабков Б. Ф.** (1980). *Ландшафтное проектирование автомобилъных дорог*. Москва: Транспорт. 189 с.
208. **Дзенис П. Я., Реинфелд В. Р.** (1968). *Пространнственное проектйрование автомобильных дорог* (Spatial planning of automobile roads). Москва. 109 с.
209. **Меллума А. Ж.** (1972). Опыт оценки пейзажной выразительности географических ландшафтов. In: *Охрана природы в Латвийской ССР.* Рига: Зинатне, с. 29-38.
210. **Орнатский Н.П.** (1986). *Благоустройство автомобильных дорог*. Москва: Транспорт. 136 с.

ELECTRONIC RESOURCES

211. Ainavas runā. Projekts "Ainavas runā. Dabas daudzveidība Latvijas ainavās". Latvijas Dabas fonds [online] [cited 01.05.2019.]. Available: https://www.ainavasruna.lv/
212. *Ainavu politikas pamatnostādnes 2013.-2019. gadam* [online] [cited 14.05.2019.]. Available: http://polsis.mk.gov.lv/view.do?id=4427
213. *Aizsargājamo ainavu apvidus "Ziemeļgauja" individuālie aizsardzības un izmantošanas noteikumi*: LR Ministru kabineta noteikumi Nr. 957. Pieņemts 20.11.2008. Stājas spēkā 27.11.2008. [cited 14.05.2019.]. Available: http://likumi.lv/doc.php?id=184294

214. *Aizsargjoslu likums*: LR likums. Pieņemts 05.02.1997. Stājas spēkā 11.03.1997. [online] [cited 21.03.2019.]. Available: http://likumi.lv/doc.php?id=42348
215. **Akalin K. B., Bilgic S., Kara C.** (2016). *Visual Landscape Assessments in Road Project* [online] [cited 21.03.2019.]. Available: http://www.researchgate.net/publication/311468451
216. *America`s Byways.* U.S. Department of Transportation, Federal highway administration [online] [cited 21.03.2019.]. Available: http://www.fhwa.dot.gov/byways/
217. *Autoceļu aizsargjoslu noteikšanas metodika*: LR MK noteikumi Nr. 162. Pieņemts 10.04.2001. Stājas spēkā 19.04.2001. [online] [cited 21.03.2019.]. Available: http://likumi.lv/doc.php?id=7166
218. *Autoceļu jomas raksturojums*. LR Satiksmes ministrija [online] [cited 21.03.2019.]. Available: http://www.sam.gov.lv/satmin/content/?cat=89
219. *Autoceļu un ielu būvnoteikumi*: LR MK noteikumi Nr. 633. Pieņemts 14.10.2014. Stājas spēkā 25.10.2014. [online] [cited 21.03.2019.]. Available: http://likumi.lv/doc.php?id=269710
220. **Bishop I. D.** *Visualization for Participation: The Advantages of Real-Time?* [online] [cited 02.05.2019.]. Available: http://193.25.34.143/landschaftsinformatik-4.2.6/fileadmin/user_upload/_temp_/2005/2005_Beitraege/001/2005-001.pdf
221. Būvniecības likums: LR likums. Pieņemts 09.07.2013. Stājas spēkā 01.10.2014. [online] [cited 14.05.2019.]. Available: http://likumi.lv/doc.php?id=258572
222. **Carter T.** (2017). *10 must-see landmarks on Norway's scenic tourist trails*. Dezeen Magazine. [online] [cited 14.05.2019.]. Available: https://www.dezeen.com/2017/08/11/norwegian-tourist-routes-architecture-landmark-roundup-peter-zumthor/
223. *Ceļu projektēšanas noteikumi*. Latvijas Valsts standarts. [online] [cited 14.05.2019.]. Available: http://www.lvs.lv/lv/services/catalogue/standardListByICS.asp?ics=426
224. *Ceļu satiksmes drošības programma 2007.–2013. LR* Satiksmes ministrija. [online] [[cited 14.05.2019.]. Available: http://www.who.int/roadsafety/decade_of_action/plan/latvia.pdf
225. *Dabas aizsardzības pārvaldes dabas datu pārvaldības sistēma Ozols*. [online] [cited 14.05.2019.]. Available: http://ozols.daba.gov.lv/pub/
226. Department of Transport and Main Roads State of Queensland. *Road Landscape Manual*. Second Edition. [online] [cited 14.05.2019.]. Available: https://www.tmr.qld.gov.au/page-not-found.aspx
227. Dienas Bizness. *Ādažiem top jauns centrs*. 2017. [online] [cited 14.05.2019.]. http://www.db.lv/atteli/article/0047/460943/2103856_ORIGINAL_1489485093.jpg?source=/galerija/460943).
228. *Eiropas ainavu konvencija*. Florence 2000. gada 20. oktobris. [online] [cited 14.05.2019.]. Available: http://likumi.lv/doc.php?id=220778
229. *European Landscape Convenction*. Council of Europe, Florence, 2000. [online] [27.03.2019.]. Available: http://www.coe.int/en/web/conventions/full-list/-/conventions/rms/0900001680080621
230. Federal Highway Administration. *Flexibility in Highway Design*. 2001. Department of Transportation, U.S.. 205 p. [online] [cited 14.05.2019.]. Available: http://www.fhwa.dot.gov/environment/publications/flexibility/ch03.cfm
231. *Gaujas nacionālā parka likums*: LR likums. Pieņemts 30.04.2009. Stājas spēkā 03.06.2009. [online] [cited 14.05.2019.]. Available: http://likumi.lv/doc.php?id=192075
232. *Grīņu dabas rezervāta likums*: LR likum. Pieņemts 16.03.2000. Stājas spēkā 19.04.2000. [online] [cited 14.05.2019.]. Available: http://m.likumi.lv/doc.php?id=3989
233. *Guide to Landscape Treatments for National Road Schemes in Ireland*. National Roads Authority [online] [cited 14.05.2019.]. Available: http://www.nra.ie/Publications/DownloadableDocumentation/Environment/file,3481,en.pdf
234. **Heath N., Bevis G.** *Why are England's roadsides blooming*? BBC News. 02.07.2019.

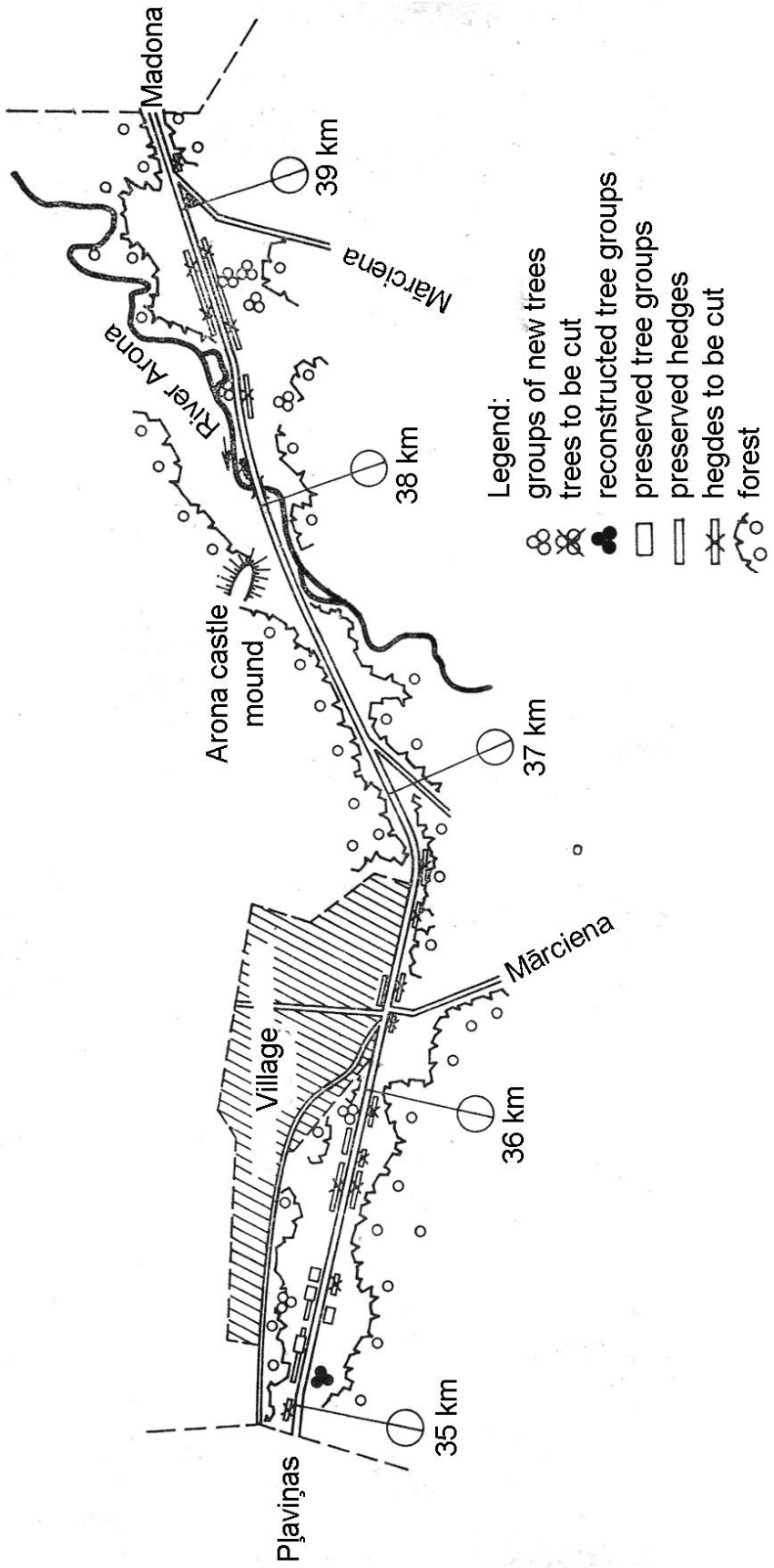
[online] [cited 03.07.2019]. Available: https://www.bbc.com/news/uk-england-48772448?SThisFB&fbclid=IwAR1l2BXrt7qlYIwzJpUNxy6Z6TqfhrCFIOFnZvRPYQj1tZECxEwFCef6mxI
235. *Iedzīvotāju skaits, tā izmaiņas un blīvums*. LR Centrālā statistikas pārvalde. [online] [cited 01.06.2019.]. Available: https://www.csb.gov.lv/lv/statistika/statistikas-temas/iedzivotaji/iedzivotaju-skaits/galvenie-raditaji/iedzivotaju-skaits-ta-izmainas-un-livums
236. *Intrinsic Qualities for Byways Designation*. Scenic America [online] [cited 04.05.2019.]. Available: http://www.scenic.org/issues/scenic-byways/intrinsic-qualities-for-byways-designation
237. *Kārtība, kādā novērtē paredzētās darbības ietekmi uz vidi un akceptē paredzēto darbību*: LR MK Nr.18. Pieņemts 13.01.2015. Stājas spēkā 22.01.2015. [online] [cited 14.05.2019.]. Available: https://likumi.lv/doc.php?id=271684
238. Ķemeru nacionālā parka likums: LR likums. Pieņemts 30.05.2001. Stājas spēkā 03.07.2001. [online] [cited 14.05.2019.]. Available: http://likumi.lv/doc.php?id=25409
239. *Latvian Tourism marketing Strategy 2010–2015* [online] [cited 14.05.2019.]. Available: http://www.tava.gov.lv/sites/tava.gov.lv/files/dokumenti/strategiskie-dokumenti/Latvian-tourism-marketing-strategy-2010-2015.pdf
240. *Latvijas ilgtspējīgas attīstības stratēģija līdz 2030. gadam*. Latvijas Republikas Saeima, 2010. [online] [cited 14.05.2019.]. Available: http://www.latvija2030.lv/upload/latvija2030_saeima.pdf
241. *Latvijas meža politika*, 1998. LR Zemkopības ministrija [online] [cited 14.05.2019.]. Available: https://www.zm.gov.lv/mezi/statiskas-lapas/nozares-strategijas-politikas-dokumenti/latvijas-meza-politika?nid=328#jump
242. *Lauksaimniecības un lauku attīstības likums*: LR likums. Pieņemts 07.04.2004. Stājas spēkā 24.04.2004. [online] [cited 14.05.2019.]. Available: http://likumi.lv/doc.php?id=87480
243. *Lauku attīstības programma 2014-2020*. LR Lauku atbalsta dienests [online] [cited 14.05.2019.]. Available: http://www.lad.gov.lv/lv/atbalsta-veidi/projekti-un-investicijas/lap-investiciju-pasakumi/
244. Lauku Ceļotājs. *Latvijas valstiskuma veidošanās ceļi* [online] [cited 21.03.2019.]. Available: http://www.celotajs.lv/lv/p/files/LV100_Karte?12
245. Lietošanas noteikumi un privātuma politika. Visidati.lv, 2019 [online] [cited 21.03.2019.]. Available: https://www.visidati.lv/privacy/
246. *Life Viva Grass integrētais plānošanas rīks* [online] [cited 14.05.2019.]. Available: https://vgrass.hnit-baltic.lt/vgsites/vgviewer/
247. **Litvins G., Markovskis K., Renner E., Statkus S.** *Sabiedrības līdzdalība teritorijas plānošanas un būvniecības jautājumos* 2008. Sabiedriskās politikas centrs "Providus" [online] [cited 14.05.2019.]. Available: http:// http://providus.lv /article_files/1780/original/Lidzdalib_MAKETS1(1).pdf?1332860156
248. *Lumion 8: 3D rendering software for architects* [online] [cited 14.05.2019.]. Available: http://lumion.com/product.html
249. *Meliorācijas sistēmas ekspluatācijas un uzturēšanas noteikumi*: LR MK noteikumi Nr.714. Pieņemts 03.08.2010. Stājas spēkā 07.08.2010. [online] [cited 04.02.2019]. Available: http://likumi.lv/doc.php?id=214609
250. *Melno punktu karte, 2014.-2016. gads*. Latvijas Valsts ceļi [online] [cited 05.04.2019.]. Available: https://lvceli.lv/informacija-un-dati__trashed/#melno-punktu-karte
251. *Meža likums*: LR likums. Pieņemts 24.02.2000. Stājas spēkā 17.03.2000. [online] [cited 07.05.2019.]. Available: http://likumi.lv/doc.php?id=2825
252. Ministère de la Culture et de la Communication. *The cave of Chauvet-Pont-d'Arc, 2002* [online] [cited 09.04.2019]. Available: http://www.culture.fr/culture/arcnat/chauvet/en/index.html

253. *Noteikumi par aizsargājamām alejām* (Regulations about protected tree avenues): LR MK noteikumi Nr. 888. Pieņemts 22.11.2005. Stājas spēkā 09.12.2005. [online] [cited 14.05.2019.]. Available: http://m.likumi.lv/doc.php?id=123129 (In Latvian)
254. *Noteikumi par koku ciršanu ārpus meža*: LR MK noteikumi Nr. 309. Pieņemts 02.05.2012. Stājas spēkā 09.05.2012. [online] [cited 14.05.2019.]. Available: https://likumi.lv/ doc.php?id=247350
255. *Noteikumi par koku ciršanu mežā*: LR MK noteikumi Nr. 935. Pieņemts 18.12.2012. Stājas spēkā 01.01.2013. [online] [cited 14.05.2019.]. Available: https://likumi.lv/ doc.php?id=253760
256. *Noteikumi par Latvijas būvnormatīvu LBN 223-15 "Kanalizācijas būves*": LR MK noteikumi Nr. 327. Pieņemts 30.06.2015. Stājas spēkā 01.07.2015. [online] [cited 12.03.2019.]. Available: https://likumi.lv/ta/id/274990
257. *Noteikumi par Latvijas būvnormatīvu LBN 224-15 "Meliorācijas sistēmas un hidrotehniskās būves"*: LR MK noteikumi 329. Pieņemts 30.06.2015. Stājas spēkā 01.07.2015. [online] [cited 12.03.2019.].
258. *Noteikumi par reklāmas objektu vai informācijas objektu izvietošanu gar ceļiem, kā arī kārtību, kādā saskaņojama reklāmas objektu vai informācijas objektu izvietošanai* (Regulation about placement of advertisements and information along the roads and order for advertisement coordination or information object placement): LR MK noteikumi Nr. 402. Pieņemts 07.06.2005. Stājas spēkā 11.06.2005. [online] [cited 14.05.2019.]. Available: http://www.likumi.lv/doc.php?id=110209
259. *Noteikumi par valsts un pašvaldību autoceļu ikdienas uzturēšanas prasībām un to izpildes kontroli*: LR Ministru kabineta noteikumi Nr.224. Pieņemts 09.03.2010. Stājas spēkā 13.03.2010. [online] [cited 12.03.2019.]. Available: http://m.likumi.lv/doc.php?id=206467
260. *Par autoceļiem*: LR likums. Pieņemts 11.12.1997. Stājas spēkā 13.01.1998. [online] [cited 12.03.2019.]. Available: https://likumi.lv/doc.php?id=65363
261. *Par autoceļiem*: LR likums. Pieņemts 11.03.1992. Stājas spēkā 02.04.1992. [online] [cited 14.05.2019.]. Available: http://likumi.lv/doc.php?id=65363
262. *Par ceļu satiksmes drošības plānu 2017.-2020. gadam*: Ministru kabineta rīkojums Nr. 180. Pieņemts 04.04.2017. Stājas spēkā 04.04.2017. [online] [cited 12.03.2019.]. Available: https://likumi.lv/ta/id/289986-par-celu-satiksmes-drosibas-planu-2017-2020-gadam
263. *Par Eiropas ainavu konvenciju*: LR likums. Pieņemts 29.03.2007. Stājas spēkā 19.04.2007. [online] [cited 14.05.2019.]. Available: http://www.likumi.lv/doc.php?id=156001
264. *Par ietekmes uz vidi novērtējumu*: LR likums.. Pieņemts 14.10.1998. Stājas spēkā 13.11.1998. [online] [cited 14.05.2019.]. Available: http://likumi.lv/doc.php?id=51522
265. *Par īpaši aizsargājamām dabas teritorijām*: LR likums. Pieņemts 02.03.1993. Stājas spēkā 07.04.1993. [online] [cited 14.05.2019.]. Available: http://m.likumi.lv/ doc.php?id=59994
266. *Par Ziemeļvidzemes biosfēras rezervātu*: LR likums Pieņemts: 11.12.1997. Stājas spēkā: 13.01.1998. [online] [cited 14.05.2019.]. Available: http://likumi.lv/doc.php?id=52952
267. *Platību maksājumi* [online] [cited 14.05.2019.]. Available: http://www.lad.gov.lv/lv/atbalsta-veidi/platibu-maksajumi/zalinasana
268. *Pļavas un ganības* (Meadows and pastures) [online]. Latvijas Republikas Centrālā statistikas pārvalde. [cited 14.05.2019.]. [Available: http://data.csb.gov.lv/ Dialog/Saveshow.asp
269. *Rāznas nacionālā parka likums*: LR likums. Pieņemts 02.11.2006. Stājas spēkā 01.01.2007. [online] [cited 14.05.2019.]. Available: http://likumi.lv/doc.php?id=147908

270. *Rīgas rajona Siguldas novada teritorijas plānojums 2008-2020* (Territorial plan of Sigulda novads Riga region 2008-2020). Siguldas novada dome. [online] [cited 14.05.2019.]. Available: http://www.rpr.gov.lv/uploads/filedir/Ter_plaanojumi/Novadi%20un%20pagasti/Sigulda/TIAN.pdf, 9 March 2013. (In Latvian)
271. *Saistošie noteikumi "Par kārtību, kādā noformējamas un izvietojamas ielu un nekustamo īpašumu nosaukumu/norāžu zīmes, ēku numuru vai nosaukumu plāksnes, daudzdzīvokļu dzīvojamās mājās (telpu grupu) informācijas zīmes Iecavas novadā".* [online] [cited 14.05.2019.]. Available: http://www.iecava.lv
272. *Satiksmes intensitāte*. 2008. Latvijas Valsts ceļi. [online] [cited 01.04.2019.]. Available: http:///wp-content/uploads/2019/01/Satiksmes-intensit%C4%81te-2008-2018-1.xlsx
273. Satiksmes ministrija LR. *Transporta attīstības pamatnostādnes 2014-2020.gadam.* Rīga. 2013. [online] [cited 14.05.2019.]. Available: http://www.mk.gov.lv/lv/mk/tap/?pid=40282105&mode=mk&date=2013-12-17
274. *Slīteres nacionālā parka likums*: LR likums. Pieņemts 22.01.2015. Stājas spēkā 25.02.2015. [online] [cited 14.05.2019.]. Available: http://likumi.lv/doc.php?id=3992
275. Sugu un biotopu aizsardzība likums: LR likums. Pieņemts: 16.03.2000. Stājas spēkā 19.04.2000. [online] [cited 14.05.2019.]. Available: http://likumi.lv/doc.php?id=3941
276. *Teiču dabas rezervāta likums*: LR likums. Pieņemts 15.05.2008. Stājas spēkā 05.06.2008. [online] [cited 14.05.2019.]. Available: http://likumi.lv/doc.php?id=176245
277. *Teritorijas attīstības plānošanas likums*: LR likums. Pieņemts 13.10.2011. Stājas spēkā 01.12.2011. [online] [cited 14.05.2019.]. Available: http://likumi.lv/doc.php?id=238807
278. *The National Roads Authority. A Guide to Landscape Treatments for National Road Schemes in Ireland, 2005.* [online] [cited 01.05.2019.]. Available: http://www.nra.ie/environment/environmental-planning-guidelines/Guide-to-Landscape-Treatments-for-National-Road-Schemes.pdf
279. *Tranpsorta attīstības pamatnostādnes 2014.–2020. gadam*. LR Satiksmes ministrija. Rīga. [online] [cited 14.05.2019.]. Available: http://polsis.mk.gov.lv/view.do?id=4607
280. Transport Scotland. *Road Furniture in the Countryside: Guidance for Road and Planning Authorities and Statutory Undertakers*. Edinburgh, 2006. [online] [cited 14.05.2019.]. Available: http://www.transportscotland.gov.uk/guides/j7538-00.htm
281. *Trends in Real-Time Landscape Visualization and Participation*, p. 16–26. [online] [cited 01.03.2018.]. Available: http://www.hs-anhalt.de/CONTENT/la/mla_fl/conf/html/public/conf2005.htm
282. *Tūrisma likums*: LR likums. Pieņemts: 17.09.1998. Stājas spēkā: 01.01.1999. [online] [cited 14.05.2019.]. Available: http://likumi.lv/doc.php?id=50026
283. *Tūrisms – Galvenie rādītāji. 2013*. (Tourism – Main indices). Latvijas Republikas Centrālā statistikas pārvalde. [online] [cited 03.03.2013.]. Available: http://www.csb.gov.lv/statistikas-temas/turisms-galvenie-raditaji-30322.html. (In Latvian)
284. *Ūdens apsaimniekošanas likums*: LR likums. Pieņemts 12.09.2002. Stājas spēkā 15.10.2002. online] [cited 27.10.2014.]. Available: http://likumi.lv/doc.php?id=66885
285. *Valsts autoceļu tīkla saglabāšanas un attīstības programma 2000-2015* (State road maintenance and development program 2000-2015). LR Satiksmes ministrija. [online] [cited 14.05.2019.]. Available: http://lvceli.lv/files/Publicejama%20projektu%20dokumentacija/Valsts%20autocelu%20tikla%20saglabasanas%20un%20attistibas%20programma_2000_2015%20gads_2.pdf, 9 March 2013. (In Latvian)
286. *Vides aizsardzības likums*: LR likums Pieņemts 02.11.2006. Stājas spēkā 29.11.2006. [online] [cited 14.05.2019.]. Available: http://likumi.lv/doc.php?id=147917
287. *Vispārīgie būvnoteikumi:* LR MK noteikumi Nr.500. Pieņemts 19.08.2014. Stājas spēkā 01.10.2014. [online] [cited 14.05.2019.]. Available: http://likumi.lv/doc.php?id=269069

288. *Vispārīgie teritorijas plānošanas, izmantošanas un apbūves noteikumi:* LR MK noteikumi Nr.240. Pieņemts 30.04.2013. Stājas spēkā 22.05.2013. [online] [cited 14.05.2019.]. Available: https://likumi.lv/doc.php?id=256866
289. *Zemes ierīcības likums*: LR likums. Pieņemts 14.09.2006. Stājas spēkā 01.01.2007. [online] [cited 14.05.2019.]. Available: http://likumi.lv/doc.php?id=144787
290. *Ziemeļvidzemes biosfēras rezervāta individuālie aizsardzības un izmantošanas noteikumi*: LR MK noteikumi. Pieņemts 19.04.2011. Stājas spēkā 11.05.2011. [online] [cited 14.05.2019.]. Available: http://likumi.lv/doc.php?id=229252

ANNEXES



The reconstruction project for the Arona river valley landscape in a section of road Pļaviņas – Madona- Gulbene

Slēde E., Vikmanis E. Latvijas PSR autoceļu būves pieredze. Rīga: Avots, 1980, p. 173

Annex 2

Requirements regarding the maintenance of State and local government motorways

No.	Requirements	Maintenance class			
		A	B	C	D
		Acceptable parameters			
1.	No washouts or landslides are permitted within the range of motorway roadbed. Deficiencies found must be eliminated	yes	yes	yes	yes
	Washouts and landslides deeper than 50 cm must be filled up or filled in	within 1 week	within 2 weeks	within 1 month	within 6 weeks
2.	Long-term accumulation of water of more than 20 cm under the motorway surface structure is not permitted in the side ditches of motorways. Deficiencies found must be eliminated	yes	yes	yes	yes
	Side ditches must be cleaned from blockages	within 1 week	within 2 weeks	within 1 month	within 2 months
3.	Shrubs growing within the range of motorway roadbed must be cut off	once a year	once a year	no requirements	no requirements
4.	The visibility of motorways, road signs or intersections stipulated in legislative enactments is ensured by cutting down the troublesome shrubs or tree branches. Deficiencies found must be eliminated	within 3 days	within 1 week	within 1 month	within 1.5 months
5.	Grass growing on the motorway shoulder and the adjacent slope within the width of 1.0–1.5 m, as well as on the dividing lane, which is narrower than 12 m, must be mowed during the vegetation period	2 times	1 time	1 time	no requirements
6.	No broken or damaged equipment is permitted in recreational areas. The equipment damaged must be repaired or removed	within 2 weeks	within 1 month	–	–
7.	In recreational areas, stairways must have secured railings. Steps must be durable and without damages. If deficiencies have been detected, warning signs must be immediately affixed and the stairway must be marked off	yes	yes	–	–
	Defective elements must be replaced	within 2 weeks	within 1 month		

End of Annex 2

Maintenance classes for State motorways

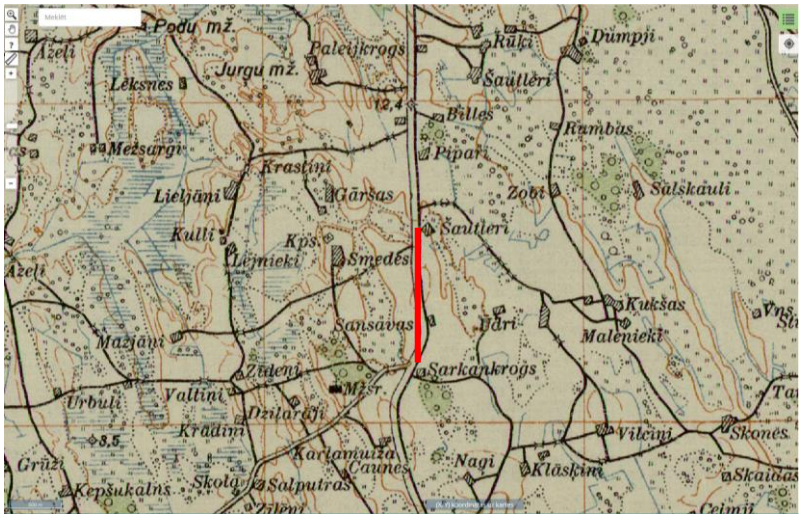
The average vehicle traffic intensity (number of vehicles per day)	Main motorways	Regional motorways	Local motorways
more than 5000	A	A	–
from 1000 to 5000	A1	A1	A1
from 500 to 999	A1	B	B
from 100 to 499	–	C	C
less than 100	–	–	D

Maintenance classes for local government motorways

The average vehicle traffic intensity (number of vehicles per day)	Local government motorways
more than 5000	A
from 1000 to 5000	A1
from 500 to 999	B
from 100 to 499	C
less than 100	D

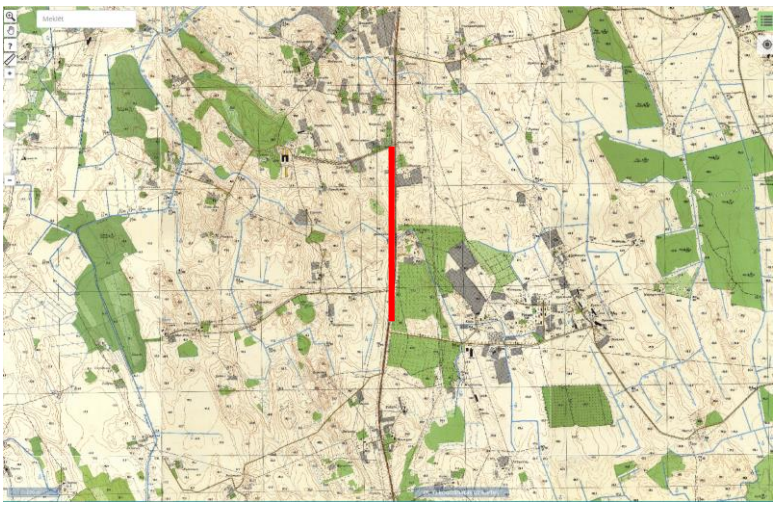
Noteikumi par valsts un pašvaldību autoceļu ikdienas uzturēšanas prasībām un to izpildes kontroli [online] [cited 14.05.2019.]. Available: http://m.likumi.lv/doc.php?id=206467

Historic maps of first case area. Section of the road A7 in Iecava regional community



Section of the case area marked with red line.

Latvia 1:75 000 – topographic map of Latvian army, territory of Latvia in the beginning of 20th century (1924-1935). [online] [cited 14.05.2019.]. Available:https://topografija.lv

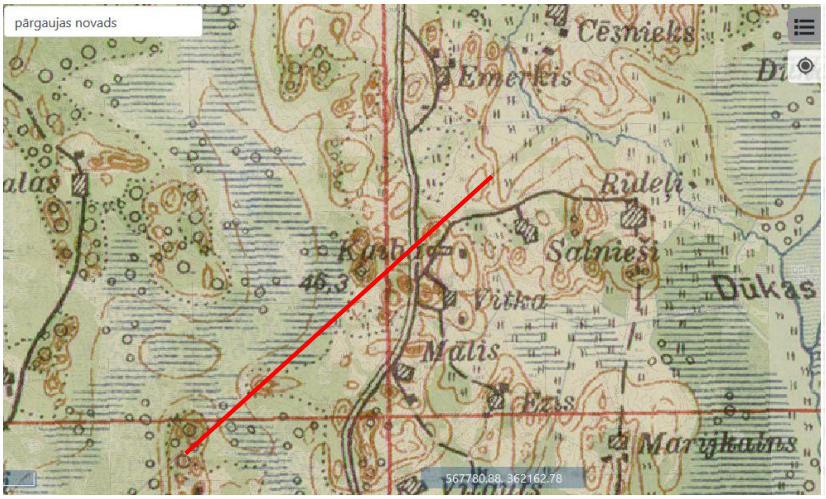


1:500 USSR - M1:500 to M1:2000 topographic plans of Soviet time and other highly detailed topographic materials (1940-1990). [online] [cited 14.05.2019.]. Available: https://topografija.lv

LĢIA satellite map 2001-2002. [online] [cited 14.05.2019.]. Available: https://topografija.lv

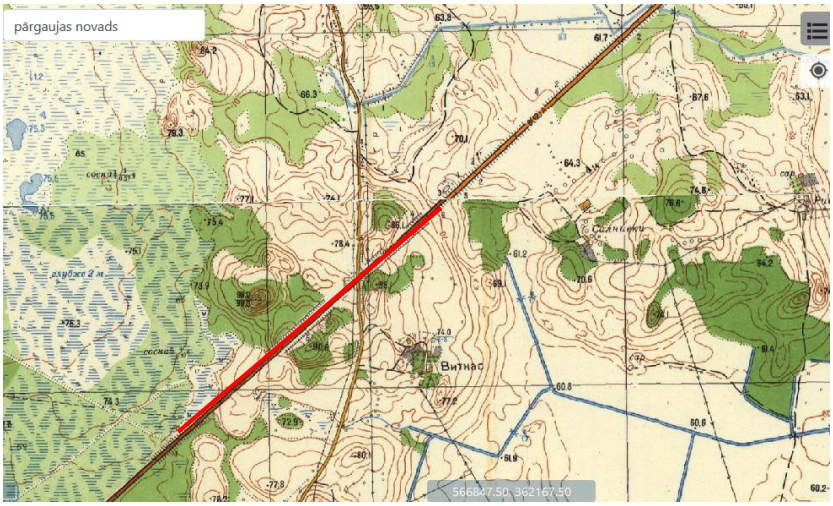

Agriculture landscape 1.case 1.scenario in Iecava regional community
to Rīga
to Bauska
N
0 10 20 40m

Historic maps of first case area. Section of the road A3 in Kocēni regional community

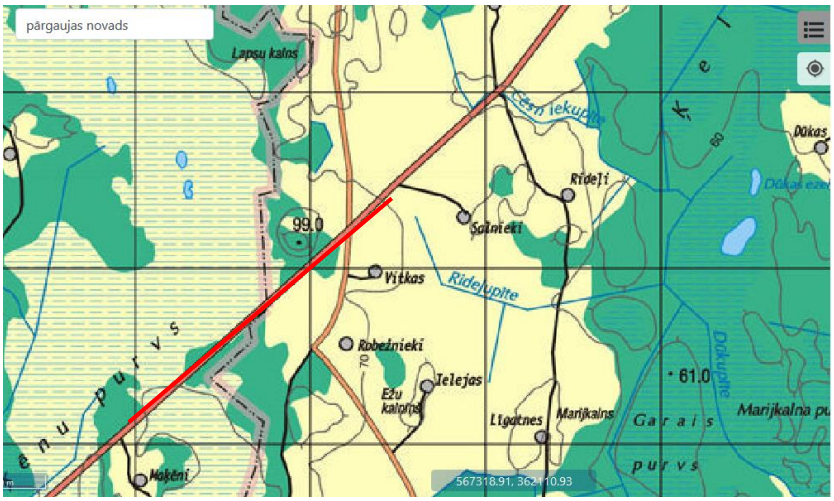


Section of the case area marked with red line.

Latvia 1:75 000 – topographic map of Latvian army, territory of Latvia in the beginning of 20th century (1924-1935). [online] [cited 14.05.2019.]. Available:https://topografija.lv



1:500 USSR - M1:500 to M1:2000 topographic plans of Soviet time and other highly detailed topographic materials (1940-1990). [online] [cited 14.05.2019.]. Available: https://topografija.lv



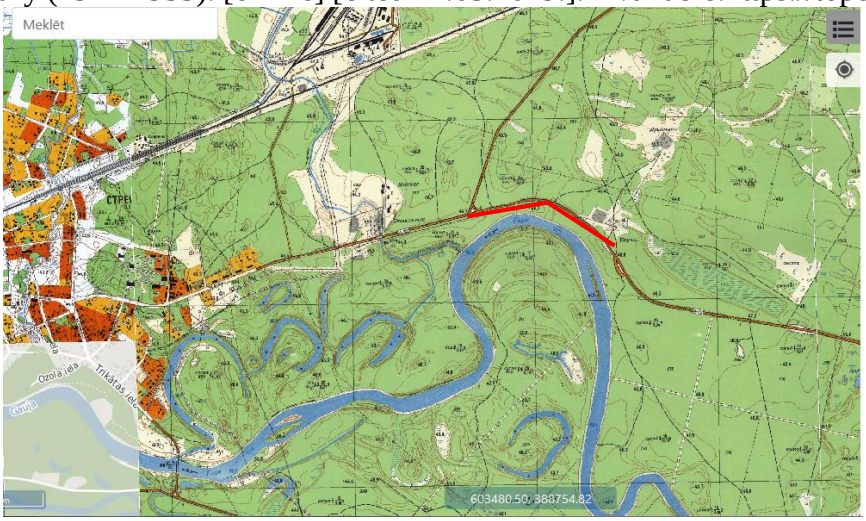
LĢIA satellite map 2001-2002. [online] [cited 14.05.2019.]. Available: https://topografija.lv

Mosaic landscape 2.case 1.scenario in Kocēni regional community
to Valmiera
to Rīga
0 10 20 40m

Historic maps of first case area. Section of the road A3 in Strenči regional community

Section of the case area marked with red line.

Latvia 1:75 000 – topographic map of Latvian army, territory of Latvia in the beginning of 20th century (1924-1935). [online] [cited 14.05.2019.]. Available:https://topografija.lv



1:500 USSR - M1:500 to M1:2000 topographic plans of Soviet time and other highly detailed topographic materials (1940-1990). [online] [cited 14.05.2019.]. Available: https://topografija.lv

LĢIA satellite map 2001-2002. [online] [cited 14.05.2019.]. Available: https://topografija.lv


Forest landscape 3.case 1.scenario in Strenči regional community
to Valka
N
0 10 20 40m
to Valmiera

Annex 8

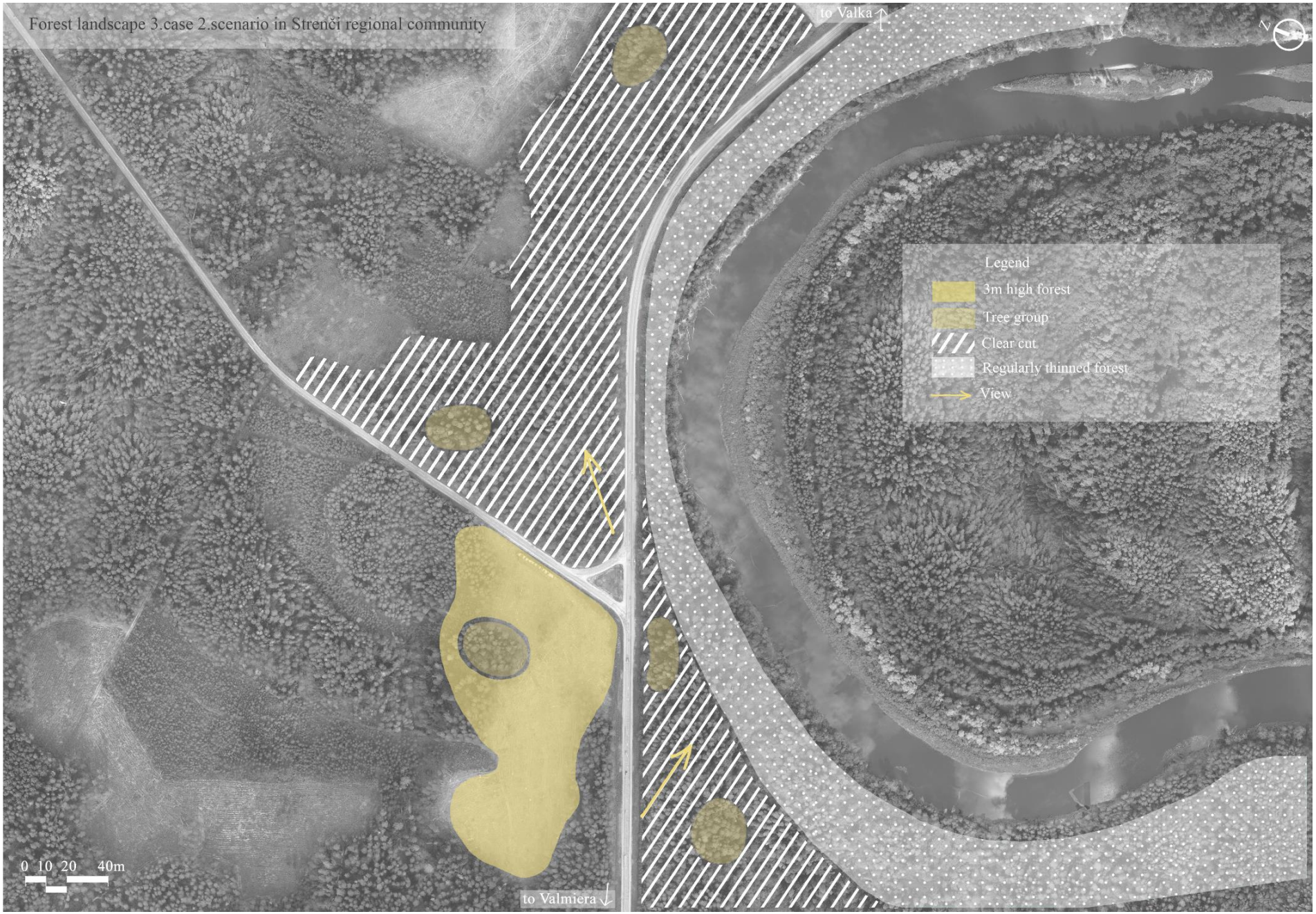
Agriculture landscape 1.case 2.scenario in Iecava regional community
to Riga
to Bauska
Legend
Apple garden
Corn field
Wind break for a farmtead
Bus stop
Shrubs and small trees to be remoeved
Row of old willow trees to be remoeved
Sign with house name
Distant open view
N
0 10 20 40m


Agriculture landscape 1.case 3.scenario in Iecava regional community
to Rīga
to Bauska
Z
Legend
Group of trees and decorative shrubs
Road side edge with wild flowers and grass
Row of old willow trees
Bus stop
Electricity line to be removed
Shrubs and small trees to be removed
Information sign
Sign with house name
Distant open view
0 10 20 40m

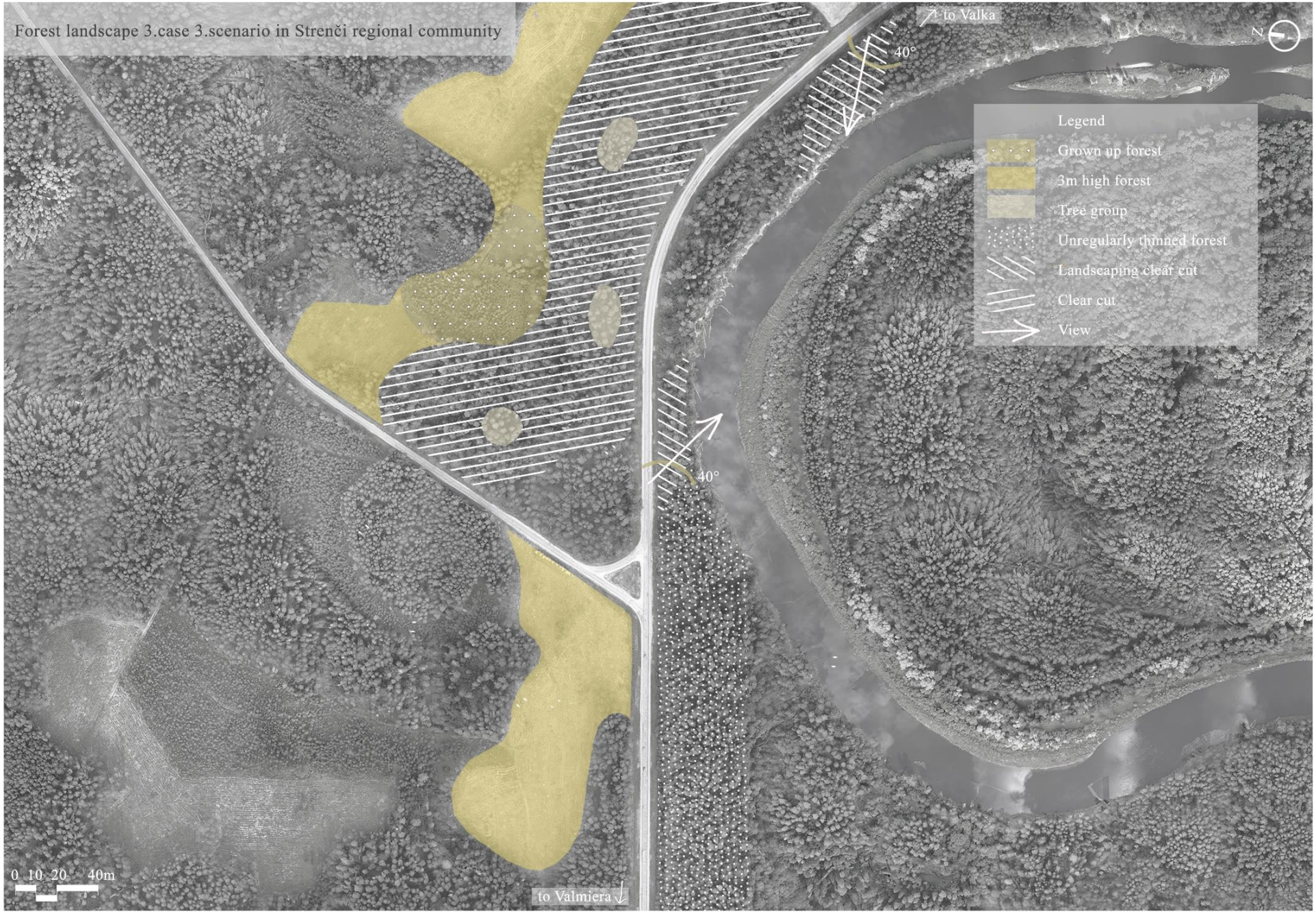
Annex 10

Mosaic landscape 2.case 2.scenario in Kocēni regional community
to Valmiera
to Rīga
Legend
Road side edge with wild flowers and grass
Flax field
Sheep pasture
Bus stop
Forest, trees and bushes taken down
Electricity line to be removed
View to the Makēni bog
Distant open view
Wide panorama view
0 10 20 40m

Mosaic landscape 2.case 3.scenario in Kocēni regional community
to Valmiera
to Rīga
Legend
Forest
Hemp
Spruce tree row
Bus stop
Electricity line to be removed
0 10 20 40m


Forest landscape 3.case 2.scenario in Strenči regional community
to Valka
Legend
3m high forest
Tree group
Clear cut
Regularly thinned forest
View
0 10 20 40m
to Valmiera

Annex 13


Forest landscape 3.case 3.scenario in Strenči regional community
to Valka
40°
N
Legend
Grown up forest
3m high forest
Tree group
Unregularly thinned forest
Landscaping clear cut
Clear cut
View
40°
0 10 20 40m
to Valmiera

Annex 14

Annex 15

Multi-factor correlation analysis

	Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7	Column 8	Column 9	Column 10	Column 11	Column 12	Column 13	Column 14	Column 15	Column 16	Column 17	Column 18	Column 19	Column 20
Column 1	1																			
Column 2	-0.04703	1																		
Column 3	0.072518	0.130415	1																	
Column 4	0.042198	-0.06817	-0.00809	1																
Column 5	0.010484	0.081791	-0.0678	0.028101	1															
Column 6	0.040864	0.120608	-0.07533	0.274067	0.068269	1														
Column 7	-0.02688	0.095544	-0.09679	-0.1904	-0.02523	0.172021	1													
Column 8	-0.01555	0.055709	0.028643	0.356332	-0.06761	0.225615	-0.25559	1												
Column 9	-0.029	-0.03972	-0.06044	0.669096	0.021525	0.186473	-0.12534	0.333709	1											
Column 10	-0.02009	0.067235	-0.0139	0.111515	0.41273	-0.01079	-0.03086	-0.01396	0.00994	1										
Column 11	0.071315	0.056681	-0.0577	0.011763	0.014881	0.401049	0.29716	0.094988	0.23644	-0.01528	1									
Column 12	-0.06688	-0.02791	-0.09413	-0.08106	-0.07088	0.097621	0.386819	-0.04196	-0.23584	0.088835	0.04516	1								
Column 13	0.055289	0.034901	0.026665	0.208642	0.043211	0.10159	-0.13954	0.479525	0.39925	-0.18824	0.184974	-0.34306	1							
Column 14	0.005166	-0.04419	-0.06588	0.574813	0.004341	0.259649	-0.07326	0.293016	0.611453	-0.08748	0.122331	-0.03521	0.233	1						
Column 15	0.084275	0.045799	-0.02779	-0.08752	0.392539	-0.01647	-0.04919	-0.10447	-0.02595	0.470769	0.049272	-0.07524	-0.0677	-0.134	1					
Column 16	0.044612	0.010486	-0.05387	0.025455	0.036407	0.346798	0.189502	0.051399	0.085244	0.002435	0.421536	0.116022	0.02414	0.317783	0.062742	1				
Column 17	0.036251	0.049944	0.069844	-0.10094	-0.05258	0.190987	0.319252	-0.10013	-0.12856	0.005209	0.188872	0.345425	-0.13135	-0.19179	0.038423	0.088586	1			
Column 18	0.060521	0.082786	-0.06543	0.196442	-0.03184	0.223265	-0.14554	0.49037	0.277338	-0.07629	0.167536	-0.08167	0.472221	0.442717	-0.18185	0.188673	-0.41883	1		
Column 19	0.021956	0.018955	0.048137	0.329584	-0.02684	0.113838	0.012791	0.229576	0.29909	-0.08145	0.157846	0.008526	0.202834	0.339871	-0.10264	0.134709	-0.09985	0.221892	1	
Column 20	0.019011	-0.01254	-0.10751	0.058905	0.159889	0.090411	0.043256	0.035471	0.081368	0.254157	0.175927	0.010052	-0.05015	0.011598	0.304825	0.063995	0.162959	-0.06135	-0.02807	1
Column 21	0.040151	0.125063	0.047063	-0.02117	-0.08148	0.20866	0.20118	0.189535	0.032446	-0.0394	0.4745	0.128323	0.074327	0.072774	0.049642	0.383332	0.09586	0.090008	0.414256	0.056544
Column 22	0.033887	0.022557	0.052357	-0.0869	0.019433	0.173529	0.322972	0.020508	-0.04127	0.021113	0.230149	0.392527	-0.08162	-0.01534	-0.08066	0.214449	0.428628	-0.12276	-0.16228	0.155454
Column 23	0.014559	-0.0288	-0.0712	0.087354	0.038911	0.172467	-0.04641	0.264291	0.086052	-0.12024	0.125471	-0.08427	0.344688	0.087995	-0.02179	0.085991	-0.22497	0.381743	0.475563	-0.1126
Column 24	-0.09592	0.110722	-0.04616	0.264458	0.047006	0.139069	0.041822	0.257199	0.391354	-0.13712	0.226654	0.079209	0.261176	0.442666	-0.10242	0.206822	-0.09284	0.32993	0.557636	0.055802
Column 25	0.036777	0.005222	-0.10208	-0.03598	0.291991	0.027197	0.090294	-0.02314	-0.01481	0.350869	0.055575	0.025686	-0.06156	-0.06993	0.45004	0.09696	0.03462	-0.06483	-0.07263	0.438314
Column 26	-0.05039	0.118707	0.047832	-0.07986	-0.0599	0.221932	0.112741	0.048539	0.008309	-0.0458	0.381266	0.129768	0.028179	0.061485	-0.01517	0.438868	0.124212	0.079878	0.190141	0.08096
Column 27	0.029972	0.061762	0.043757	-0.0475	0.031568	0.130404	0.306217	-0.04905	-0.0575	0.028735	0.154874	0.323464	-0.12911	-0.05106	-0.00388	0.112253	0.271235	-0.08002	-0.16118	0.071719
Column 28	0.065405	-0.03697	-0.09227	0.116174	-0.01594	-0.02288	-0.18937	0.208318	0.074683	-0.08673	0.054761	-0.10842	0.320572	0.17843	-0.06569	0.126747	-0.14229	0.308341	0.30172	-0.00756
Column 29	-0.01453	0.0314	-0.06289	0.152925	-0.02085	-0.00275	0.03438	0.095978	0.219083	-0.10578	0.081359	-0.07579	0.19505	0.265084	-0.04058	0.085062	-0.11585	0.123589	0.528842	-0.07979
Column 30	-0.0219	-0.01034	-0.0365	-0.01643	0.075122	0.038237	-0.04392	0.028958	-0.04019	0.190201	-0.00551	0.040731	-0.11188	0.032541	0.233922	0.125112	-0.09659	-0.04476	-0.0744	0.370433
Column 31	0.082272	0.064799	0.018099	-0.08189	-0.12739	0.187606	0.167069	0.044757	-0.13865	-0.15626	0.298004	0.093757	-0.01759	-0.0461	0.008818	0.270668	0.177653	-0.01302	0.117268	0.084098
Column 32	0.091721	-0.06084	0.086643	0.055727	-0.00178	0.260411	0.253494	0.056066	-0.01489	0.11056	0.237911	0.283055	-0.16519	0.059124	0.029082	0.296721	0.3542	-0.07565	-0.01803	0.10384
Column 33	-0.01601	0.129365	-0.0434	0.084202	0.118951	0.065953	-0.05906	0.190748	0.137509	-0.10332	0.107425	-0.15149	0.370284	0.135657	-0.04014	0.003222	-0.1608	0.345214	0.310867	-0.02275
Column 34	-0.05705	-0.02395	-0.11631	0.110679	-0.02897	0.165238	0.104328	0.096108	0.197212	-0.18179	0.147665	0.050503	0.123561	0.268307	-0.1209	0.165639	0.019751	0.174203	0.487547	-0.00825
Column 35	-0.03787	-0.04059	-0.07547	-0.03986	-0.12686	0.017835	0.029701	-0.03549	0.009098	-0.01141	-0.00428	0.076689	-0.04037	-0.01969	0.03547	0.063585	0.071262	-0.09942	0.013546	0.238063
Column 36	0.109377	0.037807	-0.06932	-0.03039	0.014628	0.327755	0.258441	-0.05286	-0.05776	-0.02226	0.315912	0.185973	-0.10905	0.005304	0.055129	0.349261	0.337529	-0.0529	0.203279	0.065785
Column 37	0.052554	0.060204	0.048842	0.008115	0.103516	0.145314	0.211381	0.065859	0.039975	0.043421	0.153976	0.232633	-0.00106	0.041522	-0.04387	0.210029	0.265547	-0.0386	-0.05587	-0.04822
Column 38	-0.01064	0.005694	-0.09523	0.000188	0.034845	0.136993	0.015853	0.095627	-0.01377	-0.08371	0.072517	-0.06394	0.12383	0.047343	-0.00864	0.035364	-0.06819	0.217567	0.21397	0.017419
Column 39	0.093084	0.021749	-0.03838	0.132407	-0.01988	0.08153	-0.00251	0.196223	0.259317	-0.15425	0.233506	0.049361	0.120783	0.261344	-0.1085	0.13362	-0.00908	0.150193	0.351068	0.129229
Column 40	0.010058	-0.03116	-0.10542	0.062781	0.026311	-0.08283	-0.13661	-0.01944	0.067443	0.225885	-0.09814	-0.0806	0.020506	0.011033	0.19744	0.046869	-0.07739	0.059078	-0.0904	0.193217
Column 41	0.234633	0.096814	0.0042	0.065776	-0.02684	0.309782	0.229592	0.075217	0.089087	0.04316	0.414935	0.111436	-0.02084	0.068946	0.121153	0.357902	0.192715	0.0162	0.112781	0.125125
Column 42	0.024801	0.015203	-0.08327	0.060065	0.013951	0.16291	0.12117	0.004032	0.084515	0.084519	0.1461	0.129878	0.060338	0.060615	-0.02749	0.170185	0.216696	0.079207	0.004915	0.048933
Column 43	0.099369	0.069868	0.027598	-0.06759	0.025672	0.144217	0.050563	0.088538	-0.0393	0.004232	0.15987	0.029485	0.00568	0.053842	0.081564	0.138525	0.005988	0.083223	0.188556	0.135442
Column 44	0.049414	-0.01884	-0.03121	0.172329	-0.01303	0.12839	-0.10741	0.171692	0.263193	-0.17145	0.176654	0.049217	0.152004	0.324535	-0.14195	0.147321	-0.05006	0.2489	0.363084	0.113812
Column 45	-0.04435	-0.01774	-0.04825	-0.05272	0.008131	-0.13088	-0.05714	-0.17267	-0.03109	0.077826	-0.11727	-0.06511	-0.09666	-0.08295	0.180684	0.023027	-0.06668	-0.09657	0.019675	0.178089
Column 46	0.132663	0.13715	0.000144	0.088999	-0.00492	0.394579	0.14881	0.094439	0.095422	0.027818	0.373289	0.050675	0.05853	0.099966	0.036252	0.381926	0.273066	0.079279	0.171023	0.181541
Column 47	0.046895	-0.00765	-0.08708	0.014091	0.005887	0.054996	0.202108	0.094439	0.02668	-0.03047	0.156886	0.155662	0.098654	0.046403	0.001491	0.210266	0.162637	-0.00013	0.071424	0.037783
Column 48	0.043655	-0.01064	-0.14125	0.033127	-0.00389	0.115584	0.246389	0.054903	0.054202	-0.00811	0.175576	0.199483	0.095186	0.081024	-0.00536	0.206053	0.174048	0.020916	0.137309	0.055242
Column 49	-0.04663	0.067596	-0.0137	-0.34262	0.016624	-0.01559	0.072017	-0.04278	-0.29716	-0.0152	-0.06133	0.053856	-0.03783	-0.31316	0.000983	-0.03481	0.053169	-0.03049	0.02122	0.004805
Column 50	0.006642	-0.18221	0.003626	0.145308	-0.0542	-0.103	-0.03817	-0.04695	0.103747	0.015507	-0.03936	-0.02887	0.049009	0.061828	-0.0223	-0.07292	-0.05791	0.056538	-0.03885	-0.00209
Column 51	0.045461	0.086905	0.011873	0.24858	0.029689	0.108362	-0.04549	0.088675	0.235327	0.003003	0.102381	-0.03374	-0.00174	0.290051	0.018665	0.10289	-0.00727	-0.01649	0.011037	-0.00344
Column 52	-0.02302	0.090413	-0.07347	0.181544	0.070202	0.141217	-0.00117	0.111712	0.154682	-0.01701	0.051738	0.005708	0.118942	0.166572	0.08366	0.111054	0.058825	0.078366	0.045327	0.143671
Column 53	-0.10766	-0.06183	0.100024	0.115889	-0.03296	0.085515	-0.11019	0.100222	0.080411	-0.02568	-0.04292	-0.08922	0.15792	0.161904	0.04078	0.080659	0.027061	0.046498	0.064023	0.055849
Column 54	-0.07947	-0.0946	-0.01628	0.187986	0.122795	0.062145	-0.15564	0.060687	0.021318	0.063225	-0.17005	-0.04989	0.026371	-0.09523	0.040904	-0.08165	-0.03857	-0.07725	0.103874	-0.04423
Column 55	0.077448	0.08233	-0.01827	-0.09947	0.067291	0.17032	0.104248	0.021974	-0.07054	0.080137	0.188339	0.058689	0.002817	-0.0426	0.112203	0.221094	0.188037	-0.02829	-0.03577	0.154077
Column 56	-0.00609	-0.11379	0.104887	-0.07517	-0.0331	0.059857	-0.03442	-0.06855	0.063769	-0.0648	0.110535	0.047223	0.027044	-0.0047	0.036483	-0.05019	0.046823	0.039651	0.03335	-0.02141
Column 57	-0.00351	0.03389	0.091656	-0.07566	-0.0731	0.066123	-0.02637	-0.01581	0.007689	-0.14491	0.034384	-0.08201	0.130565	-0.00733	-0.05062	-0.03581	-0.04017	0.125833	0.042266	-0.09416
Column 58	-0.0603	-0.11365	0.231837	0.113201	-0.22037	-0.02492	-0.04811	0.060994	0.062344	0.001323	-0.05963	0.053175	0.004194	0.035886	-0.06395	0.021957	-0.08879	0.027469	0.053601	-0.06927
Column 59	-0.01399	0.019986	-0.18158	0.04314	0.085309	-0.06035	0.013661	-0.02405	0.031896	0.04669	-0.06361	0.010746	-0.09725	-0.00199	0.027754	-0.03862	-0.00942	-0.10013	-0.0814	0.124869
Column 60	0.089093	0.053071	-0.14348	-0.07781	0.230437	0.016047	0.07082	-0.01445	-0.12017	0.134149	0.101324	0.038652	-0.05533	-0.02691	0.102774	0.074338	0.16406	-0.07076	-0.01064	0.041778
Column 61	-0.04678	0.039844	0.177005	-0.10822	-0.08925	-0.02002	-0.077	0.0468	0.034049	0.004812	0.099249	0.08667	-0.03312	0.071854	-0.00478	0.161955	0.034186	0.13111	0	0.102493

	Column 21	Column 22	Column 23	Column 24	Column 25	Column 26	Column 27	Column 28	Column 29	Column 30	Column 31	Column 32	Column 33	Column 34	Column 35	Column 36	Column 37	Column 38	Column 39	Column 40
Column 21	1																			
Column 22	0.114786	1																		
Column 23	0.248332	-0.37575	1																	
Column 24	0.279956	-0.0584	0.336622	1																
Column 25	0.008789	-0.04034	-0.08219	-0.03541	1															
Column 26	0.505927	0.139039	0.152706	0.313503	0.01054	1														
Column 27	0.129405	0.44737	-0.18468	-0.2212	0.055898	0.020733	1													
Column 28	0.070591	-0.24848	0.425065	0.46177	-0.09112	0.194585	-0.59496	1												
Column 29	0.20365	-0.14434	0.324122	0.460805	-0.09064	0.07567	-0.22725	0.298258	1											
Column 30	-0.00574	0.045521	-0.11454	0.024367	0.395154	0.062941	0.016099	-0.0749	-0.04963	1										
Column 31	0.532679	0.099542	0.129673	0.077386	-0.00105	0.359127	0.091857	0.113689	0.235209	-0.00516	1									
Column 32	0.183072	0.52233	-0.18455	-0.06843	0.032803	0.140814	0.460724	-0.22742	-0.26358	0.002615	0.116529	1								
Column 33	0.13769	-0.20175	0.535149	0.357297	-0.16047	0.149649	-0.27692	0.479103	0.453282	-0.11256	0.208623	-0.36402	1							
Column 34	0.279745	-0.0225	0.283243	0.492899	-0.01219	0.162231	-0.12253	0.275143	0.56766	0.070057	0.181881	-0.04024	0.327699	1						
Column 35	0.025169	0.043993	-0.10608	0.012417	0.174424	0.030983	0.103974	-0.11408	-0.04047	0.468145	-0.12935	0.019663	-0.13615	0.046380525	1					
Column 36	0.454193	0.194046	0.131179	0.149049	0.078107	0.364223	0.132813	0.106346	0.166658	0.133222	0.52513	0.224743	0.164965	0.404202714	-0.07471	1				
Column 37	0.115352	0.404993	-0.10113	-0.07793	-0.03626	0.071842	0.46559	-0.24726	-0.1401	-0.02058	0.125184	0.40567	-0.16572	-0.20780342	-0.00698	0.131486	1			
Column 38	0.12029	-0.14459	0.375657	0.21611	-0.03896	0.110283	-0.19463	0.420844	0.301507	-0.03728	0.177791	-0.21086	0.539461	0.508941825	-0.15728	0.264288	-0.42514	1		
Column 39	0.211106	0.097569	0.091297	0.399652	0.014467	0.223825	0.01043	0.167249	0.373118	0.051081	0.102763	0.025777	0.175442	0.465145002	0.181785	0.159335	-0.06721	0.19927	1	
Column 40	-0.15119	-0.09152	-0.06602	-0.00031	0.381932	-0.02542	-0.06326	0.057287	-0.04865	0.299529	-0.12647	-0.03966	-0.04775	-0.00204935	0.301622	-0.08099	-0.13752	-0.03252	-0.027911143	1
Column 41	0.421468	0.279619	-0.03597	0.051574	0.131196	0.331903	0.291895	-0.12575	0.006292	0.094784	0.401723	0.453501	-0.06215	0.12803937	0.066399	0.48691	0.256414	-0.01239	0.303037154	-0.03147
Column 42	0.096225	0.24428	0.04697	-0.11275	0.015251	0.105378	0.227406	-0.11869	-0.08469	0.070877	0.127357	0.188188	-0.03338	-0.07075894	-0.08713	0.17744	0.397095	-0.09745	-0.229182338	0.014818
Column 43	0.275288	0.060764	0.143551	0.217441	0.117111	0.208674	-0.00184	0.184588	0.172641	0.129966	0.128698	0.074725	0.182228	0.33236041	0.138785	0.21538	-0.11654	0.347156	0.376599535	-0.10251
Column 44	0.182561	-0.00687	0.144226	0.474444	0.017182	0.227911	-0.08377	0.266176	0.3958	0.11621	0.125338	-0.0095	0.2605	0.601325087	0.147837	0.235659	-0.14476	0.312664	0.625667562	0.03543
Column 45	-0.12675	-0.12469	-0.07877	0.003799	0.206844	-0.01784	-0.10267	-0.00311	-0.00026	0.282359	-0.10419	-0.06922	-0.0661	-0.03673586	0.45002	-0.08005	-0.16065	-0.10179	-0.025215497	0.55677
Column 46	0.413644	0.188546	0.084548	0.109646	0.045868	0.345123	0.119779	0.067491	0.073462	-0.00619	0.531902	0.362254	0.027314	0.199230569	-0.0551	0.514958	0.156206	0.12636	0.225392693	-0.0754
Column 47	0.140585	0.241298	0.016668	-0.00864	0.089164	0.123415	0.245796	-0.05337	0.059594	0.041879	0.167272	0.2771	-0.07651	-0.04854873	-0.0551	0.17536	0.491333	-0.14988	0.009486	0.036776
Column 48	0.156328	0.205797	0.028297	0.021998	0.11414	0.10607	0.227843	-0.03472	0.09157	0.05553	0.149585	0.260881	0.010424	0.041532835	-0.00183	0.202303	0.407145	-0.04909	0.032382368	0.068282
Column 49	0.137807	-0.06802	0.053026	-0.0246	0.058781	0.082345	-0.03785	0.057772	0.050923	-0.0072	0.200719	-0.11729	0.135044	0.184227648	-0.04404	0.161007	-0.08551	0.173144	0.073108082	0.00532
Column 50	-0.0662	-0.07169	0.086646	-0.04567	-0.11232	-0.12115	-0.07575	0.107589	0.005233	0.014908	-0.0649	0.031766	-0.04003	0.015261822	-0.03087	-0.02021	-0.09463	0.099847	-0.04867087	0.008609
Column 51	-0.09312	0.138366	-0.1351	0.067518	0.034729	0.016598	0.108742	-0.15887	-0.0607	-0.00527	-0.16353	0.101011	-0.11325	-0.21635232	0.075817	-0.15938	0.177932	-0.27904	-0.037400839	-0.01348
Column 52	-0.04825	0.06103	0.073627	0.20575	0.102357	0.081954	0.001538	0.190413	-0.08011	0.002544	-0.00214	0.101632	0.024926	0.01378175	0.010962	0.001246	0.037767	0.012268	0.038946481	0.124066
Column 53	0.047805	0.026929	0.006723	0.152432	0.008176	0.075704	-0.18295	0.163962	0.193881	-0.05292	0.090469	-0.10129	0.140761	0.10752675	-0.10295	-0.0107	-0.12955	0.156815	0.064101415	0.075288
Column 54	-0.11079	-0.15467	0.144153	-0.01944	-0.00403	-0.1304	-0.14105	0.140794	0.030292	-0.15057	0.010165	-0.15114	0.171379	-0.030435	-0.08917	-0.03958	-0.14244	0.193516	-0.045565966	0.08712
Column 55	0.184539	0.153292	-0.00231	0.049226	0.071913	0.1084	0.044836	0.06916	0.067055	0.078399	0.163119	0.085473	0.076764	0.054521859	0.040306	0.17781	0.085598	0.044018	0.05690014	0.086795
Column 56	0.117906	0.078911	-0.01317	0.043747	0.087904	0.049405	-0.00312	0.024688	0.129227	0.074033	0.081128	-0.00574	0.024788	0.177913637	0.067113	0.059398	-0.09808	0.127674	0.138600879	0.072421
Column 57	0.018497	0.007729	0.11937	-0.04538	-0.06327	-0.0259	0.023211	0.09024	0.101947	-0.03998	0.102218	-0.10452	0.131653	0.132112393	0.062871	-0.01185	-0.05802	0.150276	0.081095423	0.073967
Column 58	0.101658	-0.00223	-0.01157	0.051337	-0.08807	0.041268	-0.06822	0.02855	0.014993	0.067455	0.031783	-0.05885	0.007313	0.084534453	-0.00333	0.086284	-0.03095	0.017827	-0.017399721	-0.00051
Column 59	-0.09038	-0.05976	-0.11114	-0.01803	0.04237	-0.03129	-0.01023	-0.11341	-0.03834	0.039883	-0.12669	0.067789	-0.13102	-0.14119046	0.048524	-0.07637	0.040413	-0.15675	-0.008003675	-0.01775
Column 60	-0.01963	0.069377	-0.00489	0.028372	0.127452	0.030249	0.056758	-0.0066	-0.10476	-0.07163	-0.00916	0.118262	-0.0165	-0.08875475	-0.14425	0.020182	0.060157	-0.01993	-0.080251968	-0.07653
Column 61	0.174187	0.097982	-0.03923	0.030514	0.05957	0.203363	0.145644	0.024944	0.057245	0.064479	0.062711	0.011716	-0.03061	0.086126127	0.140636	0.053913	0	0.054731	0.116968503	0.051448

	Column 41	Column 42	Column 43	Column 44	Column 45	Column 46	Column 47	Column 48	Column 49	Column 50	Column 51	Column 52	Column 53	Column 54	Column 55	Column 56	Column 57	Column 58	Column 59	Column 60	Column 61
Column 41	1																				
Column 42	0.118307	1																			
Column 43	0.374026	-0.37045	1																		
Column 44	0.171536	-0.15303	0.340083	1																	
Column 45	-0.01033	-0.10893	0.000939	0.065902	1																
Column 46	0.566086	0.151161	0.206195	0.313653	-0.0885	1															
Column 47	0.264638	0.479169	-0.11544	-0.16677	-0.01995	0.186421	1														
Column 48	0.308993	0.413499	-0.01397	-0.06069	-0.00493	0.204202	0.928571067	1													
Column 49	-0.01272	0.008511	0.135665	0.094221	-0.02877	0.125219	-0.131345502	-0.06757	1												
Column 50	-0.09976	0.013539	-0.11201	0.002234	-0.04217	-0.08975	0.004087974	-0.0092	-0.5109466	1											
Column 51	0.10234	-0.02136	-0.0502	-0.10572	0.069009	-0.05841	0.140995402	0.082543	-0.6486353	-0.32283	1										
Column 52	0.132786	-0.00074	0.099215	0.080509	0.015064	0.10764	0.074051052	0.093079	-0.1773132	-0.02212	0.214816	1									
Column 53	-0.02452	-0.01525	0.080811	0.108437	-0.04744	0.042397	-0.041331032	-0.07057	0.0214983	-0.03679	0.008906	0.250506	1								
Column 54	-0.1309	-0.02629	-0.02853	-0.00825	0.035826	-0.04974	-0.015094638	-0.03401	0.0329646	-0.02962	-0.01007	0.23301	0.378332	1							
Column 55	0.193614	0.000802	0.195229	0.103791	0.041897	0.136192	0.057289083	0.089623	-0.0021641	0.058616	-0.04952	0.145998	0.139409	-0.03871	1						
Column 56	0.050692	-0.11579	0.104245	0.204201	-0.00769	0.001199	-0.071463261	-0.02366	-0.0040481	0.108425	-0.09154	-0.04976	0.157801	0.004004	0.204044	1					
Column 57	-0.00324	-0.00265	0.091803	0.036981	0.00932	-0.05478	-0.005643862	-0.00091	-0.0549647	0.137141	-0.06091	0.033128	0.143665	0.146014	0.16493	0.466607	1				
Column 58	0.037367	0.020363	0.007106	0.118848	0.029076	-0.00204	-0.050474246	-0.05621	-0.0182769	0.042513	-0.01752	-0.05726	0.082692	0.016298	0.080632	0.076703	-0.0599972	1			
Column 59	0.003736	-0.04909	-0.10737	-0.05749	0.001583	0.010778	0.031315975	0.039746	-0.0017163	-0.04689	0.043406	-0.00527	-0.16983	-0.12484	-0.20164	-0.40635	-0.719165	-0.35692	1		
Column 60	-0.04149	0.04479	0.007014	-0.10611	-0.04659	0.062407	0.022513757	0.011488	0.09666155	-0.17152	0.045439	0.024884	-0.06528	-0.0538	-0.05059	-0.18937	-0.3558839	-0.5548	0.0701	1	
Column 61	0.114059	0.036925	0.038721	0.126193	0.090542	0.023987	0.023986955	0.033222	0.05606525	-0.04648	-0.02058	-0.11554	0.054309	-0.11442	0.141129	0.389903	0.17443824	0.174937	-0.1314	-0.25797	1

Annex 16

Questions of the online survey

Question 1
Age:
□ 18-28 years
□ 29-38 years
□ years and more
Question 2
Your field of work:
□ Architecture/ building/ real estate
□ Agriculture
□ Forestry
□ Transport/ logistics
□ Tourism/ hotels/ catering
□ Environmental science/ nature protection/ landscape architecture
□ Other field
Questions 3, 10, 17, 24, 31, 38, 45, 52, 59
Watch animation (1-9) of the road in agricultural landscape (full screen) and rate what is your overall impression of the landscape. How attractive is the landscape (1- very unattractive, 5- very attractive)?
1 □ 2□ 3□ 4□ 5□

Questions 4, 11, 18, 25, 32, 39, 46, 53, 60
Is the road landscape in animation (1-9) open, with wide, distant views; partially open or fully open closed without distant views (1- open with wide distant views, 5- fully closed)?
1 □ 2□ 3□ 4□ 5□

Questions 5, 12, 19, 26, 33, 40, 47, 54, 61
Did any positive elements or activities attract your attention in the animation (1-9) of the road landscape?
□ Yes
□ No

Questions 6, 13, 20, 27, 34, 41, 48, 55, 62
Please name

Questions 7, 14, 21, 28, 35, 42, 49, 56, 63
Did the animation (1-9) of the road landscape have any negative elements or activities that stand out?
□ Yes
□ No

Questions 8, 15, 22, 29, 36, 43, 50, 57, 64
Please name

Questions 9, 16, 23, 25, 37, 44, 51, 58, 65
Would you feel safe when driving on the road as in the animation (1-9) (1- very unsafe, 5- very safe)?
1 □ 2□ 3□ 4□ 5□

Question 66
When thinking about landscape and views in a roadside landscape, rank from 1 to 3 which landscape you like the best (1) the least (3)
□ Mosaic landscape where forests change with meadows and fields
□ Agricultural landscape with distant, open view outlook
□ Forest Landscape with closed views

Question 67
Evaluate how do you like the edge of this road with a narrow, regularly cut edge of grass (1- do not like at all, 5- like very much)

1 □ 2□ 3□ 4□ 5□

Question 68
Evaluate how do you like the edge of such a wide road with flowering plants (1- do not like at all, 5- like very much)

1 □ 2□ 3□ 4□ 5□

Question 69
Evaluate how do you like the landscape with such a partly maintained roadside (1- do not like at all, 5- like very much)

1 □ 2□ 3□ 4□ 5□

Question 70

How important for is the landscape you see when traveling along the road (1- totally unimportant, 5- very important)?

1 □ 2□ 3□ 4□ 5□

Question 71

Most often you travel by car as

□ driver

□ passenger

Question 72

Please rank from 1 to 4 the reasons you use car, where 1 is most often reason and 4 least often reason:

□ to move everyday (from home to work, etc.)

□ to travel, relax

□ to shop

□ for work

Question 73

What do you think should be improved in the road landscapes in Latvia?

Question 74

Your gender

□ female

□ male