UL2L
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# Study

# “Riverbanks: how to achieve a coexistence of biodiversity, recreation and flood retention”

Project Partner:

**Kuldīga District Municipality**

2020

# Content

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# Introduction

The study is developed by the interregional cooperation program INTERREG EUROPE 2014-2020 within the project "UrbanLinks 2 Landscape - UL2L" in 2019-2020.

It is the project's main objective to increase the knowledge base and skills and to deliver tools that allow the evaluation of urban gardening, health care and selected ecosystem services compared to other uses of open spaces and consequently the enhancement of policies that support action plans and measures to use the limited natural capital sustainably.

The project partners improve their regional development programmes and policy documents on the basis of the transfer of good practices from other regions. The project activities are carried out together by 6 countries of the European Union (7 partners in total).

The partnership jointly identified main challenges in Kuldīga, which are of overall importance for the project:

- preparataion of a comparative overview of the use of rivers and rivers in historical urban areas, or adjacent to watercourses: situation, problems and solutions. Evaluation of the plans and projects implemented and proposals for the transfer of experience.
- research on the importance and use of the Venta river and the rivers in Kuldīga as a pilot area (the river from the new bridge to the Veckuldīga castle mound), its impact on the urban environment with detailed analysis of the period from the end of the 19$^{th}$ century to the present.
- perform assessment of the landscape and ecology of the river Venta and the riverbank in the Kuldīga area.
- develop proposals and recommendations for the development of the river Venta and the riverbank in the urban environment, balancing biodiversity, recreation and water management aspects.

The study document is structured in two parts: a description of the current situation with conclusions and a proposal section. Separate recommendations for the development of river and riverbanks in the urban environment are prepared. The prepared proposals will be applicable to other cities with a similar situation - location in a historic urban environment that is permeable to, or accessed by, watercourses.

The summary contains the information and conclusions gathered in the study. The summary prepared as a separate volume.

The research was developed by Kuldīga District Municipality in cooperation with Ltd "Grupa93", involving geology and hydrogeology expert MSc.Env.Eng. Inga Gavena, certified freshwater habitat expert Dr.Biol. Laura Grinberga, certified forest and grassland habitat expert MSc.Geogr. Egita Grolle, experts in sustainable stormwater management MSc.Env.Sci. Yuri Kondratenko and MSc.Geogr. Klinta Alpa, landscape assessment expert MSc.L.Arch Rita Beikmane-Modnika.

# 1 Use of rivers and riverbanks in the historic urban environment

In order to compare the use of rivers and riverbanks in the historical urban environment between different similar cities, two other cities in Latvia have been selected. Cities were compared with each other, evaluating their experience in various projects implemented with the management of rivers and their banks.

The selection criteria for the selection of comparable cities were identified as:

- location in other planning regions (planning region of Zemgale, Rīga, Vidzeme or Latgale[1]);
- a city with a rich cultural and historical heritage (includes cultural and historical protection zones of State or local government importance);
- a specially protected nature area is located in urban areas (*Natura 2000* site recommended);
- the river, as a cultural and natural heritage, is directly adjacent to the city around which it has developed.


*Figure 1 Position of selected cities in Latvia*

The cities of Valmiera and Jelgava were selected for comparison. Additional information is provided on the experience of other Latvian cities in the implementation of individual projects (see Annex 2).

[1] Project launched, cities were evaluated in all planning regions of Latvia and selected in Vidzeme (Valmiera) and Zemgale (Jelgava) regions

## 1.1 Situation characteristics, problems and solutions

The most significant projects of recent years in cities (Kuldīga, Valmiera, Jelgava) in riverbank management and comparison of cities are presented in Table 1. When evaluating the projects implemented in the cities, several project categories were identified. Implemented projects and studies were compared in the following categories:

- floods;
- spatial planning;
- utilities;
- environmental education;
- environmental quality;
- nature protection;
- other studies.

A detailed description of the city of Kuldīga is given in the following chapters.

### 1.1.1 Jelgava

According to Annex 1 of the Civil law, the administrative area of the city of Jelgava comprises sections of the following public rivers: Lielupe (~ 8,5 km), Svēte (~ 15 km) and Iecava (~ 2,1 km), as well as, according to the type of use, the river sections of Platone (~ 4,5 km) and Vircava (~ 3 km).

This study looks at the experience of Jelgava in the use and management of the banks of Lielupe and Lielupe river from 2010.

Lielupe is the largest river in the region of Zemgale, the second largest Latvian river in terms of flow, with significant water supplies from Lithuania. Half (8849 km²) of the catchment area of Lielupe is located in Latvia[2]. The area of Jelgava includes a river section of ~8,5 km, of a total of 119 km.

[2]The total area of the Lielupa river basin area is 17 600 km²


*Figure 2 Jelgava*

Latvia University of Life Sciences and Technologies (located in Jelgava palace and Palace park), Lielupe Bank promenade (built in 2011), bathing sites, boat berths, Jelgava Yacht Club, Rowing Club "KC", the island Pasta Sala (design and construction 2011/2013), ice rink, tea house "Silva", "Istaba" pub, LLU Sports House and Faculty of Engineering, Hotel "Jelgava".[3]

In general, the accessibility of the Lielupe banks has been assessed as variable - from inaccessible and overgrown riverbanks to well-developed beaches.

Large areas on the coastss of Lielupe have been identified as specially protected nature sites and specially protected nature areas of European interest, *Natura 2000*, due to the presence of significant species habitats in grasslands. In the northern part of the city, the closed-up zone "Lielupe floodplain" is defined for almost the entire area of the Island Pilssala as well

[3]Design "Installation of navigation marks for regulating small-size vessel movements in the River Driksa and Lielupe"

as for part of the area between Kalnciems road and the Lielupe on the right banlk of the river with a total area of 217,2 ha. More than 70 wild horses are grazing on the island behind Jelgava Palace, in the floodplain meadows of Lielupe.

In the summer of 2018, a 19,2-meter-high wooden view tower was set up on the island, with a well-arranged picnic site for watching wild horses, birds, two rivers and a city panorama. The sight tower begins a 3,2 km-long Health trail in the northern direction of the Pilssala island, suitable for walking, nordic walking and cycling[4]. The nature reserve territory of Pilssala island also has a seasonal restriction - pressence in this area is prohibited during bird nesting - from April 1 to June 30.

The nature reserve "Lielupe Floodplain Meadows" with an area of 54,7 ha is also defined as the territory on the left bank of Lielupe between the Vircava and Platone estuaries of Lielupe.

More than 50 bathing sites have been identified on the banks of Lielupe in the city area of Jelgava, but in accordance with Cabinet Regulation No. 692 of 28 of November 2017, "Procedures for the Establishment, Maintenance and Water Quality of Bathing sites", there are two official bathing areas in Jelgava. Both of them are located in Lielupe – a bathing area on the left bank of Lielupe "Pasta Sala Island bathing place" and Lielupe right bank bathing place (opposite to Pasta Island bathing area on Lielupe right bank promenade).

Data on the state of play regarding the management of the banks of Lielupa in Jelgava city are collected both through site visits and in consultation with local government specialists. An analysis of planning documents and regulatory enactments has also been carried out.

Based on consultation with local government and survey information on the current situation, planned and realised development projects in the immediate vicinity of public waters, and assessing the trends of recent years in the use of public waters areas, Jelgava as a whole has a tendency to increase the use of public water teritories and bankal areas, i.e. adjacent areas. In conclusion, practical work on accessing the bank started after ~2010. Until then, the availability of watersides was considered necessary in planning documents, such as the Jelgava spatial plan for 1999-2010, pointing to plans to build sports, recreational and tourism facilities on the islands Pasta Sala and Pils Sala, to restore/maintain water transport in the Lielupa section from Jelgava Palace to Jurmala and to maintain pedestrian sidewalks. The

[4] http://visit.jelgava.lv/lv/apskates-objects/nature-park/item/110-bulk-floodplains-plavas

roads on Jānis Čakste Boulevard, as well as the maintenance of water activities related to water sports.

The city of Jelgava regularly hosts several plenaries related to the development of the city, including the development of watersides, the development of the islands of Pasta Sala and Pils Sala, etc. Students of Landscape Architecture and Planning of Latvia University of Life Sciences and Technologies regularly develop study works on topics related to the well-being of Jelgava City, including the development of watersides. Organizing the floodgates allows you to get real solutions to a problem you have set up in a short time. Part of such acquired ideas has also been realized, such as a seasonal pedestrian sidewalk set up on pontoons on Driksa river below Great Street.

### 1.1.2 Valmiera


*Figure 3 Valmiera*

According to the information in Annex 1 to the Civil Law, Gauja (8 km) has been identified as a public river in the administrative territory of Valmiera. The river divides the town area in half, with different terrain conditions, and four tributaries of Gauja are located within Valmiera: the River Ģīme, the River Rāte, the Creek Kaugurmuiža and the Gaide river.

Gauja (ŪSIK code 52) is the longest river in Latvia, which starts and finishes its flow within the State borders. Its total length is 452 km and a drop of 234 m. The study looks at the experience of Valmiera in the use and management of the banks of Gauja and the river Gauja during the period from 2013.

Vidzeme University of Applied Sciences, Valmiera School of Music, Jānis Daliņš Stadium, pedestrian road and viewing terrace in the park Atpūtas Parks (constructed in 2019), as well as bathing and walking paths are located on the banks of Gauja. A project, launched at the beginning of 2019, is currently underway, with an aim of establishing a promenade on the banks of Gauja.[5]

In general, the availability of the banks of Gauja can be considered as good, even there is coverage of aquatic plants in the river and the existing steep banks prevent direct access to the coast, the banks are still being developed by creating new walking trails and promenades in addition to existing routes.

The city of Valmiera contains a protected geological and geomorphological nature monument "Steep Banks of Gauja (in Valmiera)", the protection and use of which is to be performed in accordance with Cabinet Regulation No. 264 of 16 March 2010," General Regulations for the Protection and Use of Specially Protected Nature Areas". The protected nature parks and nature monument sites, which are important for the conservation of the natural heritage, include the above-mentioned park Atpūtas Parks on the banks of Gauja.

Along the banks of Gauja in 2013, a Trail of Senses was created near Jānis Daliņš Stadium, which is ~3 km long and is a suitable place for walks. The trails are also formed along the part of the river running through the downtown area.[6] In June 2018, the inciative "100 deeds for Latvia" was launched on the left bank of Gauja, designed to promote a healthy lifestyle

[5] https://www.valmieraszinas.lv/gaujas-bank-promenades-project-framework-planot-well-convoluted-ari-starka-socket-area /
[6] https://www.sajutuparks.lv/baskaju-Trail /

with nature walking routes and to reveal the little-known landscapes of Valmiera; it links the Iron Bridge and bridge over Gauja[7] in the center of the city.

In the area of the municipality of Valmiera there are no bodies of water where a bathing site could be established according to the 10.01.2012. Cabinet Regulation No. 38 “Procedures for the Establishment and Maintenance of a Bathing Site”. A well-designed beach near Gauja, Daliņš Beach, is used as a swimming site. As of the end of 2014, the management of the Daliņš Beach site has been transferred to Vidzeme Olympic Center, Ltd. It is very difficult to install an official bathing site in Gauja because the river doesn’t have a stable seabed.

[7] http://www.visit.valmiera.lv/lv/ko_redzet_un_darit/aktiva_atputa_un_valasprieks/5961_gaujas_kreisa_krasta_pastaigu_taka/

*Table 1 cities of Valmiera, Jelgava and Kuldīga to assess projects and activities in water management*

| Category | Valmiera | Jelgava | Kuldīga |
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| **Flooding** | There are no realised projects of this scope.<br><br>In 2018, the city of Valmiera was included in the list of flood risk areas of national importance.<br><br>According to the hydrological observatory pont "Valmiera", the largest floods in the last 10 years were observed in the years 2010, 2011 and 2013, exceeding the 10% probability mark and flooding the basements of individual and apartment houses. | **"Implementation of complex measures for the recovery of the flow-through of the Svēte River and the reduction of flood hazards in adjacent areas" (started 2018)**<br><br>**Objective:** The project aims to reduce the risk of high flooding in Jelgava<br><br>**Result:** meandri (wetlands) have been created in floodplain meadows, a total of 1,2 ha, and various plants developed in these wetlands – fragrant calm, conventional reed *Phragmites australis* and purple loosestrife *Lythrum salicaria L*, thereby contributing to the diversity of flora.<br><br>**Clean-up of the Lielupa seabed and rebuilding of the dyke on the right bank of Lielupa river for the section from the railway bridge to Rīga Street (2018)**<br><br>**Objective:** Arrange the riverbank of Lielupe.<br><br>**Result:** Hydrotechnical structures have been reconstructed and built within the framework of the project over a length of 3 km, a distance of 0.,5 km along the right bank of Lielupe has been cleaned, the protective damb on the right bank of Lielupe has been reconstructed for a length of 1 km, a recreation area – | There are no realised projects of this scope.<br><br>Flood risk in the Venta valley within the city of Kuldīga is not relevant.<br><br>Information on the possibility of flooding during rainfall is provided in 3.3. section. |

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| | | promenade, a cycling path, a sand beach – has been established. | |
| **Spatial planning**[8] | There are no realised projects of this scope. | **Thematic plan "Use of public waters within the administrative borders of the city of Jelgava" (2018)**<br><br>**Objective:** to assess the actual use, availability and shipping facilities of public waters in the Jelgava city area and to develop solutions for future use of water sites and adjacent waters.<br><br>**Result:** The actual use and public accessibility of public waters and adjacent areas hase been reviewed, and proposals for priority work have been given. | **Cultural Development Plan urban transport and planning aspects of green areas, in cooperation with the partner town of Gehsthahti (2000)**<br><br>Solutions have been developed for three defined scopes of the project:<br><br>- The urban dimension of the urban center,<br>- The planning of the transport sector,<br>- The planning of the development of the green spaces. |
| | | | **Local plan for Kuldīga Old Town in the Venta valley, which changes the Spatial plan (started in 2019)**<br><br>The aim is to ensure the optimal regulatory framework for the preservation of natural and cultural environment values and the balanced development of the territory, which is based on the research and analysis of the urban environment. |
| **Utilities** | **Walking Trail for the Left Bank of Gauja set up in 2018** | Meetings on the various areas related to the development of the city are regularly organized, including the development of watersides, the development of the island Pasta Sala and the island Pils Sala, etc. Students | **Reduction of anthropogenic load in "Venta valley" nature reserve through the development of a high-quality tourism and informative network of natural infrstructure (2018)** |

[8] Spatial planning as detailed planning. Planning documents: Sustainable Development Strategy, Development Program, Spatial Planning are not analyzed in this section

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| | **Objective:** to esign a path so that the nature walking route promotes a healthy lifestyle and reveals the little-known landscapes of Valmiera.<br><br>**The result:** The participants created wooden bridge paths at a harder-to-cross stage, sawn out the troublesome bushes and branches, and mowed a path through the tall grases. The materials for building the bridge were provided by the municipality of Valmiera. | of Landscape Architecture and Planning of Latvia University of Life Sciences and Technologies regularly develop **study works on topics related to the development of Jelgava City**, including the development of watersides. | **Objective:** To reduce the potential impacts of anthropogenic loads, including tourism, erosion and environmental pollution, on specially protected habitats and species in nature reserve "Ventas ieleja".<br><br>**The result**: A nature trail has been established with two viewing platforms and a viewing tower that serves as infrastructure to focus visitors at a certain location near the river Venta. The Blue Flag bathing area has been restored in the Mārtiņsala – sand has been added to a part of the beach, while not increasing the beach area. The existing information stand has been restored, as well as a health route has been established. |
| | **Consolidation and improvement of the bankal part of Valmiera in the conservation and protection of nature and biodiversity**<br><br>**The aim is** to create an easily accessible infrastructure for recreation in nature, as | **Pilssala infrastructure development to promote tourism and health activities in Jelgava (2018)**<br><br>**Objective:** to organize the flow of visitors and to reduce the anthropogenic load in the nature reserve "Lielupe floodplain meadows";<br><br>**The result**: a viewtower has been constructed, a rest site has been set up, a health trail route has been established, billboards have been set up. | **Creating the nature trail "Venta bends" (2005)**<br><br>**Objective:** Developing the eco-tourism infrastructure for SEADs.<br><br>**The result**: The Nature Trail "Venta bends" is arranged in the city of Kuldīga and winds along the banks of Venta. It provides an opportunity to enjoy urban and natural landscapes. Information stands and guides shall be provided along the road. Benches and 3 recreational areas, walkways, ladders, etc., shall be fitted. An observation tower and a crossing over the |

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| | well as to promote clean-up of the environment.<br><br>**Result:** Four well-equipped recreational sites with two safe fire sites, tables, benches and waste bins have been provided. The rest sites are located on an area of 0.8 ha on the right bank of Gauja between the Suspension bridge and the Kazu Krāces rapids. | | river Venta was built. An informative publication about the Venta valley has been prepared. |
| | **Consolidation, improvement and development of new infrastructure to ensure environmental accessibility in Valmiera (2017)**<br><br>**Objective:** To clean up an intensely used section of the right bank of the Gauja river, which is part of the park Atpūtas Parks, in accordance with the principles of universal design. | **Improvement of the Pasta Sala island and the development of rivers as a product for tourism and active recreational activities in Jelgava (2007-2013)**<br><br>**Objective:** to make the island Pasta Sala a multi-functional place for recreational, cultural and social activities by creating the river Lielupe and the river Driksa as a tourism and active recreational product and promoting the development of a modern and attractive life environment in the city of Jelgava.<br><br>**Result**: During the project Pasta Island has been developed as a multi-functional site for recreational, cultural and public activities (Sand sculpture and Ice Sculpture festivals, swimming and rowing competitions, concerts), the necessary infrastructure has been created - pedestrian and cycling paths for 2,8 kilometres, nature | |

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| | **Result**: An organized recreational site on the bank of the Gauja River has been set up, thus making it available for different groups of people and diversifying the recreational facilities for residents of Valmiera city and town guests. | trails, benches, lighting, amphitheatre, events sites, playgrounds that raise environmental awareness and ornamental plants. | |
| | **Project for the development of the river Gauja bankal promenade**<br><br>**Goal:** Build a promenade<br><br>**Planned result:** The building project will cover the repair of the bank of the downtown area of Gauja – from the Kazu rapids to the Narrow-gauge railway bridge, including the former "Stork's nest" on the right bank of Gauja (a construction project is currently being developed). | **Development of street infrastructure and sorting of the riverside of the Driksas river (2012)**<br><br>**The objective is to** create modern and high-quality underground and surface infrastructure in the city of Jelgava, by reconstructing three streets in the city center and improving the riverbank of the river Driksa.<br><br>**Result**: reconstructed streets carriageways, sidewalks, public transport stops, the bridge across the channel, street lights, rain water collectors, parking parks, pedestrian walkways, pedestrian pavement with a cycling path along the river Driksa, a recreational area, a new pedestrian bridge across the river Driska to Pasta Island, new plants have been created. | |

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| | | **Project "improvement of the degraded area of Pilssalas Street" has been launched in 2019**<br><br>**Objective:** To develope a foundation for water tourism and the promotine of a healthy lifestyle and athletic water activities.<br><br>**Planned outcome**: Reconstruction of the section of Pilssalas street from the bridge over Lielupe to the area of the natural closed meadow of the Lielupe floodland and the meaintenance of the land adjacent to the street of Lielupe, construction of a parking lot and the maintenance of the area adjacent to it, construction of a building for the development of water tourism and sport. | |
| | | **Project "Reinforcement the banks of Lielupa in Pilssala, Jelgava" launched**<br><br>**Objective:** Reinforcing the Lielupa bankline for a distance of 170 metres<br><br>**The intended result:** a strengthened Lielupe bankline of 170 metres – from Pilssala Street 12 to Pilssalas Street 5 – forming it as a gabione with observation platforms and specially constructed places for launching boats into the river. | |
| | | **Project "The construction of technical infrastructure for business development in degraded areas" has been launched in 2019**<br><br>**Objective:** to settle the degraded industrial land areas on the bank of Lielupa river in between Prohorov Street, | |

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| | | Nerta Street, Rubeu Road and Garoza Street, and to create preconditions for logistical development.<br><br>**Expected result**: construction of communication connections, construction of solid surface areas along the river, strengthening of river banks. | |
| **Environmental education** | There are no realised projects of this scope. | **Promoting environmental awareness in the cities of Jelgava and Šiauliai (2014)**<br><br>**Objective:** Ensure the preservation and management of more sustainable protected green areas and bodies of water in Jelgava and Šiauliai cities by promoting the development of environmental education and environmental awareness issues in border cities.<br><br>**Result:** Environmentally friendly playgrounds established on the Pasta Island, nature trails installed, necessary infrastructure - benches, electricity connections, island area reinforced, 5 information stands for environmental conservation measures. | There are no realised projects of this scope. |
| **Quality of the environment** | There are no realised projects of this scope. | **Elimination of ecological accidents and reduction of environmental pollution in the area of the Lielupe basin (2012-2014)**<br><br>**Objective:** Disposal of the effects of environmental accidents and reduction of pollution.<br><br>**Result:** Developed eco-accident occurrence and prevention scenarios, early notification (WEB and SMS) | **Measures to improve the flow in the river Venta downstream of the old bridge (2012-2014)**<br><br>**Objective**: Improving hydrological conditions and providing a better water flow at the 350 m-long stretch of the river Venta below the old Kuldīga Bridge<br><br>**Result**: Developments to improve Venta's flow have been carried out and proposals have been made for further activities and measures to be taken. |

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| | | systems, theoretical and practical training in the prevention of environmental accidents. | **Recultivation of overgrown areas and rapid section of the river Venta**<br><br>**Objective:** Reinstating the conservation habitat of European interest 3260 “Straujtece”, providing habitats for rare and protected species, reducing biodiversity degradation and ensuring an integrated use of the river. Reduce the growth in the river above the fall of Venta. Improve the landscape quality of a unique geological site, the Venta fall.<br><br>**Result:** Assessments of bentisk and ihtiofauna have been carried out before and after recultivation work, and redrafting works have been carried out. |
| | | | **Recultivation of the habitats of river Venta's rapids in Kuldīga and mowing of Plants in lakes Great Naba, Little Naba and lake Vilgāle in the county of Kuldīga**<br><br>**Objective of the project:** Improve the hydrological conditions of the river in order to ensure better conditions for the passage of water and minimise the risk of clogging and flooding of the river bed on the river stage of Venta, both upstream and downstream of the old bridge in the city of Kuldīga.<br><br>**Result**: Suspended for the time being. |

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| **Nature conservation** | There are no realised projects of this scope. | **Nature conservation plan** for "Lielupe floodplain meadows", developed for the period 2007-2017, the term of which has been extended to 30 January 2018 by the Minister of Environmental Protection and Regional Development of the Republic of Latvia, K. Gerhards, Order No 1-2/18 on the extension of the term of the nature conservation plans, until 31 December 2022.<br><br>**Cabinet Regulation No. 326 of 13 May 2008 Individual Regulations for the Protection and Use of Natural Barriers "Lielupe Floodplain Meadows".**<br><br>Define the functional zoning and the conditions for individual protection and use of nature closures for nature conservation purposes. | **Natural conservation plan for the period 2010-2020 of the "Ventas ieleja"**<br><br>An exploration of the biodiversity of the site has been carried out, identifying nature values, setting long-term and short-term management objectives and the necessary management measures.<br><br>**Cabinet Regulation No. 548 of 16 September 2014 "Individual Protection and Use Regulations of the Nature Reserve" Ventas ieleja"**<br><br>Defines the functional zoning of the use of the river Venta and its bankal use and the conditions for individual conservation and use of nature closures for nature conservation purposes. |
| **Other** | There are no realised projects of this scope. | There are no realised projects of this scope. | **Janis Krastins' book on the arcitecture of the city – Kuldīga: Architecture and Urban Construction (2014)**<br><br>This book is an engageing material for all intersted parties. It expresses an attitude towards the preservation of cultural heritage and true values of environmental quality. |

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| | | | **Study/book by Aija Melluma “KULDĪGA.” Time, People, Landscape” (2017)**<br><br>A book that answers many important questions, how: Does the old city of Kuldīga as a Latvian monument of urban construction have herritage value? What can we say about Kuldīga, the ancient and yet new city in the context of world heritage? How are the assessments of researchers, experts, politicians and the understanding of local people about the values of their city reconciliated? It is known that cities are not just streets and houses, cities are also people for many generations, their lives and work. It is they who are participate in heritage building. |
| | | | **Study by Gunta Kalnina on “Kuldīga Landscape in Postcards” (2014)**<br><br>The study carried out a major analysis of postcards starting in 1897. |

## 1.2 Proposals for the transfer of experience

A number of studies in various fields have been carried out in the cities under review. Proposals for the transfer of experience in the city of Kuldīga (Venta valley) from other cities are summarized according to the evaluated proposals in the following categories:

- flood management
- spatial planning;
- creation of amenities;
- environmental education;
- environmental quality;
- nature protection;
- other studies.

**Spatial planning**

The development of a thematic plan for river, river waters and their links with urban planning (Jelgava example: "Using public waters in the administrative borders of Jelgava City") is to be positively assessed.

Thematic planning can serve as a basis for the development of future planning documents. The proposals provided in the thematic plan shall be further included in the development of the development program, spatial plan or local plan. It can also serve as a basis for the development of a detailed plan, if necessary.

The experience of Jelgava shows that a comprehensive identification of the current situation provides opportunities to create a reasonable list of priority works, which can be further implemented through other planning documents.

The city of Jelgava has the study in the field of flood management. Although floods are not relevant in the city of Kuldīga (in the study area), some parts of the city are temporarily flooded during heavy rains. Therefore, there is the possibility to elaborate the experience of the city of Jelgava that city gained during the implementation of the project "Study of the stormwater system and proposals for integrated stormwater management in Jelgava" should be evaluated.

The city of Kuldīga, by forecasting the adequacy of the stormwater drainage network system, will be able to identify the problem areas and determine the necessary maintenance measures and the necessary actions for the development of the stormwater network. Based on the results of the research, it will be possible to develop recommendations for the improvement of the regulatory enactments of the city and the development of rain sewerage networks.

**Creation of facilities**

The number of visitors has been calculated correctly

When planning a new recreational object by the water, it is necessary to correctly forecast the number of visitors and calculate the necessary facilities accordingly. The calculation should take into account that the initial number of visitors will be higher than on a daily basis. It is advisable to envisage in the improvement project the possibility to expand the offer of the respective object or to provide an alternative offer alongside or elsewhere in the reviewed period.it has to be done in order to reduce the anthropogenic load. Such a proposal is based on the experience of the research cities Jelgava and Valmiera:

- Valmiera's experience with the management of riverbanks shows that the newly created holiday sites and pathes[9] are used very intensly and significant investments are done to insure their management. The planned infrastructure has not been enough for the number of visitors it received. Valmiera highlights the importance and enchantment of the naturally occurring trails, ensuring only that the trail places are mowed.

- Also, Jelgava city municipality points to a very large influx of visitors after the creation of a new natural object (observation tower in the *Natura 2000* territory). The generated anthropogenic load is too high for the created facilities.

[9] In the bend of the right bank of the Gauja between Vansu bridge and Kazu rapids, in the area of 0,8 ha, there are four well-maintained recreation places with two safe campfire places, tables, benches and waste bins (created 2017)

**Use of natural resources for new services**

In order to reduce expenses for the creation and maintenance of new facilities, the gradual introduction of infrastructure and the creation of marked trails in Kuldīga should be considered. For example, in the section from the ferry across the Venta (planned object) to the castle mound (left bank of the Venta). The city of Valmiera has that kind of experience:

- The city of Valmiera emphasizes the importance of walking trails - guided nature trails, which are created without investments in construction, but ensured by regular mowing of trails. Such trails provide a directed flow of pedestrians. Valmiera is planning (in 2020) a project on the right bank of the Gauja (near Krišjāņa Valdemāra street), urbanizing only the part of the trail that is closer to the center.

**Environmental education, environmental quality, nature protection**

In the experience of Jelgava, more than 70 wild horses graze in the floodplain meadows of the Lielupe floodplain in the Natura 2000 territory, ensuring the maintenance of the meadows. In Kuldīga, evaluating the types of meadow management, one of the possibilities is meadow management by grazing.

In Kuldīga, the possibility of developing an environmental education project in a specific field, for example, related to geology or cultural history, or in general about the unified natural and cultural heritage, should be considered. Taking the experience of Jelgava and Valmiera as an example:

- the project “Promotion of environmental awareness in the cities of Jelgava and Siauliai” promoted the development of environmental education and environmental awareness issues in border towns. There were created environmentally friendly playgrounds on Pasta Island (Jelgava), nature trails were installed, necessary infrastructure - benches, power, strengthened island shore area), information stands reporting on environmental conservation measures were installed.

- there was established an interactive nature trail (“The Ģīme river nature trail”) in Valmiera is. It is nature trail with 100 information stands, where you can find information about the values of the Ģīme nature trail. The information on the

informative stands can be supplemented by listening to the prepared information on a smartphone and headset.

## 2 The river Venta and the riverbanks

A study on the importance of rivers and rivers historical use and impact on the urban environment has been carried out for a selected area of the river Venta: area from the new bridge to the Veckuldīga castle mound (see Figure 4). Hereinafter referred as the pilot area.

The pilot area covers the valley section of the Venta river in the city of Kuldīga with its bank slopes, terraces and the adjacent main bank.


*Figure 4 Study pilot area (map prepared by Grupa93)*

In order to assess the possibilities for the use of rivers and rivers in the historical urban environment and to assess the possibilities of restoring historical uses, research needs

to be carried out, taking into account socio-economic, ecological and landscape conditions, historical uses (use of water resources, geological, biological resources, including agricultural use of rivers, transport use, use of energy resources, building, recreation, etc.) and their impact on urban development.

### 2.1.1 Cultural heritage

The study summarises historical information on the period from the 13th century to the present, with a more detailed view of the period from the 19th century to the present.

### 2.1.2 Cultural monuments

The set of cultural and natural values determines that the landscape of the Venta river valley can be considered one of the most unique and outstanding landscapes of Latvia. In terms of natural and cultural heritage, the city of Kuldīga is one of the richest and most attractive territories in Latvia. The most expressive and characteristic are the surroundings of the old Venta bridge with Mārtiņsala and Pārventa park on the right bank of the river and the Venta fall, Alekšupīte waterfall and the construction of Kuldīga Old Town on the left bank of the river.

There are a total of 90 state-protected cultural monuments in the city of Kuldīga, including in the Venta valley within the pilot area such cultural monuments as the urban planning monument “Kuldīga City Historical Center” (national protection No. 7435), the architectural monument “Bridge over the Venta” ( national defense No. 6347), archeological monuments “Veckuldīga castle mound with ancient city” (national defense No. 1232) and “Ancient town of Kuldīga” (national defense No. 1231). The list of monuments is included in Annex 1.

### 2.1.3 UNESCO

Due to the rich cultural heritage, this area is included in the Latvian National List of UNESCO World Heritage Sites.

The National Commission of Latvia of the United Nations Educational, Scientific and Cultural Organization (UNESCO) coordinates the operation of the UNESCO World

Heritage Programme in Latvia and ensures the implementation of the UNESCO Convention on the Protection of Cultural and Natural Heritage.

On 28 February 2020, Kuldīga district municipality submitted an application that was prepared in accordance with the UNESCO Convention for the Protection of the World Cultural and Natural Heritage to UNESCO Latvian national committee and the nomination of the Latvian National List was accepted by the UNESCO World Heritage Center under the name "Kuldīga (Goldingen)".

The main values of the nomination included in the Latvian National List of UNESCO World Heritage are the territory, buildings, objects of the "Kuldīga (Goldingen)":

- The Old Town of Kuldīga integrates the medieval castle mound plateau and the medieval village Kalnamiests into a larger urban fabric created between the 16th and 18th century and later expanded, mostly outside the historic center, in the 19th and furthermore the 20th century. The proposed area covers the pre-19th century urban expansion and its significant environmental setting. The property is preserved mostly in its condition of the late 18th and early 19th century. It therefore includes the complete historic testimony of Courland retained until present, particularly legible in the unchanged urban layout, composition of urban volumes, architectural testimony and cityscape;

- Architectural Monument Red brick vault bridge (date: 1874);
- Venta Canal (date: 17th century-19th);
- The Alekšupīte river waterfall - the highest waterfall in Latvia - height 4,15 m (date: 17th century);
- Venta fall – the largest waterfall in Europe (width 240 m, height 1,8-2,2 m).

The established integrity and authenticity in preparing materials for nomination for World Cultural Heritage status within the meaning of World Cultural Heritage means:

- Due to the rigorous legal protection of the historic city and the well-managed urban conservation zone, the property is largely free of threats, which could be considered to affect the Old Town negatively in the future;

- Kuldīga's urban and architectural heritage is well retained in terms of material, design and in many cases workmanship. It illustrates continuity in function and use as residences, auxiliary structures or commercial spaces for the resident community. The Old Town further preserved its authenticity in setting and location, having preserved not only its urban layout and volume but also its environment in terms of the wider cityscape, in particular, when viewed from the opposite banks of the Venta river.

Excellence in the World Cultural Heritage means:

- Kuldīga (Goldingen) bears a unique testimony to the Duchy of Courland and Semigallia and its era of growth, international trade relations and cultural exchange, as both its first ducal residence and administrative center.
- Kuldīga has maintained not only the urban layout, but also the city scape and significant architectural fabric dating back predominantly to the 17th and 18th century. With up to three quarters of its pre-19th century masonry architecture preserved, either partially or wholly, Kuldīga is the best and last remaining urban testimony of the Courland era.
- The historic center of Kuldīga, which is exceptionally well preserved, is a compelling reminder of the Courland era of growth and exchange in the late 16th, 17th and 18th centuries, when it was known by the name Goldingen.
- Kuldīga (Goldingen) was the primary residence and administrative center of Courland's first ruler Gotthart Kettler, since 1561. During the co-regency of Gotthard Kettler's heirs, Goldingen was the ducal residence and administrative center of Duke Wilhelm Kettler who had been given power over Courland in 1596 and ruled until 1616. In a 1613 census, Kuldīga was documented to have 175 buildings. In addition to structures of traditional log architecture, Kuldīga also featured brick masonry structures, timber-framed houses, often decoratively plastered and painted as well as wood panelled surfaces, both for residential and auxiliary buildings. Kuldīga's architecture prospered due to the rich exchange of travelling craftsmen from other Hanse Towns and centers around the Baltic Sea as

well as Russia, an exchange that remains legible in its architectural styles, workmanship and decorations[10].

## 2.2 Historical use of rivers and riverbanks and their impact on the urban environment

### 2.2.1 Changes in the land use of the Venta riverbank in the historical perspective

Historic riverbanks have been used mainly as agricultural land – pastures, meadows, fields. In some places there were buildings of manors or rural homesteads. Agricultural land currently occupies ~ 98 ha, or 46% of the pilot area, forest areas or shrubs occupy ~ 50 ha or 23% of the total area, while building accounts for ~ 8,5 ha or 4% of the total area.

The following is an analysis of the change in historical land use or usage patterns of the riverbanks of Venta from the 13th century to the present day. The changes in the use of the banks of the river Venta were influenced by social factors such as the growth of the urban area and the increase in the population of the city, as well as economic factors such as the emergence and application of new forms of economic activity on the river banks and in the river.

**13th century**

The most intensive economic activity in and around the city of Kuldīga, including the use of the river Venta and its banks, has been going on for a very long time. The first information about Kuldīga has can been found since the 13th century (the generally accepted time for the foundation of the city of Kuldīga is the year 1242)[11].

There is the Kuldīga catle mound (13th century) located on the bank of the river Venta in the northern part of the pilot area. There was an ancient city, or a settlement, next to the city. Later, the settlement was moved towards the current center of Kuldīga, but in the Middle Ages, opposite the Venta fall, Kuldīga Castle was built. A vegetable garden was established around the castle. Residential buildings were located on the left bank of the river, slowly expanding along the river bank in a northerly direction. In the

[10]Information provided by the municipalities of the municipality of the municipality, "Opportunities and processes for the nomination, for the status of the World Heritage"
[11]"Kuldīga, Times, People, Landscape", Melluma, A., 2017

Middle Ages, agricultural land was located outside the city fortifications. Initially, the inhabitants of the city owned larger or smaller plots of land around the city, and later the properties were included in the management of the manor, but subsitance farming still prevailed[12].

**17th-18th century**

There have been three manor farms in the area of the city of Kuldīga on the banks of the river Venta. North of Kuldīga – Virkas Manor and Kalnmuiža Manor, south – Putnu Manor. An analysis of ancient manor landscapes has been carried out by a distinguished engineer in landscape architecture Guntis Kalniņš[13]. The information on the management of the banks of the river Venta during the time of the manors is indicating that the riverbanks were managed – they were mowed, grazed, even up to river water or fields. "The plains around Virca Manor were mainly encased with arable land, where cereals were grown, while the places where Venta valley formed lower slopes were used as pastures up to the watery shores of the river"[12]. The combined map scheme (see Map 1 "Comparison of historical maps") shows that pasture in the area remained in place during the 40th decade of the 20th century.

**18th-19th century**

The period considered (18th-19th century) is characterised by extensive use of the Venta river riverbanks by traditional farming methods – grazing, mowing, nesting of fields and root gardens.

The survey on street development in Kuldīga[14] presented an overview of historical use, which estimated that during the 40s of the 19th century, Kuldīga was well-equipped with land. This year, the city's building sites (~ 200) occupied 43 desetines (1 desetin = 1,0925 ha), so-called paddocks containing public root gardens and fields – 218 desetines, while pastures and meadows – 858 desetin lands. Each real estate consisted

[12]Website www.senaKuldīga.lv
[13]In Kuldīga Landscape Postcards, Mountain G., 2014
[14]Technical project report: "Leons Paeglis Street intersection with Jelgava Street, Jelgava Street section from Mucenieku to Ganību Street, Skrunda Street section from Jelgava Street, Jelgava Street section from Mucenieku to Ganību Street, Skrunda Street section from Jelgava redevelopment of the Street to the Zāles Street Circle in Kuldīga, Belss, 2013.

of a relatively large plot of land with the residential building, animal stables, other farm buildings and a garden, but it it also had a large paddock on the outskirts of the city, a patch of meadow away from the city, and the right to graze its livestock in comunal city pastures. From the 19th century with the development of industry, the city limits have expanded significantly. As the city expanded, the buildings were located in the city's pastures.

**20th century (40s - 90s)**

The city limits also changed significantly in the post-war period. The previously undeveloped agricultural lands were excluded from the city territory, but the residential buildings on the right bank of the Venta were included in the city territory.

In the middle of the 20th century farming was centralized, creating extensive pasture and farmland outside the city area. There was an increasing need for agricultural production and a variety of versions were searched and applied to increase yields. When assessing the topographical maps and photographs of the Soviets (see Map 1), it is concluded that the banks of the river Venta were also managed during this period. Large agricultural lands, including grasslands, remained along the rivers. Drainage of agricultural lands has been carried out in some places, and ponds have been installed in the northern part of the area. The forest areas formed small, fragmentary, narrow strips along the banks of the river or clusters of trees that developed by overgrowing river mourning. There were several farmsteads or detached houses in the riverbank strip, denser buildings of the city center have developed north of the old Kuldīga bridge, on the left bank of the river.

The Venta river as a transport corridor has had an impact not only on the formation of buildings in the oldest period of the 13th-19th century, but also in the 20th century Soviet years. During the active operation of the veneer factory "Vulkāns", its employees or employees of industries related to the operation of the factory (for example, tree floats) built private houses - mainly in the vicinity of the left bank of the Venta in the area called Putnudārzs. The housing stock was also built for factory workers.

**20th century 90s – today**

After the restoration of the independence of the state, the property rights were restored or they were transferred to the management of the municipality. The study concludes that in some places during this time there has been a coverage of aquatic plants of open areas - grasslands and coastal slopes, with trees and shrubs. In the part of the city center, a grassland was installed on the banks of the river (see Map 1 “Comparison of historical maps”).

**Location of Map 1 “Comparison of historical maps”**

### 2.2.2 Historical uses of the river

The types of historical use are widely described in Aija Melluma's book, "Kuldīga. Times. People. Landscape"[15] and, unless it is mentioned otherwise, the conclusions of the work of Aija Melluma have been used in this chapter. Historical uses are described in Map 2 "Demonstration sites of historical uses of Venta river. Recommendations".

The Venta river as a strategically important object with a wide range of uses still does not lose its relevance, however, today, the Venta river, compared to the 20th century 70s, is used passively. The Venta river was intensively used, with different but strategically equal interests - sailing, tree floating and fishing. These all were ancient occupations that provided income for both the existing power and the nobles, and therefore a struggle for priorities erupted from time to time.

*Figure 5. View of the Venta fall and the river's right bank in Kuldīga. 20s of the 20th century.*

[15]"Kuldīga, Times, People, Landscape", Melluma, A., 2017

**Fishery**

Venta has long been a fish-rich river known specifically for fish species such as salmon, river trout, river lamprey, vimba, etc. Not only today, but also in the past, fishing in the Ventas fall is associated with traditions. Information on the importance of fishing on the banks of Venta has been preserved in the names of home since the distante past. The map from around 18th of the neighbourhoods of Kuldīga features homesteads with names like Lower Fishings, Mountain Fishings, Old Fishs, River Ports.

Catching *flying fish* (vimba and salmon) on the Venta fall during the spawning season is an ancient and unique way of catching fish. It's mentioned in old documents and drawings. This unique way of catching fish is also recorded in photographs and cards on the 1st half of the 20th century[16] (see Figure 6).

*Figure 6 View to the Venta fall in 30s - 40s in the 20th century. (source: An exhibition on Venta)*

One of the oldest and most detailed descriptions of the construction traps is found in the "Universal lexicon" issued in year 1735, as the construction of lamprey trap took place, as did the canals or chutes, as was the fishing arrangements, such as the duties of

[16]"Exhibition for Vent", Museum of Kuldīga Municipality

sworn Rumba fishermen. Later, in 1938, when fishermen of Rumba were surveyed, the chutes were called “forgings.”

As an aside-watcher's eye, catching vimba in the fall were given in the memories of Doctor Rosinus Lentilius (on the time (1677–1680)[17]: “Some may find it hard to believe that the Courlanders have a way of catching fish in the air. This doesn’t surprise anyone there. (…) Not far from Kuldīga there are short rapids in the river; when the fish have swum up to the rapids, not knowing how to get through them, they try to make a huge jump to get over the elevation, but on the other side there are special baskets set up in a wide row, into which many of them slip, and in this way they are caught in the air."

A small drawing of a fishing weir on the border of map of Curland, drawn by architect Barnikel in 1747, has gained symbolic importance. According to its motives, the painting of salmon and vimba fishing weir by an unnamed author appears Figure 7.

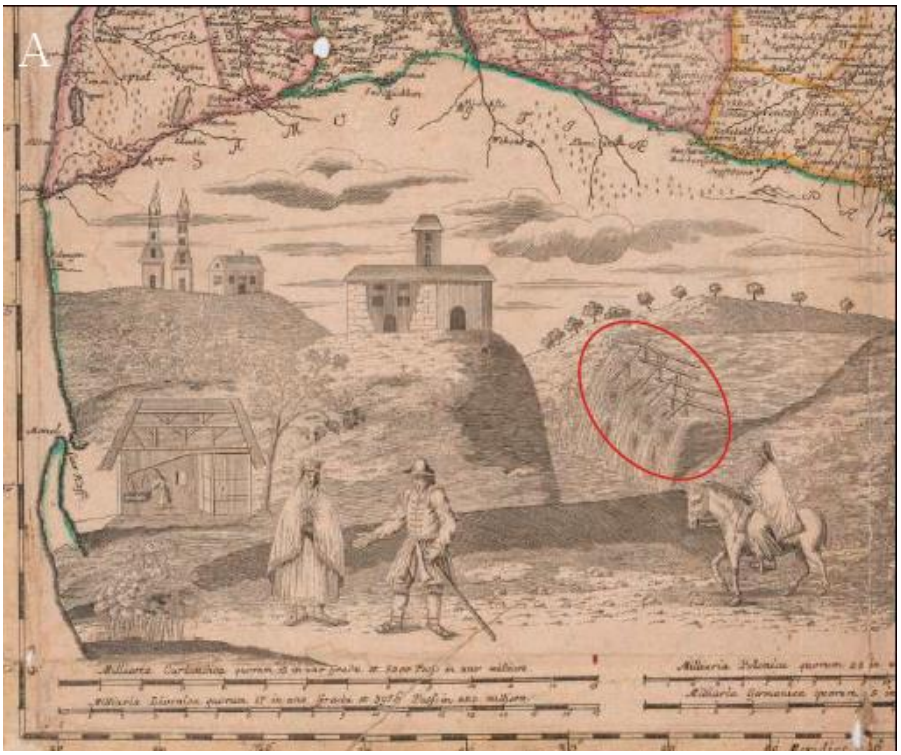

*Figure 7 Drawing of the Venta fall by map theme. Source: S. Cimermanis[18], 1998, p. 27.*

[17]Lentily R. *Curlandiae quadem notabilia.* This is kind of remarkable about Kurzeme. A. Tentel tulle from Latin *Writings of the University of Latvia.* Riga, 1924, 11, 3, 38, 40, 64.
[18]Chimerman S. *Fishing and fishermen …,* p. 27.

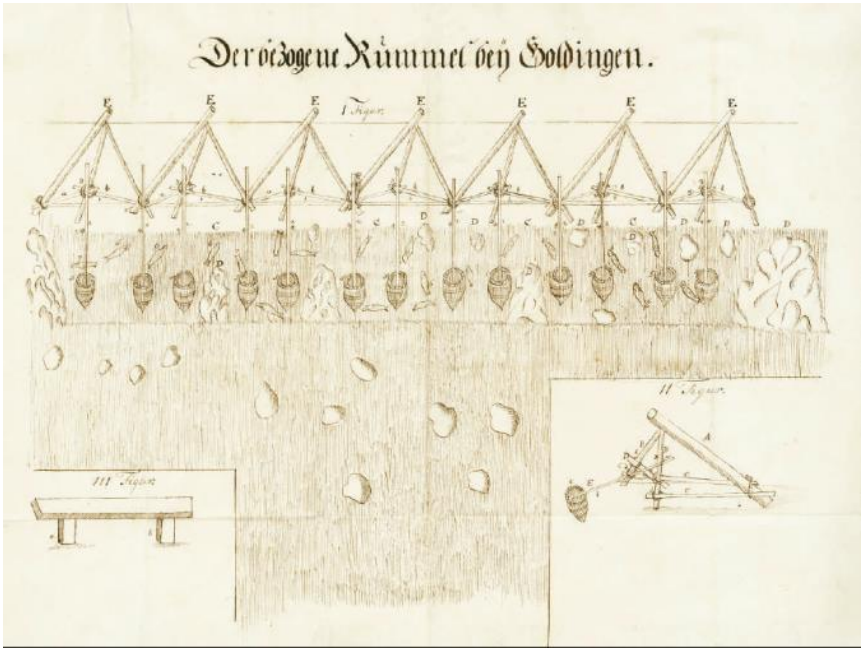


*Figure 8 Venta fall. Illustration by J. C. Weigant, 1729 Source: LVVA 7363. f., 3. apr., 951 l., p. 251.*

Most importantly, it is probably not known when the construction of the fish trap on the Venta fall occurred. An old legend that this specific type of fishing from the air was created by Duke Jacob. The historical documents suggest that such a fishing technique was known by the ancient Courlanders, as evidenced by the antique names of fishing accessories and their own activities. In addition, the construction of the fish-baskets was adjusted to the conditions on the Venta, was based on observation and knowledge about the nature of the river and about the life cycles of the fish. Therefore, it was experience gained from working at this over an extended time period.

In reality, the natural qualities of the Venta fall, as a place typical of Kuldīga, are so closely intertwined with people's lives and activities over centuries, that it is difficult to overestimate its cultural-historical importance, especially if we bear in mind the evidence about the ancient fishing method, the equipment, the names, and the breadth of knowledge and experience which developed and has existed around the Venta fall for an extended time period.

Many images of the Venta fall have been preserved in collections of old photographs, where the constructions set up for fishing needs can be seen. In looking at the aesthetics

of postcards, without knowing about the significance of the constructions, they may seem unattractive.

Whereas, information about the oldest fishing rights can be found in the Kuldīga Crown Manor's (Amt Goldingen) regulatory documents from the mid-19th century and afterwards in the matters relating to the dividing up of the manor during the agrarian reform when Latvia gained its independence. There is information on the fact that the manor leased the rights to fish on the Venta fall and placed notices about this in the newspaper, for example, on 24 December 1836 in Latviešu Avīze"[19].

The 1890 survey is especially significant in the context of the history of the Venta fall. On the map it can be seen that the channels or drains on the Venta fall can be found by both banks of the river, but that there is a free belt (as required by the regulations) in the middle of the river. At that time, there were 89 channels in total, with 32 of the channels or drains being on the town side. The documents of the time do not show the owner or who had ownership rights over the channels. The situation changed later during the period of Latvian independence.

In accordance with the 1920 agrarian reform law, the Venta river was included in the National Land Fund and it was determined that the state alone owned fishing rights. Only four old fishing establishments — both of the Rumba farms and both Upesosta farms by the Riežupe — continued to maintain their fishing rights as they had been recorded long ago in the Land Registers and other documents.

Around the 40th decade of the 20th century the survey of the Venta fall took place and 30 drains were listed on the town side with their owners' or users' surnames (see Figure 9).

[19] Other preaching. *Latvijas Avīze,* No 52, 1836, Dec 24, p. 208. Available at: www/periodika.lv

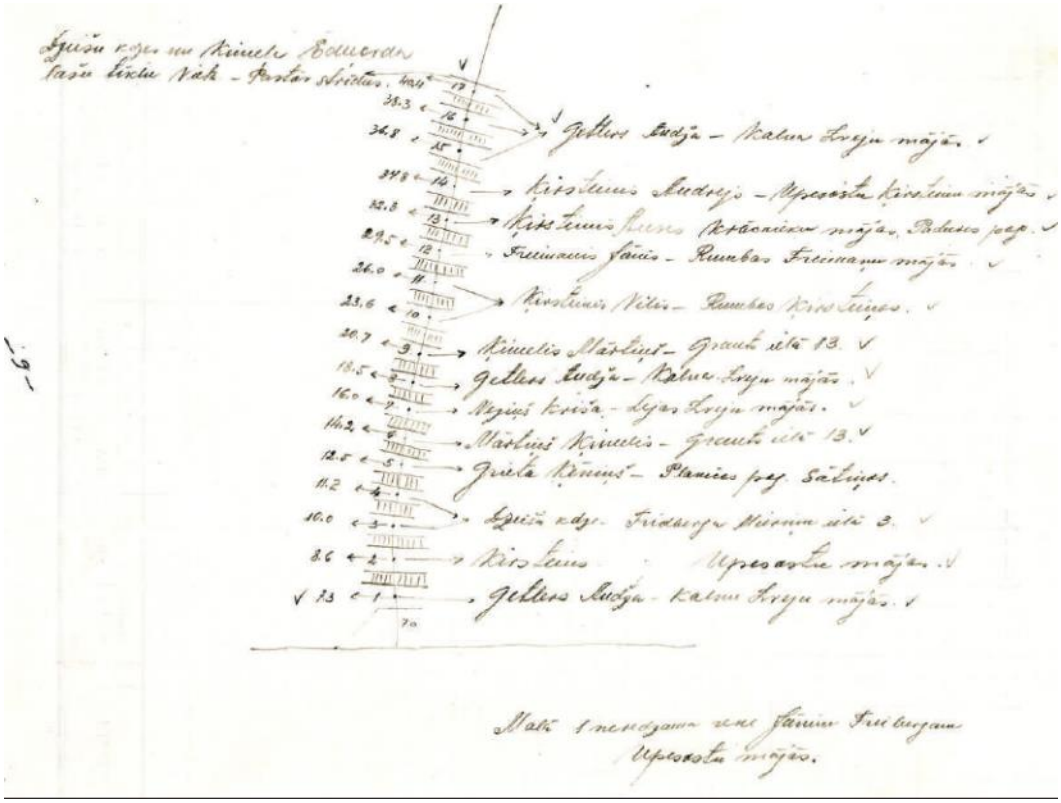

*Figure 9 measurement of Venta Ruba on the city side, 1938 (fragment) Source: LVVA 7154. f., 1. apr., 1348. l.*

**Venta as a waterway**

Venta as an important waterway and land road from Rīga through Tukums and Kandava, further to Aizpute, Klaipēda, Kenigsberg (now Kalingrad), to Marienburg (now Malbork), along with natural advantages, were the main factors contributing to the development of the Kuldīga as a residential area[20].

Venta joins wider areas - from Lithuania to Ventspils - and Kuldīga all along the way was of great importance, which was largely determined by the existence of a Venta fall. It was a natural barrier that needed to be overcome, but it required effort, since it was necessary to reload shipments of boats or rafts, to haul the boats downstream of the fall.

[20]Jobsons J. Cultural and historical heritage in a cultured urban environment. Promotion work, RTU, 2012

In this way, the power of Kuldīga was manifested. And since it was a transport hub, there was a need for warehousing and settlement places for travelers in Kuldīga.

Since the 13th century, there has been a continuous struggle in the interests of shipping, in various ways, against fishing barriers in the river, namely dams which were often deployed throughout the river and which hindered the movement along the river. Detailed rules on the deployment of fishing gears in rivers were issued in the 17th century.

By law in the 19th century. Venta was designated as a public river and was prohibited to instal anything that could hinder shipping (the river Venta, according to the Civil Law, is still a river of public waters). A free band to be left in the middle of the river, so-called *kōnigsader*, the width of which should have been no less than 14 cubits in the Kurzeme rivers (1 m corresponding to 1,87 cubits).[21]

The contradictions and disputes in the use of the river are well illustrated by the Mayor of the town of Kuldīga E.H. Stavenhagen letter to Emperor Paul I in 1800, with a simple request. Namely, to forbid fishing using weirs (they were set up at 50 sites) in the lower reaches of the Venta, as they blocked the river to its full width and goods-carrying boats could not pass through them, thereby hindering the town's development. The fishermen protested, too, as the weirs and timber rafting interfered with the fish routes, and harm was done to fishing in this way.

In ancient times, rivers served as traffic routes, and therefore concerns about the maintenance and cleaning of rivers was a fact of life. For example, town employees already participated in the cleaning up of the Venta in 1624. Care for the condition of the Venta did not subsequently diminish over the centuries, which is evidenced by the regular requests for funding

In 1631, the intention was to improve shipping conditions in Venta from the Lithuanian borders to Kuldīga[22]. It also relates to Duke Jacob's initiatives, such as the many times-mentioned attempt to blow up Venta fall in 1648. The work was not likely to continue,

[21] LVVA 5542. f., 7. apr., 196. l., 93, 94. lp.

[22] Yushkievich J. *Duke Jacob's era in Kurzema.* Riga: State Securities printing works, 1931, p. 283.

not only because (according to the stories) the palace building could be threatened, but also because the destruction of Venta fall alone would not have the necessary effect, it would not improve the situation throughout the river. Immediately after the change in power, namely, the establishment of the Courland Governorate, the Russian government's engineers, including the highest-level civil servants, became interested in this problem.

The documents recorded attempts to bomb the Venta fall, while the excavation works of the Venta fall were launched in the 17th century during the time of Duke Jacob and continued on several occasions, including at the beginning of the 20th century, but did not reach the target. Evidence of the construction of the pipeline is still available on the right shore of Venta near the Island Mārtiņsala[23] (see Figure 10).


*Figure 10 A picture of the Jacob Canal in Kuldīga. 20s 30s in the 20th century. Photo: A. Gessau (Source; www.zudusilatvija.lv)*

At the beginning of the 18th century, a project involving the deepening of Venta not only in the downstream, but also up the stream, as well as connecting Vent to the river Dubisa, which is the second-degree tributary of Nemuna. The short reports also

[23]Material from the exhibition on Vent

describe the nature of the project: digging up channels and building floodgates so that rafts and hauls can be transferred.

The work was commenced, or at least, there is information that both owners of the houses by the Venta fall were paid compensation of 100 silver rubles already in 1824, but the real canal digging work in Kuldīga took place in 1825. This is illustrated by the descriptions in the newspaper "Latviešu Avīzes". There is currently no direct information as to how long the work took place, but it is thought that it was discontinued for both political and economic reasons. However, there are two monuments from that time in Kuldīga: the bypass canal by the Venta fall (known as Jēkaba Canal) and the less known one — in the bend of the river near Kalnamuiža (opposite Firksa Manor, now Virka).

Two more significant sources confirming the existence of the great Venta improvement project (its legal side) should be mentioned, and they date from 1827. It can be concluded that broad research was undertaken on what was needed for the project's development, especially along the banks of the river where the names of the farmers and farms were established.

The second document is a large-format album of maps, 19 pages in all, which cover the complete flow of the Venta from the Lithuanian border to Ventspils. Land which was "transferred for the construction of the Venta Canal and for the statutory 10 *sāžens* wide reserve along the banks (бечевник – in Russian)" are marked on the map. There are the signatures of high officials on each page, as well as the place and date where the project was discussed. Material about the town of Kuldīga can be found on the 9$^{th}$ page, and it is interesting that the approximate area of land to be requisitioned next to both channels (nearby the Venta fall and Kalnamuiža) is marked on the map. An almost 20-year battle would take place at the end of the century and in the early 20$^{th}$ century on this matter.

Immediately after Latvia regained its independence, the renewal and development of the river channel was considered, and the utilization of the power of the river (as it was expressed at that time). In 1919, the Waterway Authority Activity Programme was developed, and the Venta was recognised as a nationally significant river within this. In the first stage, the improvement of shipping conditions from Ventspils to Kuldīga

were planned, and in the second — from Kuldīga to Skrunda, "along with the construction of the bypass canal at Kuldīga".

An economically important way of using Venta river during the 20th and 30th decade of the 20th century was by shipping traffic between Ventspils and the Kuldīga berths. This type of water traffic was used to transport both passengers and different goods. At Kuldīga, the ship's berth was on the shore of Ventas near Virka Manor. There was enough depth to allow the ship to turn around, and a comfortable place for a berth to access goods from land. Shipping traffic didn't work regularly. This was influenced by both the low water levels in the river and the developed banks and the float of timber[24] (see Figure 11 and Figure 12).


*Figure 11: Kuldīga Ships Pier. 20s - 30s in the 20th century. (source: "An exhibition on Venta", Museum of the municipality of Kuldīga)*

[24]Material from the exhibition on Vent

*Figure 12 Ship for transporting goods and passengers from Kuldīga to Ventspils and back. (berth on the beach of Venta behind LLT) 20s - 30s in the 20th century. (Source: "An exhibition on Venta", Kuldīga Region Museum)*

The importance of Venta as a waterway was reinforced in 1948, when the city's development plan, already under Soviet authority, envisaged the same thing: improving shipping conditions in Venta not only from Kuldīga to Ventspils, but also further, from Kuldīga to Nīgrande.

The only testimony about the use of the river Venta as an energy resource (construction of a hydroelectric power plant) comes from the Soviet time, when the idea of building a hydroelectric power plant near Venta fall existed. However, the idea was not realized - either the representatives of the new power were not in the course of real resources, or the developers of the development plan had not lost confidence in the great possibilities of the river Venta.

The idea of the Venta waterway, which raised its head every so often for over 300 years and was a part of life in the town, faded away after this. However, some evidence has remained.

**Timber floating**[25]

Since the end of the 19th century, when the industry was rapidly developing, the most efficient way to bring prepared timber from the forests of Kuldīga to the companies of Kuldīga and Ventspils was the Venta waterway. Floating in the 20s and 30s of the 20th century was the most widely used and economically beneficial way of transporting timber, which was also widely used after World War II. After the end of the front line, the forests of Skrunda, Rudbārži and Nīkrāce were destroyed, and the splintered timber was being floated through Venta to Ventspils, because the veneer factory "Vulkāns" was unable to use them.

In Venta, timber was floated at a stage of 176 km, starting to float 6 km from the Lithuanian border. Timber  at the length of 20-22 m were used for floating (see Figure 13). One batch of timber was "driven" by 10-80 people. Timber intended for the veneer factory "Vulkāns" were detained above the Venta fall in the "Vulkāns" water garden (see Figure 14 and Figure 15). Downstream of the Venta fall, the floating timber were received and floated to Ventspils. The most conscientious floaters built individual houses in Kuldīga at the area of Putnudārzs from their income.

In later years, as the number of road transport increased, some of the timber was transported by trucks. Already in 1967 dams, ragatas, pontoons were removed, but due to the storms and wind, the flooding had to be restored again and work had to be continued. The float works in Venta and elsewhere were completely interrupted in July 1972.

[25]Materials collected by the Kuldīga Municipality Museum for the exhibition "Exhibition for Vents"

*Figure 13 Timber floating in Venta across the Venta fall, around 1925. (source: "An exhibition on Venta", Museum of the municipality of Kuldīga)*

Contract workers and salaried seasonal workers worked in the float, about 120 people in total. The timber was floated to the Zlēka, and they were sorted out and tied in rafts in at Dikļi. The plotters carried 26 km to the Latches, where they were carried by a tug-boat to Ventspils.

*Figure 14 workers at the Finiers factory's "The Volcanon" at work in the factory's watergarden. 20s - 30s in the 20th century. (source: "An exhibition on Venta", Museum of the municipality of Kuldīga)*

In 1947, Venta's bed was dredged, deepened and cleaned to allow the ship to go. By 1948, a special ship with a low draught carried rafts from Dzikļi to Ventspils, and the heavy work of the hands was reduced.

Due to the fact that the popular farm needed timber, transport was lacking, timber was placed in the float, which should not actually be floated, for example: aspen, pine tops, burning wood. That increased the percentage of sunken timber. Normally sinks about 1-2% of timber, in practice more. The sunken timber started to be highlighted from 1949. Around 1958, some 900 cubic meters of sunken timber were highlighted, while another 2,000 cubic meters were lifted in the rest of the year.

There were difficulties in the life of the float, because they had to stay in front of the river, where they were, only to start renting out private houses and sleeping houses to the float. Around 1964, it began to bring people to work and back.

All these years of float, the veneer factory "Vulkāns" was supplied with veneer and sawn wood. 10 to 14 thousand cubic meters of timber were suspended upstream in Ventas fall water garden and released to the veneer factory "Vulkāns". The "Vulkāns" also held timber near Zlēkas, and was transported from there by road to the Vulcan. The

other timber was received by factory “Ventspils koks”. The timber transshipment base was received by pulp mills, while the firewood was received by consumers through the sales base.

*Figure 15, a group of workers in the factory's “Vulkāns” adopt trees on Venta. 1930s (source: “An exhibition on Venta”, Museum of the municipality of Kuldīga)*

**The veneer factory “Vulkāns”**

A special place in the memory of the people of Kuldīga is the factory “Vulkāns”, which occurred as a match factory but became a major wood recycling factory, and for decades has given work to many inhabitants of Kuldīga. This is especially remembered by the representatives of the older generations, whose years of strength coincide with the years of Soviet rule and who worked in the factory themselves. Although "Vulkāns" is no longer in operation today, many people from Kuldīga are reminded of the buildings, apartments and memories of their working lives.

There is a story from the history of the factory “Vulkāns” about delivering the production to Stende Station till the First World War. It was usually carried in six and seven carriages, a man with a bushy, long beard, dressed in black as a coachman. Mailing pigeons were used to notify Kuldīga that the cargo had been delivered on time.

During the development of the study in 2019, a few buildings have remained on the company's territory, containing ruins of demolished structures, rubble, three sites being potentially contaminated sites (their contamination has not been investigated, areas close to the river where the company has accumulated shavings. This situation does not affect the stability of the river Venta. With the closure of the factory, abandoned buildings and rubble in the area, the landscape of this part of the city has changed, which has historically been a calling card of the city's economic life for a long time. However, it does not affect the study area - the landscape of the Venta valley - locally - changes in this landscape can be observed in a small section of the left bank of the Venta river, which is located closer to the territory of the former company.

**Recreation and activities**

In the 50s - 70s of the 20$^{th}$ century at the end of July in the Venta river, below the old bridge “Driver days” were celebrated. Representatives of district council farms, collective farms and companies with their work cars took part in this festival. During the “Driver days”, competitions in several classes and several disciplines were organized. Drivers competed in agility rides, mountain driving, and one of the disciplines was forcing Venta by car. (see Figure 16 and Figure 17).

*Figure 16 Kuldīga ATU-7 transport along the competition route across Venta. 60s of the 20$^{th}$ century.*

*Figure 17 'Drivers day" in Kuldīga. On the right shore of Venta, the drivers are ready for competition - Venta's forbidding in road transport. 60s - 70s of the 20th century. Photos: J. Lapins*

Sports activities in Venta were actively organized in the 70s, when water tourism competition "Spring at Venta fall", "Venta 72", etc. were organized. The competition took place two days in April, shortly after the spring floods near the old bridge in Venta. The best water tourists in the republic participated in the competition, showing skill and agility in overcoming streams and rapids in double peaks and inflatable boats. In the later years, activities have also taken place in Venta, where the route to be conducted with different watercraft was from the old bridge to the mouth of the river Riežupe (see Figure 18 and Figure 19).

*Figure 18: Spring at Venta fall. Organized by the Kuldīga tourist club. 1971 10. -11. IV.*

*Figure 19 of the tourism competition "Venta-72" in Kuldīga, 22-23 April 1972.*

**Conclusions**

The Venta valley nature complex, including the city, has remained as a place of existence of rare and endangered species and habitats, with coastal terraces, a unique nature formation - Venta fall, which together with cultural heritage sites forms a characteristic landscape of Kuldīga.

The change of land use type (economic activity) in the study area has been closely related to the stages of historical development, when the growth of the city and its surroundings took place.

The use of the riverbanks was impacted also by expropriation of land for the dredging of the Venta river and other works related to the improvement of navigation conditions.

Impact on the socio-economy

The development of Kuldīga was influenced not only by the Venta river as an important transport corridor, but also by the existence of the Venta fall as an obstacle. The Venta fall served both as a fishing spot and was a natural barrier to navigating the Venta. This was the basis for the development of a transport hub (stop) in Kuldīga, which promoted the development of other services - the hospitality industry, warehouses, and the development of craft services.

Based on demand, the supply of accommodation for timber floating developed.

The Venta river has been used as a transport corridor and thus has had an impact on the formation of the city's buildings not only in the oldest period of the city's development in the 13$^{th}$-19$^{th}$ centuries, but also in the 20$^{th}$ century Soviet years. During the active operation of the veneer factory “Vulkāns", its employees or employees of industries related to the operation of the factory (for example, timber floating) built private houses - in the vicinity of the river Venta left bank – area called Putnudārzs. The housing stock was also built for factory workers. According to the demand, the supply of accommodation for tree floats developed.

Impact to the landscape

Main ascpects that impaceted landscape formation

- in the Middle Ages, agricultural land was located outside the city fortifications. Residential buildings are located on the left bank of the river, slowly expanding along the river bank in a northerly direction;
- in order to improve navigability, the construction of a canal around the Venta fall began in the 17th century. The construction works did not result in a navigable canal, but had an impact on the landscape by introducing a landscape element that is not typical of the Venta valley;
- during the times of manors (17th-18th centuries) the river banks were managed - mowed, grazed, up to the river water or fields;
- the beginning period of 18th-19th and the 20th century is characterized by the use of the Venta riverbanks, using traditional agricultural methods for the management of the territory - grazing, mowing, cleaning of fields and vegetable gardens;
- in the interwar period, agriculture was not intensive. Due to the shortage of people and horses, 30-45% of the fields were uncultivated and unsown;
- In Soviet times (mid-20th century), agriculture was centralized, creating extensive pastures and agricultural land outside the city. The need for agricultural products increased, so various solutions to increase the yield were searched and used;
- after the restoration of the independence of the state, the property rights were restored or they were transferred to the management of the municipality. The study concludes that in some places during this time there has been overgrowing of open areas - grasslands and river riverbank - with trees and bushes;
- the aesthetic quality of the modern Venta river has decreased because the river is not used intensively (economic need has disappeared) and therefore the area of the water surface, which is an important element of the landscape, has decreased.

Impact on ecology

The historical use of the Venta has affected the ecological status of the river, as the river and its bed have been regularly cleared of aquatic plants and their roots during the maintenance of the water transport route and the floating of timber, thus limiting the spread of aquatic plants and coverage of aquatic plants. This, in turn, prevented the

development of eutrophication processes, as less nutrients from dead aquatic plants accumulated in the river.

Today, the ecological status of rivers is more significantly affected by other factors (climatic conditions, nutrient inputs from catchment areas), so the positive impact of restoring potential historical uses will be relatively small.

**Location of Map 1 "Demonstration sites of historical uses of Venta river. Recommendations"**

## 2.3 Assessment to renewal of historical uses

The oldest use of the river can be restored as a demonstration of historical uses, demonstrating certain activities related to the earlier use of the river for educational and cultural purposes. For proposals see Map 2 “Demonstration sites of historical uses of Venta river. Recommendations”.

As **renewable uses** are offered:

- renewal of water tourism competitions - in order for the competitions to be successful, they would need a municipal initiative, taking part as the organizers of the competitions. The competition is held in the spring, during the high-water level season in Venta river. Suitable place - downstream of the Venta fall to the brick bridge.
- barge route - downstream of the castle mound. Offer for summer time. The barge route is possible from the berth at Virka Manor and below, assessing the depth of the river. In total ~ 40 min long trip (round trip).
- routing of boats, rafts, SUPs and other floating craft (mainly during the summer season) from the new bridge up to the Venta fall. Recommended as an opportunity to return to the Ventas fall for those who walk along the Venta river left bank path to the new bridge.
- restoration of Duke Jacob's canal - by clearing the coverage of aquatic plants and giving it an educational and entertainment function. Possibilities to demonstrate geomorphology throughout the exhibition site.
- installation of fish baskets on the Venta fall to demonstrate the ways in which fish were caught in baskets in the past.
- crossing the Venta river by horse. The offer can be created in cooperation with private businesses. There are shallow places in Venta river suitable for river crossing. Crossing the Venta by horse can be both an alternative to a pontoon bridge and a parallel offer.

The study concludes that there are also historical uses that **are not renewable** directly from their previous use. Those are:

- timber rafting in Venta;
- "Driver Festival".

## 2.4 Specially protected nature areas

The vast majority of the area of the study (almost 90%, 186 ha) is occupied by a nature reserve "Ventas ieleja" that concentrates its natural values. Tehere are identified 6 types of grassland habitats, 4 types of forest habitats as well as one type of freshwater and one habitat for rock outcrops of European Union importance[26], to be protected. There are 16 specially protected or rare plant species, including 8 specially protected species[27], 4 species for which micro-reserves are to be formed[28]. They are all included in the Latvian Red Data Book. In addition, the area is important for the protection of fish and for the conservation of biodiversity. It contains 3 specially protected fish species of limited use in Latvia[29.], 3 specially protected species of invertebrates have also been identified in the area of the study. A detailed description of the nature values of the pilot area is given in Chapter 3.5, their placement is shown in Map 8 "Nature values".

In addition, the geological and geomorphological nature monument "Ventas rumba" and protected trees are still in the vicinity of nature.

The location of the functional zoning of specially protected nature areas, the nature conservation "Ventas ieleja", is shown in Map 3 "Specifically protected nature areas".

[26]Auniņš A., 2013. European Union protected habitats in Latvia. Detection manual. 2. Expense specified. Riga: Ministry of Environmental Protection and Regional Development
[27]Cabinet Regulation 18.11.2000. Regulation No 396 "Regulations regarding the List of Species to be Specifically Protected and Species to be Limited"
[28]Cabinet Regulation No. 940 of 18.12.2012., Regulations Regarding Procedures for the Establishment and Management of Microreserves, Their Protection, as well as the Determination of Microreserves and their buffer zones
29Cabinet Regulation 18.11.2000 Regulation No 396 "Regulations regarding the list of specially protected species and restricted specially protected species" Annex 2

### 2.4.1 Nature reserve "Ventas ieleja"

The conservation status of the nature complex in Venta valley has already been established in 1957, with a special status in 1999: nature reserve status[30]. The site is a protected nature area of European interest *Natura 2000*[31]. A nature conservation plan for the area has been developed for the period 2010-2020[32]. The functional zoning of the territory and the individual requirements for protection and use of nature closures are determined by Cabinet Regulation No. 548 of 16 September 2014 on the "Individual Protection and Use Regulations of Nature reserve "Ventas ieeja"".

Nature reserve is designed to protect the specially protected habitats of the importance of Latvia and the European Union (such as Tilio-Acerion forests of slopes, screes and ravines, boreal forests, semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco-Brometalia*), water courses of plain to montane levels, etc.) and species (e.g. wingy pig, maurdock, lax, masonry bracken, lark dijtaurin, marble rosebeetle, salmon, trout, river lamprey, etc.), their habitats (especially the spawning and residence of salmon-shaped fish and lamprey), as well as the river Venta valley as a single ecologicaly important complex (Regulation No 548, paragraph 2, of Cabinet regulation 16.09.2014.). there are defined 4 functional areas for the protection and use of the site: nature conservation zone, nature park area, landscape protection zone and neutral zone.

In the pilot area, the wider areas (122 ha) are occupied by a landscape protection zone. It is designed to ensure and promote the development of areas of deep and socio-economic importance of nature conservation, without lowering the landscape value of the nature reserve. The nature restricted zone is defined in the northern part of the study area of 25 ha, which also contains the Veckuldīga mound. The nature conservation zone has been established to ensure the protection and management of forest habitats and species of special conservation of the role of Latvia and the European Union. The nature park area (29 ha) is defined in the area around the nature conservation zone and the

[30]Cabinet Regulation No 212 of 15 June 1999 — Provisions on nature closures in 1999
[31]The Law of the Republic of Latvia On Specially Protected Natural Areas. Annex "Latvian *Natura 2000* — List of nature protected areas of European interest" (version of Law 1993, 15.09.2005.)
[32]Nature conservation plan for the period 2010-2020. Estonian, Latvian & Lithuanian Environment Ltd, 2010.

separate areas at the eastern edge of the study area. The nature park area is designed to protect the natural park landscape structures and the natural and aesthetic values of landscape elements, biologically valuable areas and specially protected habitats. A neutral zone has been defined to ensure the development and sustainable economic exploitation of densely built areas, as well as to ensure the maintenance and development of transport infrastructure facilities and covers 10 ha from the pilot area. In assessing the objectives of establishing functional zones, it can be concluded that, along with the nature conservation objectives, particular attention has also been paid to ensuring the protection of the landscape of Venta valley, which is permitted in the landscape protection zone and nature park area.

The nature conservation plan outlines the long-term objective: the nature conservation area combines the interests of the conservation of nature, municipalities and landowners and ensures the protection of a single natural complex (river valley); preserves the terrain, landscape and ecological processes inherent in the area, ensuring the conservation and maintenance of the most biologically valuable areas and habitats in the river Venta and its valley.

The area of the “Ventas ieleja” is a developed tourism infrastructure based on the sustainable and gentle use of local natural, cultural, historical and human resources, promoting the activity and education of visitors to the area on environmental and nature protection issues.

**Location of Map 3 “Specially protected nature areas”**

### 2.4.2 Protected trees - noble trees

There are four protected trees in the area of the study[33,34]: the three pedunculate oaks *Quercus robur*[35] growing in the Kuldīga mound and one ash *Fraxinus excelsior*[36] at the site of the Kuldīga medieval castle.

The requirements for the protection and use of protected trees in relation to the area of the study are included in Regulation No 548 of the Cabinet of Ministers on 16.09.2014.

### 2.4.3 Geological and geomorphological nature monument "Venta fall"

Just above the old bridge over Venta is the Venta fall, which ranges from 100 to 275 meters, depending on the season. The height of the Venta fall itself is approximately 2 metres. The status of the geological and geomorphological nature monument "Venta fall" has been established for the Venta fall since 1977. At present, the protection of the natural monument is determined by Cabinet Regulation No. 175 of 17 April 2001, Regulations Regarding Protected Geological and Geomorphological Natural Monuments (Annex 85). Its territory is included in the *Natura 2000* area (nature reserve "Ventas ieleja"), thereby contributing to the preservation of this unique nature structure. The requirements for the protection and use of this natural monument are included in Regulation No 548 of the Cabinet of Ministers 16.09.2014. and are aimed at preserving the natural monument of the natural monument and the natural aesthetic, ecological and cultural and historical value.

**Conclusions**

The natural heritage of the study area is one of the preconditions for the development of the landscape characteristic of the Venta valley. Venta valley landscape protection and development measures in the territory of the nature reserve "Ventas ieleja" have to be

[33]Nature Conservation Management Natural Data Management System "Ozola" Information
[34]Protected trees shall be in the case of local and non-indigenous species (trees, the circumference of which at 1,3 metres above the tree root neck or height of which is not less than the dimensions referred to in Annex 4 of these Regulations) - and the area around trees in the crown area, as well as in a 10-metre wide band from the outer edge of the crown of the protected tree (measured from the projection of the crown of the protected wood))
[35]In Map "Specially Protected Nature Areas" Nos 1, 2 and 4
[36]In Map "Specially Protected Nature Areas" No 3

planned in the functional zones of landscape protection and nature park, because the protection and development of landscape structures and landscape elements of natural and aesthetic value is defined in the objectives.

# 3 Landscape and ecological assessment of the river Venta and it's riverbanks

The landscape and ecological assessment of the river Venta and its riverbanks has been carried out by identifying problems, evaluating the projects already implemented in the territory and the conclusions reached.

Venta has a total length of 346 km (of which 178 km on the territory of Latvia), a pool area of 11 800 km$^2$, 6600 km$^2$ on the territory of Latvia[37].

## 3.1 Geological and geomorphological structure, assessment of nowadays geological processes

The absolute height markings of the lowland of Pieventa in the city of Kuldīga and its adjacent area shall not exceed 35-40 m a.s.l., but in the valley of Venta (floodplains) not exceed 10 m a.s.l. The decrease of the river bed at the study phase ~ 6 km is on average 1,5-1,8 m/km. The depth of the river at this stage shall not exceed 3 m at normal water level. There are clowns and islands on the bed.

Just above the bridge over Venta is the Venta fall (Figure 20), which ranges from 100 to up to 275 meters, depending on the season. The height of the Venta fall itself is approximately 2 meters. The status of the geological, geomorphological nature monument "Venta fall" has been established for the Venta fall since 1977. Its territory is included in a specially protected nature area in the nature reserve "Ventas ieleja", which is also included in the list of specially protected nature sites of European interest *Natura 2000*, thereby contributing to the preservation of this unique structure.

[37] National Encyclopedia, 2018

*Figure 20 Venta fall (photo I. Gavena, 2019)*

The configuration of the Venta fall is not static – the water falling across the fall is temporarily washing out, the thin-faced dolomite of the Plavinu formation, forming the river base, which causes Venta fall to move up the stream very slowly.

Venta valley is terraced throughout the exploration area, composed of several over flood terraces and floodplains.

### 3.1.1. Geological structure

The city Kuldīga, like all of Latvia, is part of the NW part of the Eastern European platform. Its geological structure is characterized by two radically different structural elements of rock composition, age and development history: crystalline basement and sedimentary blanket.

**Crystalline basement**

Basement rocks are composed of a wide variety of composition and age metamorphic and intrusive rocks dislocated at the pre-platform development stage. The denuded surface of these rocks is covered by a variety of composition denuding crust (depending on the mother

rock). Due to the high depth, the level of exploration is low, and its geological structure does not reflect to any extent and does not affect the area of the study and its exploitation objectives in the River Valley of Venta.

**Sedimentary blanket**

The second, the newest element of the platform, is composed mainly of homogeneous (chemical precipitation) and clastic (rubble) rocks. Sediments have mainly settled in sea basins of varying depth and salinity of water.

The estimated thickness of the sedimentary blanket in the area of the city of Kuldīga reaches approximately 1300 m. The sedimentary blanket consists of two substantially different geological elements – pre-quaternary sediments and quaternary sediments (Map 4 "Pre-Quaternary geological map and sections").

The deeper layers of pre-quaternary sediments are composed of the clastic sediments of the Cambrian period, consist mainly of sandstones with interlayers of clay and aleuritis, and cover the crystalline basement. In the research and adjacent areas have not deep wells that would disclose Cambrian sediments, according to general data, predictable thickness of Cambrian system sediments ranging from 250 to 300 m.

The sediments of the Ordovic system are embedded above the Cambrian system sediment, represented mainly by carbonate rocks - marl, clay, limestones, dolomites, argilites. There are no wells in the exploration and adjacent areas to reveal this layer, the estimated thickness of which is 100-150 m in the city of Kuldīga.

Silurian system sediments cover the carbonated Ordovic rocks. The Silurian sediment layer is the thickest with possible thickness approximately 550 m in the exploration area. The Silurian system consists of marls, limestones, clay, argillites, domerites and dolomites. All these sediments have been formed under marina conditions, in the paleo-Baltic basin.

The widespread and well-researched sediments of the Devonian system lie above the Silurian system rocks. The Devon period is characterized by significant changes in paleogeographic conditions and sediment composition. In the area of the city Kuldīga, the total sediment thickness of the Devonian system exceeds 400 m. The sediments of the

Upper-Devonian forming a surface of the sub Quaternary surface as well as exposed in the Ventas Valley.

The sub Quaternary surface in the study and adjacent areas consist of the Upper Devonian clastic and carbonate rock. Carbonate rocs of Pļaviņu, Salaspils and Daugava formations are recognized from the new bridge to the Venta fall. Meanwhile, the clastic sediments of Gauja and Amata's formations form make sub Quaternary surface downstream of the Venta fall, north of Kuldīga. The boundary between these rocks in Venta valley is the Venta fall, which is made up of the Dolomite of the Plavinu formation. The formation of the Ventas fall has been determined by the presence of a dense monolithic layer of bioherms (coral, stromatolite, etc.) at the base of Venta valley. The dense horizontal layer of dolomite, together with the leaching of less durable layers with the river stream, ensures the formation and existence of a distinctly continuous step over the entire width of the river valley. Below of step, in the bottom of the river the more easily washed clastic sediments of the Amata eformation – sandstones, clay, aleirites – are exposed.

**Location of Map 4 “Pre-Quaternary geological map and sections”**

*Figure 21 Plavinu formation dolomite outcrop (Photo I. Gavena, 2019)*

The dolomites of the Pļavinu formation (Figure 21) are exposed in the river bank in surrounding area of the fall and upstream of it.

The outcrops of dolomite at the edges of the fall will also continue slightly along the edges of the riverbed in the direction of the downstream. In bank outcrops are well-observed dolomite layers structure and with a layering, individual fossil and mineral formations (stomatocytes, calcyte crowds, etc.). The outcrops of dolomite have both scientific and aesthetic value. They are the habitat of European Union importance for 8210 *Calcareous rocky slopes with chasmophytic vegetation*.

The sandstones of Amata entourage are exposed only on the river bed, where they are mostly covered by a layer of alluvial sediments that, not exceed 1 m thickness.

Dolomites in the Venta fall and the adjacent banks gradually erodes. The cracks with in the dolomites accelerate this process - but the process is very slow. According to the results of the consultations with the Nature Conservation Agency geology specialists it is concluded that there are no specific measures are needed to stabilize the Venta fall. It should be noted

that the change in the Venta fall has historically occurred as a result of human economic activity – the dolomite from the fall area has been used in construction (13th century). During the the building process of the Order's Kuldīga Castle), the nuggets for fishing were set up in the Venta fall. Historical information is insufficient to detail the extent and location of impacts in the Venta fall.

The dolomites of the Plavinu formation are also exposed to the bed of the river Alekšupīte, creating it in the form of a climber.

There is an artificial float created on the river Alekšupīte - a former mill lake maintained by an existing dam (Figure 22). In general, the downstream area of Alekšupīte has been substantially transformed over time, both during the construction of the Order's Kuldīga Castle and later by setting up the mill. An artificial spill and an artificial overhead has been created to ensur the operation of the mill. When installing a mill floodplain, the riverbed was artificially deepened below the floodplain, possibly by cutting the dolomite material and using it in construction. It is possible that there has already been a small waterfall originally, which has been substantially artificially elevated, both by building a dam and by deepening the bed. In the absence of any historical evidence of Alekšupīte in the area prior to its transformation, it is virtually impossible and pointless to detail the extent of the changes at this time.

*Figure 22 Alekšupīte waterfall and mill dam (photo I. Gavena, 2019)*

**Quaternary sediments**

Quaternary sediments are distributed throughout the rest of the exploration area. Their thickness, origin and lithological composition are variable. The thickness of the quaternary sediments varies between 5-7 m and 15-20 m (Map 5 "Quaternary geological map and section").

The largest part of the exploration area is covered by the limnoglacial sediments of the Baltic series (lgIIIbl), consisting of clay, dusty sand, sand mixed with gravel and pebbles in some places formed in adjacent glacier basins. The layer thickness of these sediments is predominantly approximately 10 m but may also reach a thickness of 20 m. On the left bank of the river Venta in Kuldīga, the limnoglacial sediments are exposed in about ~ 20 m high scrap. It consists mainly of sand with small interlayers of clay and dusty sand. An unbound sand in scrap is subject to an active erosion process.

The limnoglacial sediments form a river valley-bound plain with separate low hills.

The over the flood terraces throughout the Venta valley are formed by alluvial (near glacier water stream sediment) sediments of the Baltic series (aIIIbl). Their lithological composition consists of sand of various coarseness with more or less admixture of gravel and pebbles. The thickness of alluvial sediments in the top terraces varies from 1-2 m to 4-5 m.

The fluvial terrace and the islands on the riverbed are formed by the alluvial sediments (aIV) of the Holocene (nowadays or post ice age), their lithological composition include sand, parts with pebbles and gravel. The thickness of these sediments does not exceed 2 m, slightly higher on an island where 3 m can be reached.

Holocene proluvial diluvial sediments (pdIV) (sediments of ravines and shaves) occur sporadically, in some places on the slopes of the steeper and upper fluvial terraces. The thickness of these sediments does not exceed 1 m and consists of sand and clay sediments (see Map 6 “Geomorphological map and sections of Venta valley”).

**Location of Map 5 “Quaternary geological map and section”**

### 3.1.2. Geomorphological conditions

Venta valley, the city of Kuldīga, and its immediate surroundings, are located in the lowland of Pieventa. Its relief is mainly formed by a flat wavy limnoglacial plain crossed by a terraced valley of the Venta river.

The absolute height of the surface of the land of the plain range from 27-30 m to 35-40 m a.s.l., but in the Venta valley, the absolute height of the surface of the river terrace does not exceed 10 m a.s.l.

Outside the Ventas Valley, low (3-5 m), slow-glazed hills rise in some places above the plain, while the accumulation slope of the marginal terrain are in the south-west of Kuldīga.

The depth of the Venta river valley increases from north to south. Above the Venta fall, it gradually increases from the new bridge to the fall from 10 - 15 m to 20 m, further down to the Veckuldīga castle mound the depth of the valley increases to 40 m.

*Figure 23 Venta valley and Alekšupīte inflow in Venta (Foto I. Gavena, 2019)*

The width of the valley is variable and ranges from 1,3 km to 2,1 km in the pilot area[38]. In certain sections of the valley different level terraces can be traced, starting from II to IV

[38]Venska V., Review of the Geological Construction of Venta valley, Geomorphological, Hydrao - and Engineering Geological Conditions in the City of Kulgia and its immediate surroundings, Riga, 1989

(see Map 5 “Quaternary geological map and section”). No detailed terrace mapping was found during the preparation of the study.

An Alekšupīte flooding, with a historically built dam, currently forms an artificial waterfall. The bottom of the river below the waterfall is most likely man made during the construction of a dam and construction of the Order’s Kuldīga Castle. The bed below dam is deepened to the bedrock (Figure 23).

*Figure 24 on the right shore of the River Terrace Venta (Photo I. Gavena, 2019)*

Visual observations show that the width of the terraces varies greatly, from 10-15 m to 100 and more meters. Their surfaces are flat with a pronounced slope towards the river (Figure 24).

In separate phases of the valley (upstream form Venta fall on both banks and downstream from the city on the left bank of the river Venta), the upper fluvial terraces form a scrap, with up to 20 m high, just above the bottom of the river (Figure 25). Mostly, the scrap is covered with trees and shrubs, just downstream of Kuldīga, it forms a partially covered outcrop.

*Figure 25 Scrap bank, Venta left bank, Black Kolka (photo I. Gavena, 2019)*

The flood terrace or floodplain in the study area can be traced on both banks of the river, except for the sections with the scrap banks described above, whose bases mostly reach the river level and water level fluctuations and currents contribute to the development of erosion processes. The width of the floodplain is mostly small, up to 10 m, and only in some places it is wider. The floodplain is characterized by a pronounced slope towards the river (Figure 26).

Several islands have developed downstream from the Venta fall.

*Figure 26 Floodplains and up floodplain terraces on the right coast of Venta, scrap banks on the left coast of Venta (Photo I. Gavena, 2019)*

**Location of Map 6 “Geomorphological map and sections of Venta valley”**

### 3.1.3. Hydrogeological conditions

The study area, the city of Kuldīga and the Venta valley are located in the central part of the Baltic artesian basin. The active water exchange zone in which fresh waters (corresponding to drinking water quality waters) are present in the exploration area from the below-lying slow water exchange zone in which the salt waters (corresponding to the composition of the table mineral waters) are separated by ~ 100-105 m thick Narva ($D_2nr$) regional low permeable formation, formed by layers of siltstone, marl, dolomite and clay.

The active water exchange zone (freshwater distribution area) in the research area formed of quaternary and pre-quaternary upper and middle Devonian sediments. The following aquifers are defined in the area:

- Quaternary aquifer (Q);
- Upper Devonian Plavinas aquifer (D3pl);
- Upper Devonian Gauja - Amata aquifer complex (D3gj + am);
- Middle Devonian Arukila - Burtnieki aquifer (D2ar + br).

In the Venta vally and its tributaries, the alluvial aquifer are formed by alluvial sediments in the river valley. Their lithological composition is relatively uniform (various grained sand with a potential mixture of gravel and pebbles). This aquifer is unconfined, distributed only in the river valley, mostly with a small thickness (not exceeding 5 m). The aquifer is hydrologically related to the Venta river, during floods the river complements the water horizon, while in the low water period there is a leakage of groundwater into the river. Water resources on the aquifer are limited by water level fluctuations from 0,5 m to 3 m. The water level is close to the surface of the earth in some places on the lower topmost over flood terraces and there is overswamping processes determined.

In places where sandy rocks of limnoglacial origin are located at the base of the upper flood terraces, a common unconfined water complex of alluvial and limnoglacial horizons is formed.

The recharge and leakage of aquifer is a complex and often changing system. Under normal conditions, the river Venta is a leakage area of alluvial and limnoglacial aquifers, but when water levels in the river are high, leakage is disturbed or completely interrupted, but in some cases river waters charge aquifer. Alluvial sediments are characterized by high water

permeability and the aquifer is located on the surface, so it is highly sensitive to surface contamination.

In an area outside the Venta valley the groundwater horizon is shaped by the limnoglacial aquifer. Its lithological composition – sand of a variety of graining, some places with a small mixture of gravel and pebbles. The water permeability of these sediments is good. The thickness of the horizon is variable. The limnoglacial aquifer is replenished by atmospheric rainfall, while the leak area is the river Venta, in the form of small sources on the slopes of the over flood terraces.

Confined or artesian aquifers related to the sediments of Upper Devonain Pļaviņas and Amata formations. In the area of exploration there is no observed leaking places (springs), however, taking into account that in many places the rocks of Pļaviņas or Amata formations are directly exposed in the riverbed, Venta is considered to be a local outflow area of these horizons.

### 3.1.4. Engineering geological characteristics

The sediments to be assessed within the framework of the engineering profile in the Venta valley and the adjacent area are stained, sandy quartar sediments or cemented bedrock.

Clay sediments are associated with the quaternary clay of limnoglacial origin, which is exposed to the surface of the ground or occurs as interlayers in sandy sediments of the same genesis, or lying under alluvial sediments in some places. Clay is characterized by a tightly plasticized or semi-solid consistency and slightly increased compressibility.

Sandy sediments of alluvial, limnoglacial and fluvioglastic origin are distributed in most parts of the area: various grained sand, mixed with gravel and pebbles, sand and dusty sand. The density of these sediments varies from loose (mainly alluvial sediments) to medium-dense and dense. Rock water permeability are dependent on lithological composition and density.

The cemented bedrock group is represented by the Dolomites of the Pļaviņas formation, which in some places exposed at the Venta valley upstream of the Venta fall. They are

covered throughout the rest of the area by a relatively thick layer of Quaternary sediments. Dolomites are dense, cracked and the cracks determine water permeability.

The sediments of Amata's formation – clay and poorly cemented, loose sandstones, found in some places in the low depths of Venta, are exposed at the foot of the terraces. Clay is characterized by a tightly plasticized or semi-solid consistency, while sandstones are lax.

### 3.1.4. Exogenous geological processes

In Venta valley, the development of nowaday exogenous processes is observed, mainly related to the geological activities of Venta river and geological processes in Venta valley, mainly on the slopes.

One of the most pronounced processes is the erosion of Venta's left bank at a distance of approximately 300 m downstream of Kuldīga. The bank here is formed mainly by sandy rocks intersected with clay layers. The surface of the slope is being washed off (especially during heavy rainfall) as sandy rocks are easily washed by the water. Due to the fact that the slope is very steep, the roots system of the trees and bushes forming the rounds cannot provide protection against sand leaching. Micro ravines and breakdowns are forming.

*Figure 27 Sand material collapses Venta's left bank, Black Kolka (Photo I. Gavena, 2019)*

On the other hand, the surface of the layers of clay is exposed to the release of ground water, which significantly lowers the resilience to collapses and landslides of the slope.

At the bottom of the steep bank, developing of the process of suffusion have been identified in some places. The development of suffusion processes is supported by fluctuations in river water levels and ground water levels observed during spring floods and severe rains. Due to suffusion processes decrease the persistence of sandy sediments forming the lower part of the slope. At this area, the width of Venta decreases, which increases the force of the stream that contributes to the erosion of sandy rock-shaped Venta left bank (Figure 28).

*Figure 28 River eroding activity, signs of sufusion (Photo L. Grīnberga, 2019)*

Unfortunately, so far, there have not been regular observations on the process development speed, a time when they are the most powerful. Only such observations may serve as a basis for recommendations to reduce bank eroding processes.

At the other areas of Venta valley, the expression of exogenous geological processes is relatively weak. Landslide occurs at certain stages on steep slopes

In several places, on the over flood terraces and the slopes of the base shore are recognized almost entirely subsided ravines. The development of the ravines in the valley has

practically stopped, the slopes are covered with grass, shrubs and trees, and only seasonal runoff beds are seen in the bottom of individual ravines. The presence of runoff beads shows that currently the ravines are also performing the functions of collecting and draining surface water, and the process of forming a ravine is underway: its deepening during the melting of snow or very intense rain period. But the process is periodical and not intensive.

The ravines have been formed in intensive surface drainage areas, mainly in the process of severe rainfall or rapid snow-melting water leaks. Most of the ravines of valley of Venta are the slopes ravines, which morphological feature is their placement relative to the slopes on which they are formed. The slope ravines do not hydrologically bind to the hypsometrically higher area and the local level of the erosion base. The ravine bed is localized only on the slope on which it was formed, or it crosses slope crot, but only the smallest part of the ravine (< 5 m). The process of formation of slope ravines can take place under the influence of both anthropogenically induced or the concentration or changes of surface runoff caused by natural changes in micro relief and vegetation cover. In the first case, it is the relief microforms of anthropogenic origin, such as arches, road surface recesses, existing terrain reductions, etc., that ensure the concentration of primary water runoff and the beginning of development of microravines. A large amount of precipitation water (in extreme rainfall) or snow-melting water (in the event of a very rapid melting, if a thick snow blanket is maintained) may lead to a rapid development of the ravines on the slope. Under the influence of human activities, with agrotechnical treatment of slopes, removal of coverage of aquatic plants or concentration of runoff in drainage system ditches or collectors and entering them upstream of slope ravines, regressive erosion intensifies and the top of slope ravines moves deeper into the slope. Thus, by obtaining a permanent water catchment basin, the ravine becomes hydrologically connected and begins to develop rapidly, becoming a typical ravine (Figure 29).

In order to avoid the risk of developing new ravines, a significant assessment of the activities carried out in the slope upstream of the croquet, since ill-conceived solutions can lead to a concentrated water leak down the valley.

Any measures in the areas of the existing ravines should be very carefully assessed as they continue work as surface drainage collectors and drains. A solution is to be welcomed by

strengthening the base of the ravine with, for example, gravel, riverbank of pebbles that prevents the ravine from deepening, without, at the same time, interfering with the leakage of water. Artificial removal of ravines (backfilling) can lead to the formation of new ravines in adjacent areas.

In small areas of the limnoglacial plain, and in some places on the lower surface terraces, there is overswamping.

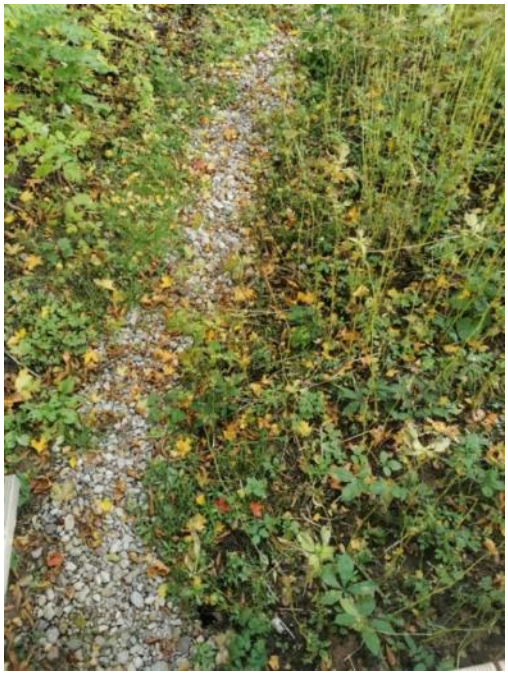

*Figure 29 A ravine, the base of which is protected from deepening by the burial of pebbles – rubble, on the right bank of the Venta in the section between Ventas Street and Vidus Street (photo I. Gavena, 2019)*

**Conclusions**

In order to analyze the structure of the Quaternary sediments of the Ventas Valley at a level to assess the compatibility of the planned management measures with the geological and hydrogeological conditions of the site, it is possible to use only the geological mapping materials of the level 1:200 000, which is not sufficiently detailed.

The only geological exploration work on the geological conditions of Venta valley is a report by Vilma Venska on the geological structure of Venta valley, geomorphological, hydro and engineering conditions in the area of the city of Kuldīga and its immediate

surroundings, Rīga, 1989. This report is also prepared on the basis of the materials of Soviet time mapping works. Further, for more accurate information, mapping of Quaternary sediments should be carried out in the area of the study.

The characteristics of hydrogeological conditions have insufficient information on the spread of individual aquifers, water resources and quality, and their treatment (i.e. seasonal and long-term changes in water levels).

The exogenous processes in the majority of river Venta valley are weak, with the exception of certain active erosion sites, the most important of which is the landfall of Venta's left bank downstream of Kuldīga, where erosion is promoted as river activity (leaching of the base of the floor, particularly during the floods), geological conditions (the landfall is largely loose, mainly fine grained sand sediments) as well as hydrogeological conditions (leakage of ground waters causing suffusion occurs at the base of the slope).

The dolomites of the Venta fall have partly decayed and dolomite pieces are removed from the fall under the influence of water operation and are gradually receding to the upstream river. However, this natural process is slow, so it is not necessary to take further special measures.

The outcrops of dolomite have both scientific and aesthetic value. They are the habitat of European Union importance for 8210 *Calcareous rocky slopes with chasmophytic vegetation*.

The slopes of Venta valley are stirring ravines, mostly stable at the moment, and there is virtually no development, but some areas of seabed leaching. In order to avoid the risk of formation of new ravines, a significant assessment of any ground works or water drainage measures taken upstream of the slope shall be carried out. Artificial removal of ravines (backfilling) can lead to the formation of new ravines in adjacent areas. It is recommended to reinforce the base of the ravine (e.g., with a splinter, pebbles riverbank), which prevents the ravine from deepening while not interfering with the leakage of water.

## 3.2 Hydrological characteristics of the river

For the hydrological characterization of Venta river the data from The Latvian Environment, Geology and Meteorology Center hydrological observation station Venta-Kuldīga was used[39]. The distance of this station from the estuary of the river is 81 km, the zero mark of the station is 5,33 LAS (Latvian height system) (5,16 BAS (Baltic height system)). Water level and water temperature measurements are automatically measured at the hydrological station, and the flow rate and ice thickness are measured manually. Since the pilot area covers a relatively extensive section of the river ~ 6 km, the data from the hydrological station was used without recalculating.

The hydrological regime of the river Venta is determined by the impact of the sea with relatively warmer winters and cooler summers. Venta is part of the hydrological district of West Latvia, characterised by two runaway peaks (spring floods and autumn rains floods) and a relatively short period of ice on rivers[40].

### 3.2.1. River bed

The bottom composition of the Venta river bed in the Kuldīga area is variable: upstream of Ventas's fall and fall is composed of dolomite, but downstream is composed from the sand, gravel, clay, and pebbles and stones. The established dense aquatic plant stands promote the accumulation of sludge and detritus (dead parts of plants) in a slow phase upstream of the fall and downstream on coasts and boddens.

### 3.2.2. Water level, flow rate and run-off

Figure 30 reflects the fluctuation of the annual average water level in the river Venta in 1961-2018. Overall, water levels have been stable and, with the exception of individual years, there are no marked increases or decreases. The highest annual average water levels in the period considered were in 1981 (173 cm) and 2011 (159 cm).

[39] https://www.meteo.lv/hidrologijas-station-map/? nid = 465

[40] Glazačeva, L., 1975. Surface waters. V.pool (red). The encyclopedia of Latvian PSR, the second, an additional edition. Science, Riga, 84-90.

Given that flow rates are closely linked to water levels, there is also no trend of increase or decrease for the flow rate over the considered period (Figure 31). The average flowrate from 1961-2018 is 69,4 $m^3/s$. The period from 1961-1976 can be described as a small-water period and 1977-2002 as a multi-water period. The highest annual average flowrates were in 1980 (122.8 m $^3/s$), 1981 (114,7 m $^3/s$) and 2011 (112,8 $m^3/s$). The lowest annual average rates were 1969 (33,6 $m^3/s$), 1976 (35 $m^3/s$) and 2006 (37,7 $m^3/s$). In the last five years, with the exception of the rainfall-rich 2017, a small-water period with a flowrate below normal has been observed.

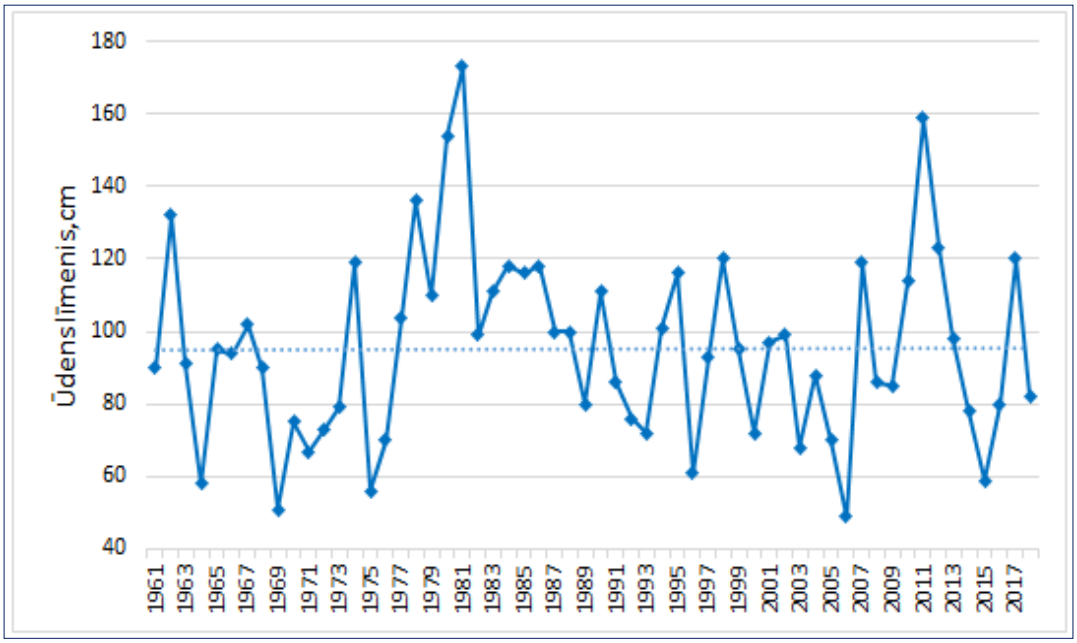


*Figure 30 Annual average water levels variability Venta-Kuldīga 1961-2018*[41]

[41]Images included in Chapter 3.2 are prepared using the data of the Latvian Environmental, Geology and Meteorology Centre regarding the hydrological observation station Venta-Kuldīga

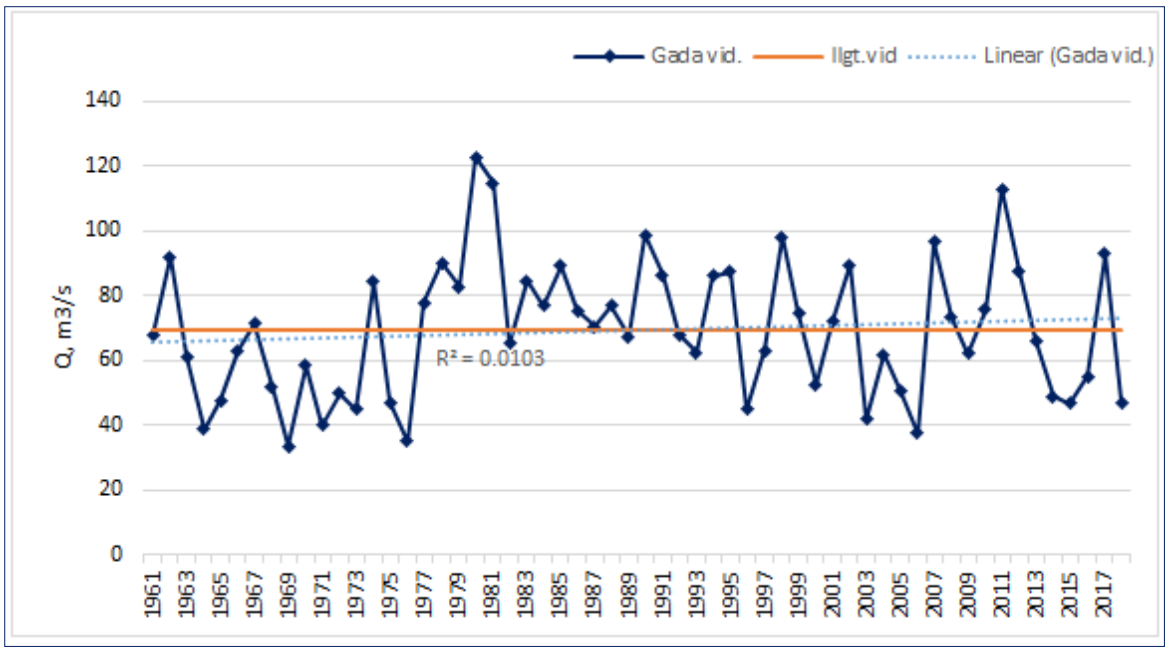


*Figure 31 Long-term changes to the annual average flowrate in Venta-Kuldīga 1961-2018*

In the long term, the lowest monthly average rates have been in July (23.5 $m^3/s$) and June (23.9 $m^3/s$), but the highest in April (132.2 $m^3/s$) and March (118,2 $m^3/s$). During the period 1961-1987, the highest monthly average flowrates were observed in April (168.3 $m^3/s$) and March (111.2 $m^3/s$), while the highest monthly average flowrates for winters in 1988-2018 are observed in January (126.9 $m^3/s$), March (124.2 $m^3/s$) and February (121.9 $m^3/s$).

Although the total flow rate has not changed significantly, significant changes have occurred in the seasonal distribution of the runoff (Figure 32) as the effects of climate change become more pronounced. Compared to the period 1961-1987, the winter runoff between 1980 and 2018 has increased by ~14%, while the spring and autumn periods are characterised by a drop-off trend of 9% and 4% respectively. During the summer period, no changes in the distribution of the runoff are observed in practice. The largest drop-off growth trend is typical in February (~7.4%) and January (~7%), while the largest decrease is in April (8.8%).

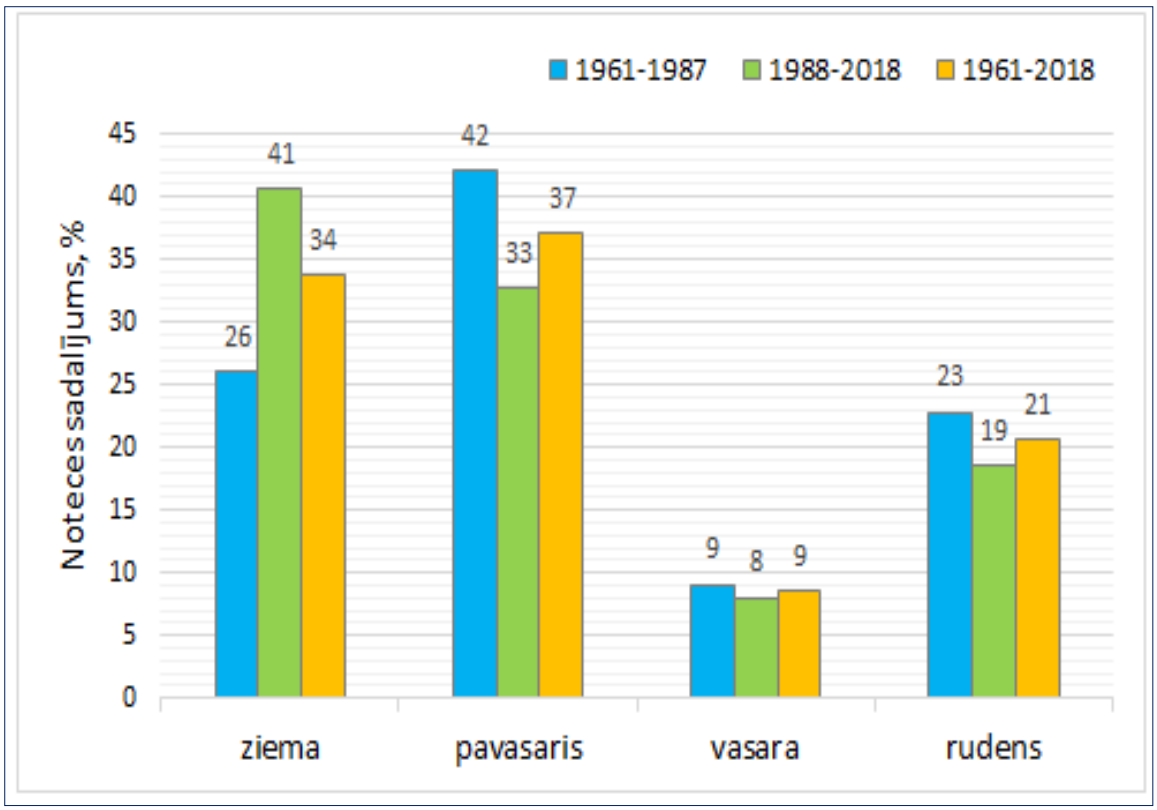


*Figure 32 Season change in runaway in Ventas by periods*

### 3.2.3. Ice cover changes

During the reviewed period, significant changes in the ice regime have been observed in the Venta river. Starting from 1987, the number of days when a stable ice cover is covered in Venta (in Kuldīga) has significantly decreased (see Figure 33). If before 1986 the ice cover had formed on average 50 days in the winter, then after 1987 only 15 days on average. Spring ice congestion is also decreasing in Venta.

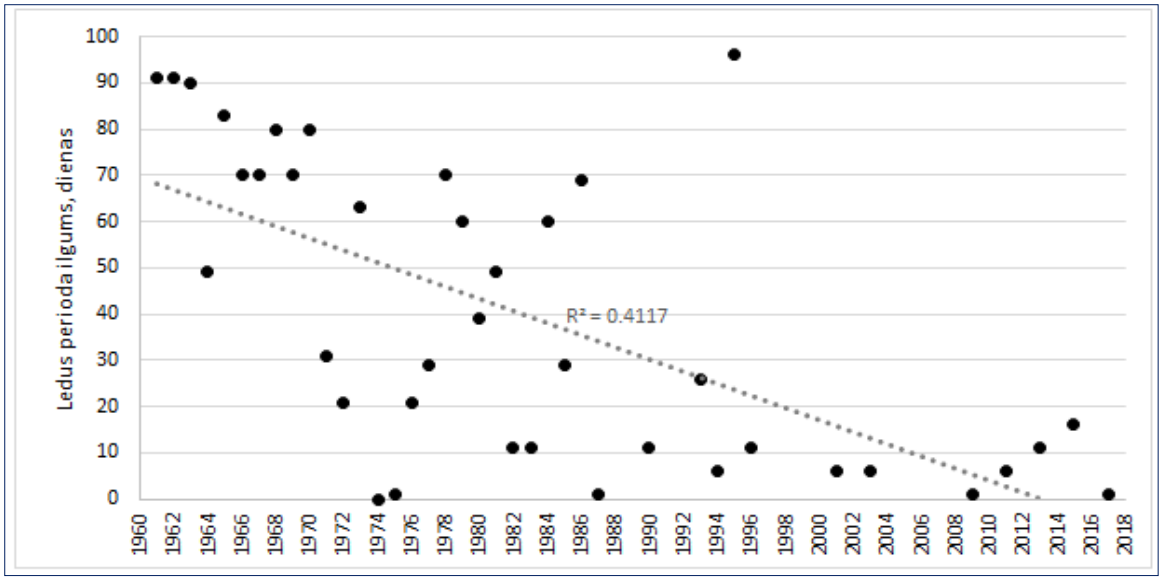


*Figure 33 The duration of the ice period 1961-2018*

The thickness of the ice cover during the observed period is characterized by a small, statistically insignificant decreasing trend. The thickest ice cover in the river Venta was in the winter of 1995/1996, when it reached 59 cm (Figure 34). The ice formed at the end of December and held until the end of March, which is the largest ice cover duration in the period considered. In general, since the late 1980s, the period when Venta river is under the ice has been decreasing and ice cover becom thinner.

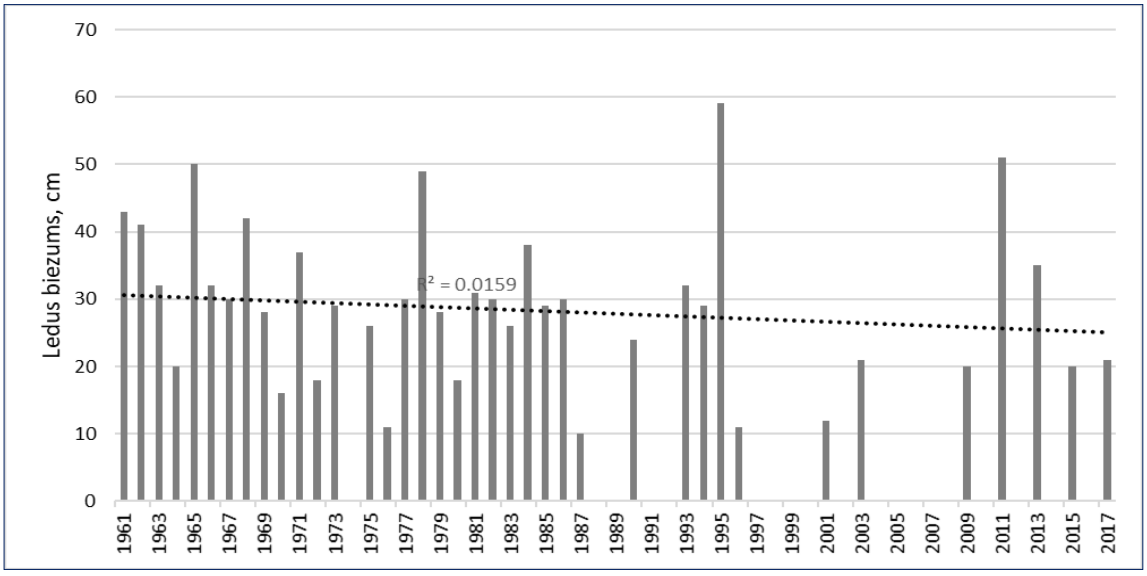


*Figure 34 Maximum Ice Thickness in Venta-Kuldīga 1961-2017*

### 3.2.4. Flood process and floods

The studied area of the river Venta does not belong to the flood risk areas of the national importance of the river Venta basin area[42]. In the pilot area, Venta forms a vast valley with steep shores that serves as a natural anti-flood defense and significant flooding in the city is not observed.

Levels of flooding of the banks of Venta:

- the water level of 10% flooding at the site of observation station Venta-Kuldīga (81 km from the estuary of Venta) is 12,87 m (Latvian height system).
- the water level of 1% flooding at the site of observation station Venta-Kuldīga (81 km from the estuary of Venta) is 14,81 m (Latvian height system).

In the Venta, flooding of floodplains begins if the water level exceeds 12.60 m (Latvian height system) or is 735 cm above the zero mark of the observation station.

Overall, peak water levels tend to decrease (Figure 35) and peak flows are mostly below the floodplain flooding limit. The highest water level was established in 1968 (739 cm), which exceeds the flooding level (735 cm) by 4 cm. The second highest water level was observed in 1967 (717 cm). By 1987, ~70% of the maximum water levels were observed during spring floods (March, April), while after 1987 nearly half of the peak water levels were observed during the winter season (January, February). This is due to increased temperatures and decreased ice cover during the winter period.

[42]LEGMC, 2015

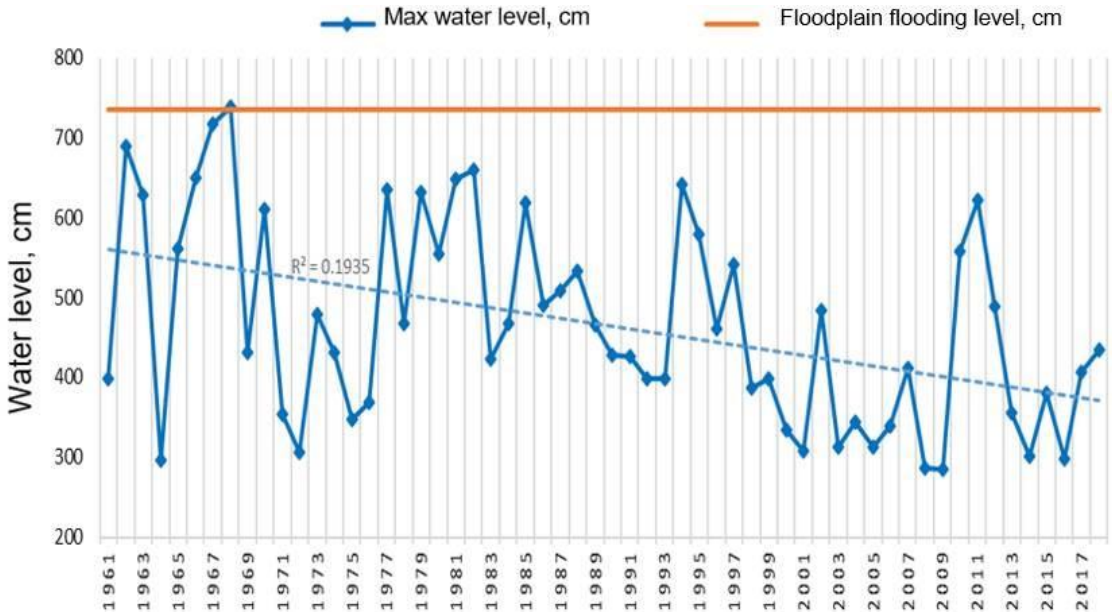


*Figure 35 Maximum water levels in Venta - Kuldīga 1961-2018*

**Conclusions**

Evaluating the data of long-term hydrological observations at the station Venta-Kuldīga in 1961-2018, it can be concluded that:

- the water level in Venta is stable, except for some years, and there is no significant upward or downward trend;

- the flow of the river does not show an upward or downward trend. The average flow rate is 69,4 $m^3/s$;

- there has been a significant change in the seasonal distribution of runoff. Between 1980 and 2018, compared to the period from 1961 to 1987, runoff in winter has increased by about 14%, while in spring and autumn there is a downward trend in run-off of 9% and 4% respectively;

- significant changes have also been observed in the ice regime of the Venta river. From the end of the 1980s, the ice period in the Venta river decreases and becomes thinner. By 1986, the ice cover had formed in the winter for an average of 50 days, but after 1987 - for an average of only 15 days. Spring ice congestion is also decreasing in Venta river. The

thickness of the ice cover is characterized by a slight, statistically insignificant decreasing trend.

Changes in runoff and ice regime are mainly affected by climate change.

Venta river in Kuldīga forms a valley with steep slopes, which serves as a natural flood protection. Therefore, the study areas of the Venta river section are not characterized by large flood areas.

There is a declining trend in maximum water levels. Maximum water levels are generally well below the floodplain.

The hydrological parameters of the river have a significant impact on the habitats in the Venta. Without the formation of an ice cover and an increase in flow during the winter, runoff from the surrounding areas increases and thus the amount of nutrients in the river increases. In turn, the decrease in flow in the spring and autumn period has a potential effect on fish migration and spawning. All the above-mentioned factors (non-formation of ice cover, decrease of flow in the spring period) promote the development of coverage of aquatic plants of the river. As the degree of coverage of aquatic plants of the river increases, the oxygen conditions in the water deteriorate, which has a negative effect on salmonid fish species. This impact is all the more important as there are priority salmonid fish waters in the Venta study area.

As the flow of the river decreases and the flow of water equalizes throughout the year, there is no seasonal and extensive flooding of the river banks. There are no temporary or long-term wetlands important for plant species growing in floodplains. More uniform vegetation is developing, as well as plant species characteristic for the drier habitats or monodominant stands of a species are beginning to dominate.

As the ice period and ice congestion decrease, the biodiversity of grasslands in the river floodplain decreases. On the other hand, ice flow and congestion, as well as seasonally strong stream, cause mechanical disturbances in the grassland area, partially destroying the vegetation, thus creating an area free of coverage of aquatic plants suitable for non-competitive plant species. As a result, the area's biodiversity increases and the preservation of open, non-bushy areas is ensured.

## 3.3 Stormwater drainage system in Kuldīga

In Kuldīga, the stormwater drainage system consists of open moats and rivers and of underground pipeline systems. Urban drainage of surface water is provided by the River Alekšupīte (Water drainage of national importance CODE 3638:01), rain sewer systems installed in part of the city (see Figure 36) and surface ditch network.

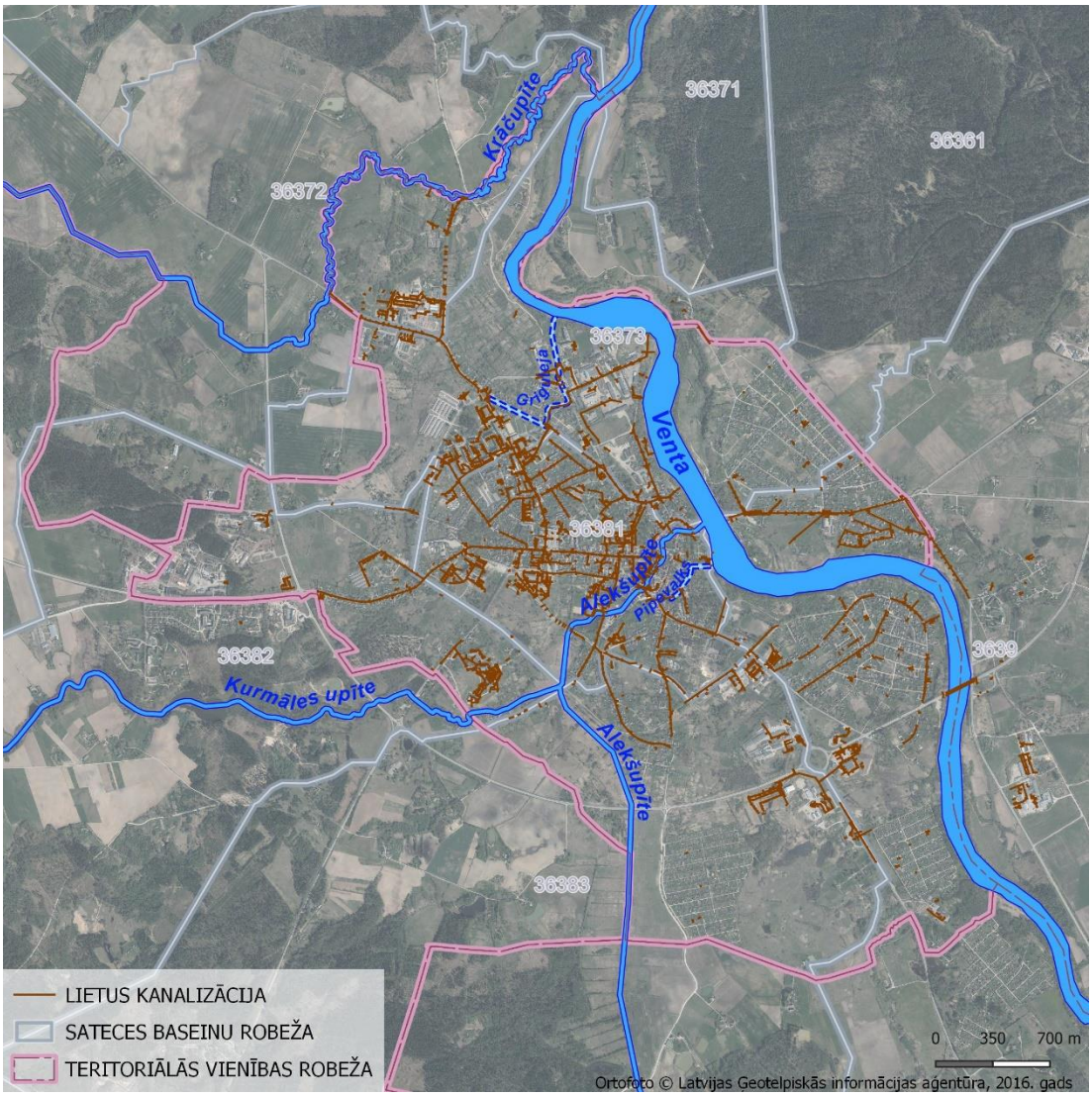


*Figure 36 Existing stormwater drainage system in Kuldīga*

Here is also a watercourse in the northen part of Kuldīga – in Virka, which is called Griguleja. Historically, there was also a second runoff on the left bank of Venta – Pipevalks (a tributary of Venta river). The watercourse flowed into Venta 350 m below the mouth of Alekšupīte. As the city developed, Pipevalks was partially built and discharged

underground. Contemporary placement of Pipevalks is to be clarified by geophysical exploration methods. The choice of the appropriate method and the measures to be taken to ensure research may be determined by geophysicist.

According to the information published by the State Limited Company "Ministry of Agriculture, Real Estate" (MARE) in digital a melioration cadastre information system www.melioracija.lv, the city of Kuldīga is divided into five catchment areas of State importance – No. 36373, No. 36381, No. 36382, No. 36383 and No. 363839.

### 3.3.1 Climate change and increased flood risk

The challenge in Kuldīga as well as in Latvia – how to transform stormwater from the (urban) problem to the (urban) resource into the urban environment, minimizing the risks of flooding areas during intense rainfall. In this issue, it is possible to direct the overall development in two directions:

1. Maintaining the existing approach: renovating old networks, focusing on conventional or "grey" solutions;
2. Existing networks are being renovated by integrating sustainable stormwater management elements – modern green solutions, with specific requirements for new development areas.

Urban stormwater forms from water-resistant coverings and can either be drained by conventional, or "grey" infrastructure solutions that direct stormwater to purification plants or open water bodies, either by means of sustainable stormwater management or "green" infrastructure solutions that provide for stormwater infiltration in natural pathways, while at the same time performing aesthetic functions. Research has shown that the costs and environmental impacts of "green" infrastructure solutions are generally lower than "grey" infrastructure solutions and are able to ensure water purification, but like any infrastructure, it requires maintenance and efficient management[43]. Sustainable stormwater management

[43]Dhakal, K.P., Chevalier, L.R. 2017. Managing urban stormwater for urban sustainability: Barriers and policy solutions for green infrastructure application. Journal of Environmental Management. 203 (2017), 171 – 181.
Foster, J., Lowe, A., Winkelman, S., 2011. The Value of Green Infrastructure for Urban Climate Adaptation. Washington, DC, Center of Clean Air Policy.

or “green” infrastructure solutions include, for example, landscape ports, cascades, gutters, ponds, rainyards, wetland, small rivers, water-permeable coverings, etc.

According to the data of the Latvian Environment, Geology and Meteorology Center, more frequent and intense stormfall is expected in the future throughout Latvia, including Kuldīga. Permanent observation data show ongoing climate change - overall average air temperature in Latvia has increased by 1 degree in the 20th century, while annual stormfall in the last 100 years has seen fluctuations with a tendency to rise from the second half of the 20th century.

The existing rain sewer system in Kuldīga does not have sufficient capacity[44] to accommodate more stormwater and protect areas from flooding in the event of extreme rainfall. For the identification of specific risk areas, hydrological modelling should be carried out, for example by using the *Storm Water Management Model (SWMM)* programme in short-term scenarios, identifying the necessary maintenance measures and the necessary activities for network development.

Assessing the experience of other countries in dealing with the consequences of floods, it has been concluded that floods cause great economic losses to both the city and its inhabitants, as well as hinder movement, disrupt road traffic and flooded property. The main risk areas include areas with a high proportion of water-tight coverings, where the main emphasis in stormwater management is placed on conventional (underground pipelines) networks, the exact risk areas in Kuldīga can be identified using hydrological modelling, with particular attention being paid to areas where flooding problems are already experiencing during intense rainfall.

Although there is a dense building structure in the older parts of the city of Kuldīga, where the use of green infrastructure solutions such as meadows, rainyards, large trees and other elements requiring a large area is not possible or is difficult, the building density on the periphery of Kuldīga is significantly lower, so that there is enough free, unconstructed area. successfully integrating green solutions into existing buildings or building new buildings, adapting preventive to climate change and avoiding future flooding risks.

[44]Assumption based on the experience of other cities with similar-age stormwater sewer systems

### 3.3.2 Principles for sustainable stormwater management (SUDS)[45]

Sustainable stormwater management is implemented through open moats, vegetation and water-permeable surfaces.

SUDS a set of techniques and complex techniques that mimic the drainage of rain water into natural ecosystems. The use of such systems in practice is experiencing increasing and justified popularity due to both climate variability and extreme rainfall and the various benefits and benefits. SUDS systems control and eliminate flood risks, improve and clean water, improve the quality of public outdoor areas, and ensure the promotion of biodiversity.

The introduction of SUDS solutions makes it possible to effectively combine both public and private governance with a view to creating a single stormwater management system that would bring urban landscape, ecological, aesthetic and recreative values into line.

The practice of SUDS provides the following **benefits**:

Improved environmental conditions in the urban environment:

- transforms the management of rain waters to a much closer cycle in natural ecosystems;
- reduce the quantity and concentration of impermeable coverings;
- increase infiltration capacity;
- reduce the risk of erosion;
- improving the microclimate by providing a variety of environmental functions (ecosystem services);
- increase areas covered by vegetation;
- reduce the urban heat-frost effect;

[45]Information from the project "Promoting the development of sustainable storm water management systems in cities of Estonia – Latvia's cross-border area for improving the environment of active and sustainable communities". Acronym "(D)rain for Life", project number EU41702. More information is available on the www.drainforlife.eu website of the project

- increasing biodiversity;
- reduce the size of the ecological “foot”;
- ensure the purification of water and the protection of natural water bodies.

Reduced load on the physical space of the urban environment:

- reduce the load on existing rain water drainage pipeline networks, collectors;
- reduce the load on existing water treatment plants;
- reduce the risk of flooding.

Improve the quality of the urban social environment:

- the public has the opportunity to be in physical and mental contact with open waters. Water is no longer matter that is trapped underground in the pipelines;
- SSWM solutions may be used for recreational purposes;
- promote the formation of civil society by directly addressing issues relating to the management of a harmonious environment and teaching the role of collective responsibility to local communities;
- draws attention to environmental protection and quality issues;
- educating the public on the ecology aspects of the urban environment.

### 3.3.3 Water flow direction model for Kuldīga

Using the possibilities offered by the ArcGis geographic information system, a water flow direction model for the whole city of Kuldīga has been developed (see Figure 37). This model takes into account only the existing terrain (does not take into account piplines and stormwater drainage networks), thus it allows to locally assess the direction of natural water runoff and select the most appropriate solutions to improve the situation, but not suitable for city-wide use.

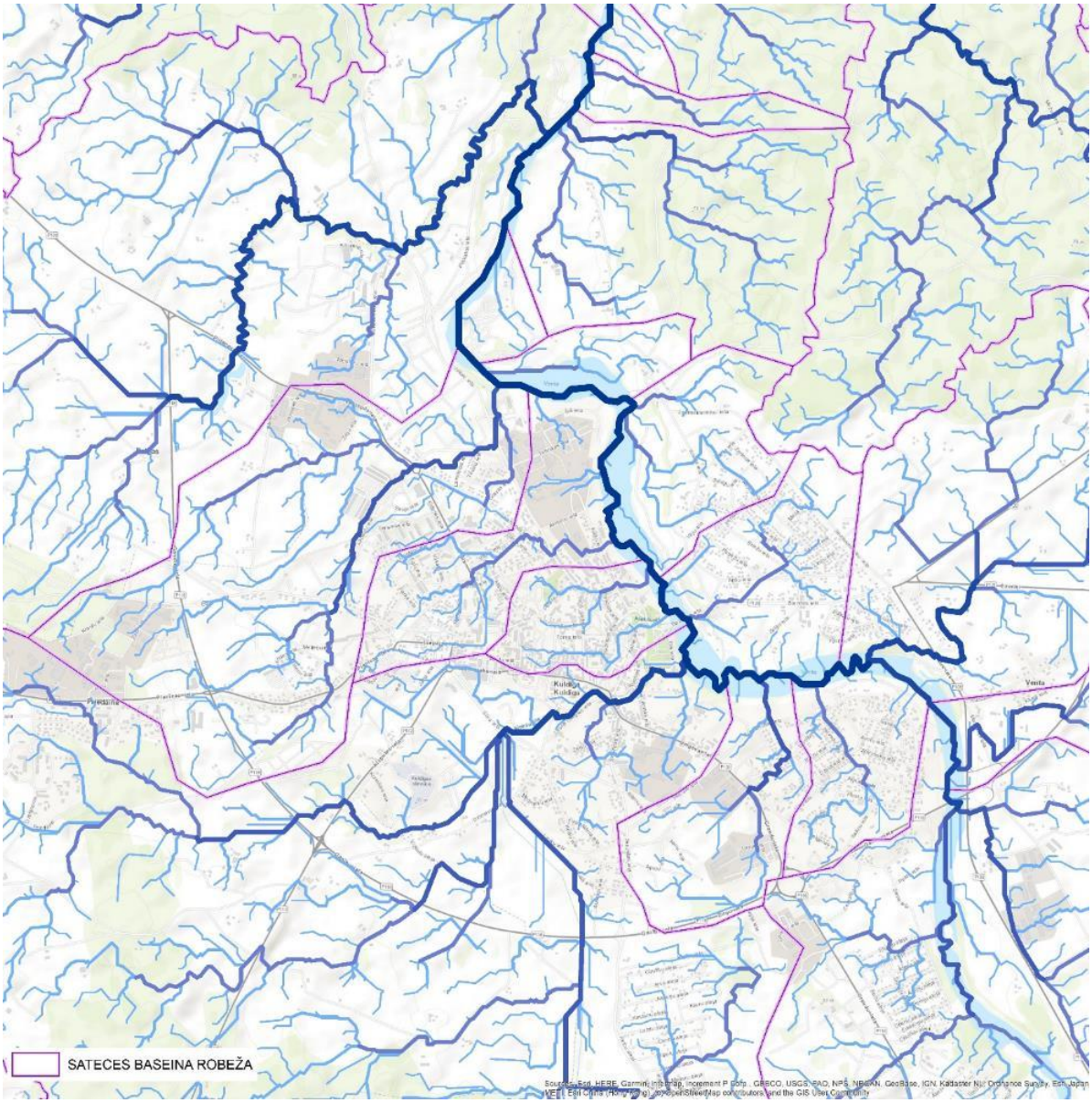


*Figure 37. Water flow direction along the terrain model for the city of Kuldīga*

### 3.3.4 Sewage outlets

According to the information of the state statistical report "2Ūdens" [46], treated domestic wastewater from Ltd "Kuldīga water" flows into Venta (downstream of the study area). Kuldīga city wastewater treatment plant (WWTP) is located on the right bank of the river in Rumba parish "Jaunlīmeņi" The WWTP is located in the protection zone of the Venta river (width - not less than 300 m) and in the neutral zone of the nature reserve of European significance (*Natura 2000*) nature reserve "Ventas ieleja". Domestic wastewater is collected at the WWTP, incl. from the Kuldīga city centralized sewage system and treated in biological wastewater treatment plants. In places where the coverage of the centralized sewerage network is not provided, Ltd "Kuldīga water" ensures the removal of wastewater from septic tanks and reservoirs by specialized vehicles. This also treats municipal wastewater from the decentralized system. According to SIA "Kuldīgas ūdens" category B polluting activity permit No. LI10IB0047 (updated on October 25, 2017), normatively clean (with treatment) wastewater is discharged into Venta[47]

During the pilot area site visit in autumn 2019 it was found that wastewater of unknown origin may also be discharged at certain inflows of drainage ditches in Venta. Since the study has been carried out in a relatively short period, it is likely that such intake sites are more than currently identified. According to the information of the State Environmental Service of the Republic of Latvia, at the beginning of 2020 it has been established that oil products have also been injected through the city's stormwater sewerage outlet at Kaļķu Street in Venta.

Discharges from wastewater as well as drainage and stormwater collection systems are shown in Map 7 "Anthropogenic impact".

[46]Latvian Environment, Geology and Meteorology Centre
http://parissrv.lvgmc.lv/#viewType=reportIndexView&type=2W&incrementCounter=1
[47]http://www.vpvb.gov.lv/lv/piesarnojums/a-b-discount

**Conclusions**

Priority should be given to arranging the existing ditch system by cleaning up ditches and integrating "green" solutions into the urban environment (e.g. municipal and/or rain gardens), which would reduce the risks of flooding during intense rainfall.

The need for "green" solutions in the urban environment and their economic benefits are confirmed by various scientific studies, such as the 2017 Climate-KIC Imperial College London study "Blue Green Solutions. A Systems Approach to Sustainable, Resilient and Cost-Efficient Urban Development"[48].

When developing new areas, it is desirable to limit the runoff, for example by setting the permitted amount of discharge in conventional networks 5 l/s (so as not to load stormwater systems), with the view that the amount of other rain waters should be able to be kept on its own by integrating green solutions. In case of filling ditches, you should create, for example, rain gardens on your property, which compensates for the lost volume.

The Law on Water Management Services stipulates that the local government must issue binding regulations on the operation and use of centralized sewerage, and that local governments may issue binding regulations on stormwater management. In order to solve stormwater management, it is recommended that Kuldīga municipality develop binding regulations in the field of stormwater management and drainage systems.

The situation in which the existing ditches are not maintained and the systems are arbitrarily modified, thus the system is interrupted, and it is not able to function fully, it is necessary to explain the role of the ditch systems in the urban environment.

In order to prevent possible entry of pollution into the Venta, measures should be taken in the areas adjacent to the study area to prevent river pollution from the stormwater drainage system.

[48] The study is available here https://www.climate-kic.org/wp-content/uploads/2018/03/BGDGuide.pdf

## 3.4 Ecological status of the Venta river

Biological and physico-chemical parameters are used to assess the ecological quality of rivers. Biological parameters provide information on the long-term ecological status of a water body, as they reflect the situation that is appropriate for a particular composition of fish, aquatic invertebrates and aquatic plant species. These three groups of organisms are closely linked in the food chain: aquatic plants provide food and shelter for fish and invertebrates, while invertebrates are the main food base for fish.

The monitoring of physicochemical parameters of water is performed by the Latvian Environment, Geology and Meteorology Center. The main parameters characterizing the ecological status of the river are the concentrations of nutrients (nitrogen, phosphorus compounds), biochemical oxygen demand, as well as the concentration of dissolved oxygen.

### 3.4.1. Ecological quality, including coverage of aquatic plants

*Figure 38 Venta downstream of Ventas fall (photo: L. Grīnberga, 2011)*

The ecological status of Venta has been assessed by the aquatic plant species composition and abundance, by analysing data from the "Inventory of protected habitats of EU importance in Latvia" project, as well as by adding data from the 2019 on site survey. In addition, the physical data of the monitoring water of the Latvian

Environment, Geology and Meteorology Center - chemical analysis data, accompanied by the results of the project “Monitoring the rivers of Lielupe and Venta river basins and a survey of farmers on environmental issues”.

*Figure 39 Venta straitjacket upstream (photo: L. Grīnberga, 2011)*

#### *3.4.1.1. Composition and abundance e of aquatic plant species*

In Venta, species specific to nutrient-rich waters dominate the river below the Kuldīga new bridge to the Kuldīga mound. The most common species in both the fast flowing and slow flowing stretches are the arrowhead *Sagittaria sagittifolia* (submerged form), common clubrush *Scirpus lacustris* (both submerged and emerged ), fennel-pondweed *Potamogeton pectinatus*, the perfoliate pondweed *P. perfoliatus*, the shining pondwwed *P. lucens*. In the zone of emergent plants frequently occur the sweet flag *Acorus calamus*, the common reed *Phragmites australis*, the flowering rush *Butomus umbellatus*, the reed canary-grass *Phalaroides arundinacea*, the bur-reed *Sparganium erectum*.

In the downstream section, more common are free-floating species common duckweed *Lemna minor*, the greater duckweed *Spirodela polyrhiza*, the frogbit *Hydrocharis morsus-ranae*, as well as the yellow waterlily *Nuphar lutea*, waterlilies *Nymphaea sp.*

Rarely occur stands by stoneworts *Chara vulgaris*, formed on the river bottom.

*Figure 40 High coverage of emergent plant species is characteristic throughout the river (photograph: L. Grīnberga)*

The ecological quality of river assessed using the "The methodology for evaluating the ecological quality of water bodies of rivers and lakes"[49]. In order to assess the ecological quality by the composition and abundance of aquatic plant species, the Latvia has adopted the British MTR (Mean Trophic Rank) index adopted by Poland – MIR Index (Polish Macrophyte River Index). The index is based on the composition and abundance f aquatic plant species, which is used to determine the level of river eutrophication. In total, five ecological quality classes – high, good, medium, bad and poor quality – are divided. The calculation of the index may be carried out if at least 7 to 8 species are present, optimally above 10.

Considering there is both fast flowing and a slow flowing stretch in the city Kuldīga, the MIR index was calculated separately for both stretches. Totally 17 species have been identified at the slow flowing stretch, and 16 species at the fast-flowing stretch.

In both stretches s, the results of the MIR index correspond to the good quality (range 35,0 to 37,9) provided by the high abundance of species.

[49]River Venta Basin Management Plan 2016-2021, 2015.

*Figure 41 The highest coverage of aquatic plants is typical in the upstream and downstream of the Venta fall (photo: L. Grīnberga)*

*Figure 42 The highest coverage of aquatic plants is typical in the upstream and downstream of the Venta fall (photo: L. Grīnberga)*

### 3.4.2. Physicochemical analysis of water

Water quality monitoring is carried out by the Latvian Environment, Geology and Meteorology Center, the monitoring point located approximately 2,5 km downstream from Kuldīga. This study uses the results of monitoring as well as water physical-chemical analysis data obtained in the framework of the project “Monitoring of rivers in the river

basins of Lielupe and Venta and the survey of farmers on environmental issues"[50]. The quality assessment is based on the methodology for evaluating the ecological quality of water bodies of rivers and lakes approved in Latvia.[51]

Contamination with nutrients, mainly nitrogen and phosphorus compounds, can be considered as one of the most significant problems in the quality of Latvian waters. The concentration of nutrients in Latvian waters has increased significantly until the early 90s of the 20th century. [52].

The results of the water quality monitoring of the Latvian Environment, Geology and Meteorology Center show that the water of Venta corresponds to the moderate ecological quality class. The total phosphorus concentration does not correspond to the good ecological quality class. Good ecological quality is characterized by concentrations ranging from 0,06 to 0,09 mg/l. In Venta waters, this concentration varies from 0,091 to 0,135 mg/l and corresponds to the moderate class.

The total nitrogen concentration does not reach the high/good quality during the winter months when nutrients are not consumed for the development of aquatic plants. In the summer, however, nitrogen levels in water are often very low (Table2). In many stretches, water plants are very dense in Venta, and during the plant decomposition process organic materials are released into the water, as well as nutrients accumulate in the root system, ensuring growth next year.

*Table2 Assessment of water quality based on total nitrogen (total N) concentration (monitoring point downstream from the Kuldīga)*[53]

| A year | Spring | Summer | Autumn | Winter |
|---|---|---|---|---|
| 1993 | | | | |
| 1994 | | | | |
| 1995 | | | | |
| 1996 | | | | |
| 1997 | | | | |
| 1998 | | | | |
| 1999 | | | | |
| 2000 | | | | |
| 2001 | | | | |

[50]Report on Ecological Status and recommendations …, 2014.
[51]River Venta Basin Management Plan 2016-2021, LEGMC, 2015.
[52]Latvia. Land, nature, nation, country. 2018.
[53]Data source: LEGMC monitoring data

| | | | | |
|---|---|---|---|---|
| 2002 | | | | |
| 2003 | | | | |
| 2004 | | | | |
| 2005 | | | | |
| 2006 | | | | |
| 2008 | | | | |
| 2009 | | | No data | |
| 2013 | | | | |
| 2014 | | | No data | No data |
| 2018 | | | | |

| |
|---|
| high |
| good |
| moderate |
| bad |
| poor |

The monitoring station downstream from Kuldīga has also been monitored for hazardous substances[54]. In any of the rivers of the river Venta Basin area, the average annual concentration of a hazardous substance has not exceeded the regulatory threshold, so surface waters can be considered as satisfying the quality requirements of the hazardous substances in general and correspond to good chemical quality.

### 3.4.3. Water quality in protected areas

In accordance with the provisions of the Water Management Law on, specific quality requirements and environmental quality objectives are determined for the waters in protected areas:

1) in specially protected nature areas;

2) bathing water;

3) priority fish waters.

The River Venta Basin Management Plan for 2016-2021 assessed that the quality of the habitat 3260 *Water courses of plain to montane levels with the Ranunculion fluitantis and Callitricho – Batrachion vegetation* in nature reserve "Ventas ieleja" is excellent (including

[54]Cabinet Regulation No 118 Provisions concerning the quality of surface and groundwater (12.03.2002.)

the conservation of habitat structures and functions, as well as the assessment of the possibilities of habitat restoration).

According to the Health Inspectorate of Latvia, the long-term quality of water in the city bathing area Mārtiņsala in 2015-2018 is excellent[55]. Excellent water quality in the bathing area has also occurred between 2008 and 2014[56,57]. Since 2010, the bathing area has been granted an international "Blue Flag" certificate attesting that the bathing site complies with international bathing water quality, safety, environmental accessibility and other criteria (33 criteria are fully evaluated).

Venta in Kuldīga has been defined as a priority salmonid fish waters[58]. The River Venta Basin Management Plan for 2016-2021 provides information on the quality of the priority fish waters for 2009-2014 and concludes that certain indicators of the quality of salmon-like fish waters (e.g. oxygen concentration in 2013) exceeds of limit set for them[59].

### 3.4.4. Impacts and hazards

Ensuring good ecological quality of the river Venta within the city limits of Kuldīga is problematic, because this stretch includes both fast-flowing and slow-flowing stretches. In the slow-flowing stretch above the Venta fall, the water heats up, sediment accumulation is observed, which promotes growth of aquatic plants. When aquatic plants decompose (in autumn), nutrients (nitrogen and phosphorus compounds) enter the water, and thus promoting the accumulation of nutrients also downstream from the Venta fall. In addition,

[55]A report on bathing water quality and monitoring during the 2018 bathing season. Health Inspectorate, 2019.
[56]The long-term assessment of the quality of bathing waters has been carried out since 2012, as it has to be carried out in accordance with the requirements of Directive 2006/7/EC and Cabinet Regulation No 608, taking into account the data of the last four bathing seasons
[57]http://www.vi.gov.lv/lv/vides-veseliba/peldudens/pelduden-monitoring,
[58] Specified in Annex 2.1 "Priority Fish Waters" of Cabinet Regulation No. 118 of 12 March 2002 "Regulations on the Quality of Surface and Groundwater". Pursuant to Article 10 of Cabinet Regulation No. 118 (2002), the existence of salmon (*Salmo salar*), sea trout and trout trout (*Salmo trutta*), perch (*Thymallus thymallus*) and whitefish (*Coregonus*) lives or can be ensured in priority salmonid waters. Kuldīga-Riga highway bridge as a border for priority salmonid and carp fish waters "from Kuldīga – Riga highway bridge to Zlēku parish Zlēku bridge"
[59]Set out in Annex 3 "Water quality standards for priority fish waters" of Regulation No 118 of 12 March 2002 on "Provisions on surface and groundwater quality"

the river is wider and significantly shallower upstream and downstream the Venta fall, resulting in the formation of denser aquatic plant stands.

The ecological status of the river Venta can also be affected by historical pollution (soil, bottom, groundwater, especially groundwater) in the city. According to the information of the Latvian Environment, Geology and Meteorology Center "Register of polluted and potentially polluted sites", there are 2 contaminated sites and 10 potentially contaminated sites (see Map 7 "Antropogenic impact"). Their pollution areas have not been studied.

In particular, the site and surroundings of the former factory "Vulkāns" should be noted. It contains three potentially contaminated sites (former woodworking plant chemicals storage and hazardous waste storage ruins, fuel station), building rubble, abandoned buildings and shears/piles relatively near Venta river (see Map 7 "Antropogenic impact"). It can be distinguished as a problem area from the point of view of environmental protection and landscape. In the long run, the spread of pollution from potentially contaminated sites or chip placement sites, without research of potentially contaminated sites and, if necessary, remediation, or landscaping (shaving plots), may cause additional pollution in Venta.

It should be t considered that the River Venta is a cross-border river and a high coverage of aquatic plants can be observed in many sections of the Venta up to Kuldīga both in Latvia and Lithuania. Half of the river basin is located in Lithuania. In the territory of Latvia, Kuldīga is also closer to the lower part of the Venta. This means that the river has received water from large areas, many settlements, agricultural lands and forests both in Latvia and Lithuania. In the Venta river Basin District Management Plan for 2016-2021, the part of the Venta river receiving water from Lithuania (water body V056) and its right bank tributary Vadakste (border river, V066) are assessed as water bodies with a significant transboundary pollution load.

The development of high coverage of aquatic plants has been promoted not only by high concentrations of nutrients but also by climatic conditions. In recent decades, there has been a tendency to increase water temperatures in the river during the summer months, especially in July and August (Figure 43).

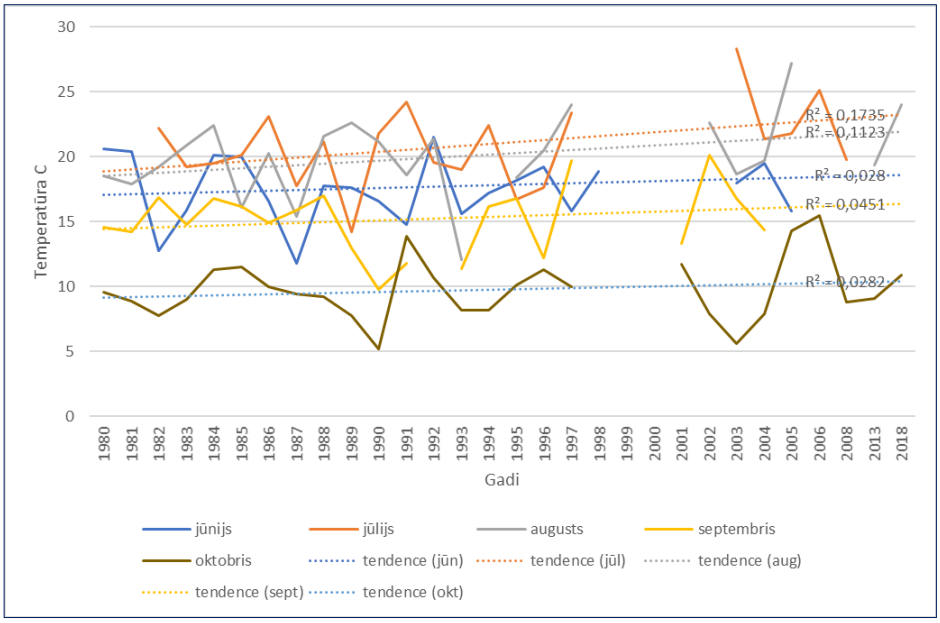


*Figure 43 Long-term variability of water temperature at the monitoring station downstream from Kuldīga (data source: Latvian Environment, Geology and Meteorology Center)*

Hydrological data (Chapter 3.2) shows that in the last five years, mainly (except in 2017), low water periods with rates below normal are observed. Since 1987, the number of days of a stable ice blanket covering the river has decreased significantly, and spring ice congestion in River Venta is also reduced, which contributes to natural bed cleaning and reduces the formation to be planted.

In view of the above, in, it is recommended to manage the study area by reducing coverage of aquatic plants in the river Venta. Mowing and removing the mass of mown plants from the river should be carried out regularly because the concentration of nutrients in water is high, additional nutrients lead to the decomposition of aquatic plants during the autumn and winter season if they remain in the river after the season of vegetation.

**Conclusions**

Evaluating the composition and abundance of aquatic plant species in both sections of the Venta river (above and below the Venta fall) the results of the MIR (Polish Macrophyte River Index) index correspond to good quality (ranging from 35,0 to 37,9). This is due to the high diversity of species.

Venta waters correspond to the moderate ecological quality class. The total phosphorus concentration in water does not correspond to the good ecological quality class.

According to the information of the Health Inspectorate of Latvia, the long-term water quality of the city bathing place "Mārtiņsala" in 2008-2018 is excellent. Since 2010, the bathing area has been awarded the international Blue Flag certificate.

The study area of Venta in Kuldīga are identified as priority salmonid fish waters. For priority salmonid fish waters quality certain indicators in 2009-2014. (e.g. oxygen concentration in 2013) have been found to exceed the limit values set for them.

In order to improve the ecological status of Venta and the quality of s priority salmonid fish waters, it is recommended to regulate the coverage of aquatic plants in Venta by mowing and removing aquatic plants from the river. Management activities should be done regularly, because the concentrations of nutrients in the water are high, additional nutrients are caused by the decomposition of aquatic plants in autumn and winter.

In order to prevent possible inflow of pollution into the Venta, measures must be taken to prevent river pollution in the areas adjacent to the study area.

Ensuring good ecological quality of the river Venta within the city of Kuldīga is problematic because:

- due to coverage of aquatic plants, nutrient concentration is increasing in the water, which promotes the development of eutrophication processes.
- the Venta is a cross-border river and a high degree of coverage of aquatic plants can be observed in many sections of the Venta up to Kuldīga in both Latvia and Lithuania. Half of the river basin is located in Lithuania.
- The development of high coverage of aquatic plants has been promoted not only by high concentrations of nutrients but also by climatic conditions.

**Location of Map 7 “Antropogenic impact”**

## 3.5 Ecosystems, nature values and their management

### 3.5.1. Ecosystems, ecosystem services

The study area consists of freshwater-river, grassland and forest ecosystems.

#### *3.5.1.1. Freshwater - rivers*

Freshwater ecosystems are complex, with many important factors to characterize their structure: geomorphological structure, nature and diversity of bottom sediments, distribution of microbiotopes and species, water depth, transparency, nature of currents and related physico-chemical processes. Environmental regulation and maintenance services provided by freshwater ecosystems:

- regulation of environmental pollution by attracting nutrients in the biochemical cycle and ensuring self-purification of waters;
- maintenance of physical, chemical and biological conditions, including provision of habitats for living organisms, maintenance of spawning grounds for fish;

Freshwater supply services:

- water for economic purposes, such as irRīgation, as well as for industry;
- fish for human consumption;
- aquatic plants as a raw material, for example, for basketry.

Cultural services provided by freshwater:

- opportunities for tourism and recreation (fishing, boating, swimming, etc.);
- scientific and educational value, study classes in the environment;
- aesthetic value - landscape as a source of inspiration for various art, literature, etc.;
- cultural and historical value - ancient fishing traditions, changes in river in different time periods (canal excavation, bridge construction, etc.).

Licensed fishing is aalowed in the pilot area. Industrial fishing of the river lamprey is carried out in the nature reserve “Ventas ieleja”. Fish resources are also reproduced artificially within the framework of the State Fish Resources Reproduction Program. Venta is included in the Latvian eel stock management plan, and glass eels are released into it.

Alekšupīte (a tributary of the left bank) flows into the Venta river below the Venta fall. A waterfall has been created on it during the construction of the mill. The river flows through the city, it is surrounded by historical buildings. It ensures the self-purification of water, the environment and the conditions for the existence of living organisms in it. Alekšupīte is a part of the city's cultural heritage, which forms the characteristic urban landscape of Kuldīga.

#### *3.5.1.2. Grassland*

More extensive farming is located in the northern part of the pilot area, from the Old Kuldīga Bridge to the Kuldīga mound. To the south of the bridge, open areas remain in narrow lanes, mostly in the flooding part. Grassland accounts for the highest proportion of the area. The grasslands are partly mown, partly overgrown with shrubs, where bush cutting has been carried out. The smaller area is covered by fields. There are former small-scale areas, overgrown with non-grass-specific species, fitted with horse paddocks. In places where a rare, unsealed plant has recently been removed from the surface of natural soil or another substrate has been dumped as a result of construction work, growing plant species growing in ruderal areas dominate[60]. Grassland and plantings have been installed near tourism sites.

Of the total agricultural area (~ 98 ha[61]), natural grasslands represent ~ 24% (23 ha).

The most recent characterisation of grassland ecosystem services is provided in the guidelines for the conservation of protected habitats in Latvia[62] and has been used in the preparation of this chapter. Grassland ecosystem services include both support and regulation services and supply and security services. In the livestock sector, grassland is used for hay harvesting and livestock grazing. Secondary products and raw materials for the preparation of products are derived. Higher-value products are derived from organic grassland feed.

[60]Ruderal species: a species that has adapted to growing in human highly transformed and degraded habitats (non-saplings, trampled areas, areas where the surface of the soil is stretched, etc.).
[61]Areas have been determined using topographic cards M1: 10 0000 © Latvian Geospatial Information Agency, 2008-2012, using ArcGIS 10.6.1 software.
[62]Rusna S., (red). Guidelines for conservation of protected habitats in Latvia. Volume 3. Natural meadows and pastures. NCA, Sigulda, 2017.

Natural grasslands provide greater biodiversity in terms of both plant species and animal species. In such grasslands, the number of species 1 $m^2$ varies from 30 to 80, and the number of species in relatively cultivated grasslands generally does not exceed 20. In Latvia, a third of the total number of plant species in the country is found on grassland, as well as a third of the number of plant species to be protected. Grassland as habitats and feeding sites is used by a third of the invertebrate species present in the country, grassland is the only breeding site for a number of bird species.

Naturally, grassland is an important resource for the development of cultivated granular varietals as well as for the selection of shorage plants. In fact, most medical plants are present on the grasslands. Bright flowering plants attract bees, honey is produced.

In several countries grass is used to produce bioenergy. This service is not yet widely applied in Latvia, but the development of opportunities for using "green energy", such as biogas as fuel for use in vehicles, is expected to increase demand for various types, including grass, of raw material for bioenergy production.

Grassland protects soil from erosion, ensures soil formation, organic matter accumulation in soil. Flood grasslands regulate the strength of the pals, ensure the circulation of nutrients, clean up the surface waters. Herbaceous plants vegetation effectively takes nitrogen from rivers and nitrogen from surface drains into the floodplains. Mowing and hay gathering ensure that nitrogen is removed from the ecosystem, protecting rivers and grassland itself from overenrichment with nitrogen and reducing biodiversity.

Floodplain grassland lanes on the shores of water bodies limit the amount of flooding. As the water level increases during spring floods and floods, the areas adjacent to the river in the lower terrain areas are flooded. The water mass is spread over a wider area, forming shallow water zones. As a result of flooding, the speed of the water stream is delayed, preventing the concentration of large amounts of water in the lower reaches of the river.

Grassland also provides cultural and intangible goodwill – historical tools, beliefs, customs, traditions related to grassland management. They shall ensure that aesthetic and landscape values are increased and provide opportunities for scientific research.

Natural grassland is the most biologically diverse and ecologically important part of farmland. They are an essential element of the traditional rural landscape of Latvia and are

an important cultural and historical heritage in the context of both human material and intangible culture. The proportion of natural grasslands is an indicator for low-intensity farming, the concentration of natural and semi-natural habitats, and the diversity of landscapes.

In the pilot area ~ 23 ha is made up of natural grasslands. Grasslands are mostly mown – used for hay harvesting, with a relatively large number of plant species, including species specific to long-term grasslands. Grasslands provide a habitat and feeding site for invertebrates (species of insects, spiders, molluscs and other species) and birds, with a number of protected, rare and threatened plant species. Open areas shall ensure the formation, transparency of the river landscape. Parking lots, pedestrian walkways, recreational areas are installed in several places, providing a recreational function. Areas of grassland situated in a part of the river floodplain and carrying out a function of soil erosion and reducing the number of floods.

#### *3.5.1.3. Forests*

According to topographic information, almost 35 ha are covered with forest in the study area[63]. Forests are formed by dry forest types. The largest areas are pine forests, less common are white alder, aspen, maple, willow and birch forests. Forests can be found on the slopes of the river bank, slightly - in the immediate vicinity of the riverbed. In the rest of the area, the coverage of aquatic plants consists of low shrubs or shrubs and trees. Areas overgrown with bushes and trees are mostly formed by overgrown with grasslands and river mourning or the slopes of the river valley.

In the vicinity of the old Kuldīga bridge and the industrial building district, there are these park-like tree stands. In the future, it is desirable to plan measures for their care. Biologically valuable forest stands formed by habitats of European Union importance are found in the study area in the area of 14,89 ha[64].

[63]Topographic cards M1: 10 0000 © Latvian Geospatial Information Agency, 2008-2012, information, area determined using ArcGIS 10.6.1 software.
[64]The nature management data included in the nature data management system "Ozola" until 07 October 2019, the area is determined using ArcGIS 10.6.1 software.

The most up-to-date nature of forest ecosystem services is provided in the guidelines for the conservation of protected habitats in Latvia[65]. Some of the atmospheric precipitation accumulates in the tree crowns, which is returned to the air as a result of evaporation. Many forest species have adapted to the microclimate that develops in forests. The condition of the forest provides protection from rapid changes in environmental conditions - direct sunlight, wind, thus introducing species that are sensitive to environmental changes. In total, 51% of all protected species in the country are found in forests. Forest ecosystems provide biodiversity in the study area.

Forests provide residents with renewable natural resources- wood, as well as non-wood resources - berries, fungi, herbs, honey, feathered animals, etc. Forests also provide seed material for many plant species[66]. In the area of the study, this group of ecosystem services has not been expressed because forest areas are relatively small, are located in both the SPNT and the urban area where the extraction of wood and non-wood resources is not primary.

Forests provide cultural and intangible goodwill. They are used to organize various tourism, sports and recreational events. Forests have a high aesthetic value; they improve human health and provide opportunities for research[67].

The largest areas of the study are covered by forests formed on slopes or floodplains. In addition to air purification and regulation of water circulation, they play a role in reducing soil erosion. Forests are characterised by plant species that increase the overall biodiversity of the site.

Nature reserve “Ventas ieleja” is a natural conservation area and also a protected nature area of European interest, *Natura 2000* and is included in the national biodiversity monitoring programme, is periodically examined, natural values are being documented, management measures have been put in place, thereby also performing the knowledge and scientific function.

[65] Ikauniece, 2017
[66] Idisse S., guidelines for the conservation of protected habitats in Latvia. Volume 6. Forests, 2017
[67] Idisse S., guidelines for the conservation of protected habitats in Latvia. Volume 6. Forests, 2017

**Conclusions**

The study area consists of freshwater-river, grassland and forest ecosystems.

River habitats shall ensure the self-cleaning of surface waters. Freshwater ecosystems provide a living environment and feeding areas for many species of invertebrates, fish, amphibians, birds and mammals. The recreative function of freshwater ecosystems is important.

Grasslands and forests provide different types of ecosystem services, mainly related to the extraction of materials (grass, hay), the provision of biodiversity, as well as recreation, site information and scientific function.

The evaluation of the methods of grassland management will be carried out during the preparation of the study proposals, where the best practices will be evaluated, taking into account both the type of grassland and the species to be protected and the regulatory framework.

In the future, it is recommended to maintain the currently untreated park-like stands near the Old Kuldīga bridge and the industrial building district.

### 3.5.2. Habitats of European Union importance

In terms of ensuring biological diversity, grassland, forest and freshwater habitats have a conservation value that complies with the minimum quality criteria for protected habitats specified in regulatory enactments[68] and the European Union Manual for the Designation of Protected Habitats in Latvia[69].

A total of 6 types of protected grassland habitats have[70] been identified in the area, 4 types of forest habitats to be protected, as well as one type of freshwater and one rock crop habitat. The mapping of habitats in the nature reserve "Ventas ieleja" in Kuldīga has been carried out in the framework of the European Union Cohesion Fund project implemented by the Nature

[68]Cabinet Regulation No. 350 of 20 June 2017, Regulations Regarding the List of Specifically Protected Habitats Types; Cabinet Regulation No. 153 of 21 February 2006, Regulations Regarding the List of Priority Species and Habitats of the European Union in Latvia

[69]Auniņš A., 2013. European Union protected habitats in Latvia. Detection manual. 2. Expense specified. Riga: Ministry of Environmental Protection and Regional Development

[70]In September 2019, the Nature Protection Agency provided copies of the questionnaires for carrying out the study, the information being evaluated by certified experts on species and habitats involved in the development of the study.

Conservation Agency, entitled “Preconditions for better biodiversity preservation and ecosystem protection in Latvia” or “Nature Census” in 2018 and 2019. In this study, information on the state of habitats of European Union importance, hazards and conservation and conservation measures is prepared using the results of the “Nature Census” project, compiled in the Nature Data Management System of the Nature Conservation Agency “Ozols”, as well as the information contained in the habitat mapping questionnaires. Management measures have been assessed on the basis of the management measures set out in the nature conservation plan of nature reserve “Ventas ieleja”, with experts also surveying the area in nature in September and October 2019.

The deployment of habitats of European Union importance in the area of the study is presented in Map 8 “Nature values”.

**Location of Map 8 “Nature values”**

### 3.5.2.1. Grassland habitats status, hazards, conservation and protection measures.

6120* *Xeric sand calcareous grasslands.* In Latvia a specially protected and priority protected habitat of European interest. One grassland polygon in the northern part of the area, ~ 2,97 ha, is present in the area of the study[71], representing 0,5-0,6% of the total grassland area in the country.

They are dry grasslands with unclosed vegetation in sandy, more or less calcareous soils. In Latvia, the habitats are not only matched by chalky, but also by medium - and poorly acidic plant societies belonging to *the Plantagini-Festucion* union, as they also form appropriate plant societies and play a major role in the preservation[72] of the typical species and societies of this habitat.

Prerequisites for the existence of a habitat:

1) *nutrient poor soil;*
2) *rare, unclosed vegetation, which provides a sharp variation in the day-to-day temperature of the surface of the soil;*
3) *large area, grassland exposed to wind activity;*
4) *open sand areas;*
5) *the grassland can be flooded.*

Grassland is found in Latvia in areas of 582-774 ha[73], its total state of protection is identified as unfavourable-bad, development trend unknown[74].

[71]Data source of information on habitat areas of European Union importance provided for in Chapter 3.5: Natural Conservation Management Nature Data Management System "Ozols", compiled by the study developer "Grupa93" in October 2019 using ArcGIS 10.6.1 software.
[72]Auniņš A., 2013. European Union protected habitats in Latvia. Detection manual. 2. Expense specified. Riga: Ministry of Environmental Protection and Regional Development
[73]Section 3.5 Areas of habitats of European Union importance are indicated in Latvia according to the information of the Nature Conservation Agency
[74]In Chapter 3.5, the overall conservation status of habitats in the country and development trends are presented in line with Article 17 of the report to the European Commission on the status of habitats and species of European Union importance for each country as defined by Council of Europe Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats, wild fauna and flora (2019 Report) on the period for information from 2013 to 2018. See: https://www.daba.gov.lv/public/lat/dati1/zinojumi_eiropas_komisijai/, full report on species and habitats available on the EIONET website, https://rod.eionet.europa.eu/obligations/269/deliveries

The habitats are characterised by high diversity of plant and invertebrate species, open sand areas, low vegetation, places dominated by moss and lichen, rainforest species. The grassland is managed – mowing or grazing, not overgrown with shrubs, no dense layer of turf forms.

In the area of the study, the quality of the grassland is medium,[75] common (~ 80% of the grassland area) for natural grassland indicator species as well as umbrella species. The quality-lowering factors are the swelling of trees and bushes in virtually all areas of the grassland, invasive plant species are present in the area: garden lupin *Lupinus polyphyllus*, Canadian goldenrod *Solidago canadensis*, where the stands are made up of an expansive plant species – wood small-reed *Calamagrostis epigos*. The area of the grassland is relatively small, located in a forest-surrounded area that minimizes the effects of wind activity. Trees and shrubs contribute to the enrichment of the soil with nutrients, as well as to shading and shelter. The distribution of expansive and invasive plant species may threaten the conservation of grassland-specific species. Expansive plant species form a dense and high plant plant that is not representative of a well-favoured grassland. The invasive species present on the grassland are characterised by massive stalks and a large part of the wax, with additional nutrients coming to the soil when dying and broken down.

The area of the grassland is fragmented by a car road and a parking lot of gravel covering, with an area for riding horses in the central section. Fragmentation reduces habitat area and limits the mobility and distribution of species.

The grassland is not mowed every year. At the time of the survey on 8 October 2019, it was concluded that during the 2019 season it wasn't mown. According to the information provided in the nature conservation plan "Ventas ieleja" it should be mowed. The results of the survey are presented in Map 9 "Implementation of management measures, survey results 2019".

[75]In Chapter 3.5, the assessment of the quality of the habitats is provided in accordance with the results of the "Nature Census" project, as indicated in the survey questionnaires for the specific habitats, Data Source: Nature Protection Agency

**Location of Map 9 “Implementation of management measures, survey results 2019”**

*Figure 44 Fraged, augmented graslland near the Veckuldīgas castle mound (photo: E. Grolle, 2019).*

In order to ensure a favourable conservation status of the grassland, it is necessary to take measures for ecological restoration: cutting trees and bushes, limiting expansive and invasive plant species, mowing or grazing and formation of sandfields.

6210 *Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia) (*important orchid sites).* Habitat specially protected in Latvia and protected in the European Union. Grasslands identifying orchid species are priority protected habitats of European interest.

The most common grassland habitat in the study area was found in a total of 9 localities with a total area of ~ 15,03 ha or ~ 0,3% of the total grassland area in the country.

In one area of the polygon area, two species of orchids have been identified, and this polygon should therefore be considered as a priority protection at European level.

They are dry or almost dry grasslands in neutral and basic, nutrient-rich soils (Auniņš, 2013). Habitat variant 1 is mainly represented in the area – chalky grasslands in the western part of

Latvia with calcified species typical of the Western latte[76]. Option 3 is slightly present – grasslands in poorly acidic and neutral soils mainly in the western part of Latvia, calcified species are less present and their importance is relatively small.

Prerequisites for the existence of a habitat:

1) *Drought and poor but calcareous soil;*
2) *There may be flooding to ensure that the soil response is increased;*
3) *Shorter or longer periods of drought when the soil completely dries up, reducing the proportion of grasses.*

The grassland in Latvia is found in an area of 4455 - 5800 ha, its overall protection status in the country is defined as unfavorable-poor, development trends are deteriorating.

The habitats are characterised by a high diversity of plants and plant societies in a favourable conservation state. The grassland is managed – greased or mown, not overgrown with bushes when the hay is cleared, does not form a dense layer of turf.

In the area of the study, the quality of grasslands is medium to low. Natural grassland indicator species are relatively common (average 50-60%) on grasslands. Several grasslands are not managed or managed partly; unmanaged areas overgrown with shrubs. Relatively large areas (average 40%) occupy expansive plant species, lowering the quality of the habitat, changing its inherent structure and vegetation. In two localities of the grassland, a species of alien plants has been identified - soapwort *Saponaria officinalis*.

[76]Calcifitis, a plant adapted to growth in calcium-rich soils but unable to grow in sour soils. Commonly occurring in habitats where the soil response is neutral or alkaline, less rarely acidic.

*Figure 45 Moved grassland with a resting area (Photo: E. Grolle, 2019)*

Grassland areas are mostly small, surrounded by shrubs and forests. Species typical of forest borders, more plentiful soils, come into the plant. The swelling of trees and shrubs contributes to enriching the soil with nutrients and creates shading. The spread of expansive plants may threaten the conservation of grassland-specific species. Expansive plant species form a dense and high plant plant which is not representative of a well-favoured grassland. The invasive species identified on the grassland[77] is characterised by an array of stalks and a large portion of wax, with additional nutrients coming to the soil when dying and broken down.

Grassland localities are crossed by parked transport tracks, grassland is used for organising events, recreation.

[77]An invasive species, an alien species capable of rapidly breeding, infesting large areas and dominating local species, usually the spread of invasive species in wild ecosystems is associated with a reduction in biodiversity and often with economic losses.

*Figure 46 Grassland in the Veckuldīgas castle mound (Photo: E. Grolle, 2019)*

In order to ensure a favourable conservation status of the grassland, it is necessary to carry out ecological recovery or maintenance measures: cutting trees and bushes, reduction of soil fertility, limiting expansive and invasive plant species, restorative mowing or grazing and and then mowing or grazing to maintain the restored habitat.

*6410 Molinia meadows on calcareous, peaty or clayey-silt-laden soils (Molinion caeruleae).* A specially protected and protected habitat of European importance in Latvia. In the area of the study, the grassland is present in one polygon, in a complex with another protected grassland habitat, in the northern part of the area, in an area of ~ 0,46 ha or ~ 0,01% of the total surface area of the grassland in the country.

They are moliny *Molinia* meadows for more or less humid, nutrient-rich poor soils. In Latvia, this habitat is also matched by grasslands and pastures that are not dominated by moles (they may not be at all), but other species specific to *Molinion* (Auniņš, 2013) are present with great cover.

Prerequisites for the existence of a habitat:

1) *A regular change in soil humidity with wetting periods and subsequent desiccation;*
2) *Calcareous soil*.

Grassland in Latvia is found in area 3253-4230 ha, its total state of protection is identified as unfavorable-bad, development trend unknown.

The habitats are characterised by a high diversity of plants and plant societies, both with low grass and higher levels, including umbrella species. The grassland is managed – mowing, collecting or grazing the wall, not overgrown with shrubs, no dense layer of turf, not drained. Orchids and gorgeous flowering plants are present on the grassland.

In the area of the study, the grassland is present in a fragmented complex with other protected grassland habitats. The grassland area is small, represented by habitat option 4: grassland without highly dominant species, with high species diversity and many double leaf species. In general, the medium quality of the grassland is assessed for the whole polygon. There are two indicator species of natural grasslands on the grassland, the grassland is partly mowed, the wettest places are not mottled and are overgrown with shrubs. 60% of the total habitat polygon area is dominated by expansive plant species. Invasive species are not present. In total, 3 protected plant species have been identified throughout the polygon area.

A resting area in the northern part of the grassland – a wooden table, a step, a fireplace installed. Transport tracks remaining along the river. At the time of the survey, the largest area of the grassland has been mown, the hay has been harvested.

In order to ensure a favourable conservation status of the grassland, it is necessary to take measures for ecological restoration: cutting trees and bushes, limitation of expansive plant species, restorative mowing or grazing and later - mowing or grazing to maintain the habitat.

6430 *Hydrophilous tall herb fringe communities of plain and of the montane to alpine levels.*
Protected habitat of special conservation and European interest in Latvia. In the area of the study, the grassland is present in two places, with a total area of ~ 3,69 ha or 0,6-0,7% of the total surface area of the grassland in the country.

These are the stands of nitrophiles[78] high in wet soils along the rivers and lakes, and moderately humid to humid soils on the forest borders (Auniņš, 2013).

Prerequisites for the existence of a habitat:

[78]Nitrophyte, a plant that grows well and develops in nitrogen-rich soil.

1) *Fluctuations in water levels can be a recurring dryness.*
2) *Water-borne nutrients and saneses.*
3) *Mechanical disturbance affects river activities by ensuring the conservation of open areas.*

Grassland in Latvia is found in areas of 514-669 ha, its total state of protection is identified as unfavourable-inadequate, but stable.

Habitats in a favourable conservation state are characterised by a variety of plant species, not one or two dominant species, and there is no invasive plant species. Grow different, lower places, higher places. Habitats are affected by waves and river sands, which provide a sufficient level of disturbance to keep the habitat without management measures. River water is not contaminated, it contains seed material typical of the habitat, the shores have not been altered. The grassland can be extensively grazed.

Medium grassland quality in the area of study. Habitat option 1 – riverside stands represented. Grassland is not managed, the polygon of grassland in the central part of the area is overgrown with bushes. However, the grasslands are flooded and no invasive plant species have been identified.

*Figure 47 Overgrown grassland (Photo: E. Grolle, 2019)*

Ensuring a favourable conservation status of the grassland, a polygon in the central part of the territory, requires the taking of ecological restoration and maintenance measures: cutting trees and bushes, mowing or grazing.

A polygon site in the southern part of the area does not need management. Smooth development shall be ensured.

*6450 Northern boreal alluvial meadows.* In Latvia a specially protected and protected habitat of European interest. In the area of the study, the grassland is present in one polygon, in a complex with another habitat, with a total area of ~ 0,16 ha or ~ 0,001 ha of grassland in the country.

They are grasslands along large rivers, which are characterised by slow stages and are frozen every winter, affected by spring floods. In Latvia, such grasslands are also found in the flood plains of lakes and small rivers (Auniņš, 2013).

Prerequisites for the existence of a habitat:

1) *Floods are a key prerequisite for the existence of the grassland, which provides a variety of humidity conditions and microrelyefs, and reduces the growth of bushes.*
2) *Adequate water quality of the river without contributing to excessive soil enrichment.*

Grassland is found in Latvia in areas of 13830 – 17980 ha, its total state of protection is identified as unfavorable-bad with a trend to deteriorate.

The habitat is characterised by diversity of plant species and plant societies in a favourable conservation state, a variety of microrelyefs with wetted depressions intersected with drier mounds. The grassland is managed–mowing, gathered and sheathed in the real, not overgrown with shrubs, does not form a thick layer of turf. No drainage has been performed.

In the area of the study, the grassland is present in a fragmented complex with other protected grassland habitats. The area of the grassland is small, represented by habitat option 1: high grasses and masonry grasslands. In general, the size of the whole polygon is low. There are four identifying species of natural grasslands on the grassland, one of which can be found on the plains' grasslands. The grassland is not managed, growing with shrubs. It is estimated that 80%

of the total habitat polygon area is dominated by expansive plant species. An alien plant species has been identified in a small area – the soapwort *Saponaria officinalis*.

Ensuring a favourable conservation status of the grassland requires the taking of ecological restoration and maintenance measures: cutting trees and bushes, reduction of soil fertility, limiting expansive and invasive plant species, restorative mowing or grazing and later - mowing or grazing to maintain the habitat.

*6510 Lowland hay meadows (Alopecurus pratensis, Sanguisorba officinalis).* In Latvia a specially protected and protected habitat of European interest. In the area of the study, grassland is present in a single locality, in the central part of the site, with an area of ~ 0,67 ha or 0,01-0,02% of the total surface area of the grassland in the country.

They are species-rich meadows in slightly or medium-rich fertilised soils that plant companies own in *Arrhenatherion*. These grasslands are rich in double-leaf. In Latvia, grasslands are also included in the habitat, where grazing is taking place and the herbaceous herb of this habitat has remained (Auniņš, 2013).

Prerequisites for the existence of a habitat:

1) *Mowing;*
2) *Diverse terrain conditions — flat areas, hills, slopes, depressions, floodplains which rarely or temporarily flood;*
3) *Soils are moderately wet to wet throughout the season; depressions can be moist;*
4) *Nutrient rich soils.*

Grassland is found in Latvia in areas 4339 to 5640 ha, its total state of protection is identified as unfavourable - bad, with a trend to deteriorate.

The habitats are characterised by the diversity of plant species in a favourable conservation state, including a large number of richly flowering plants, a well-established grassland structure. The grassland is mown, the hay is harvested, it is not overgrown with shrubs, it does not form a dense layer of turf. The grassland has not been drained.

In the area of the study, grassland was identified in a single locality site, representing habitat option 1: typical, species-rich grassland, moderately fertile and fertile neutral soils. The quality

of the grassland is low, not managed, and the share of expansive plant species accounts for 80% of the grassland area. There are only two indicator species of natural grasslands. The value of the grassland is increased by its presence in a complex with solid grassland habitats, as well as by the proximity of the old river, which is likely to provide temporary flooding of the grassland. Invasive plant species have not been identified in the area.

Ensuring a favourable conservation status of the grassland requires the taking of ecological restoration and maintenance measures: reduction of soil fertility, limitation of expansive plant species, restorative mowing or grazing and later - mowing or grazing to maintain the habitat.

**Evaluation of grassland habitat management measures**

Following management measures for grassland habitats that are specified in Nature Protection Plan 2010 – 2020[79] of nature reserve "Ventas ieleja" are proposed:

- since the main objective of grassland management in nature conservation is the restocking of species composition and biodiversity, rather than providing habitats for birds, the mowing of meadows is desirable before 24 June. For the restoration of degraded grassland habitats mentioned in the Chapter 3.2. and shown in the Annex 5 of Nature Protection Plan, the optimal process would be the initial mowing twice in the summer, for the first time before Midsummer, for the second time at the end of August or early September, both in terms of collecting mown material. It is desirable to maintain such a regime for at least 3 years. An expert's opinion is then recommended whether it is possible to switch to mowing once a year. Other grasslands shall be managed on the basis of rules for the management of biologically valuable grasslands;
- mowing is the preferred way of managing meadow types;
- grazing is recommended for the islands in the river Venta in the city of Kuldīga;
- as a recommended measure, the gradual retrenchment of grey alder groves on slopes where meadows have once been present is a step.

According to information provided by the local government for the development of this study, grassland is mown in the second half of July or in August, depending on the weather. At the

[79] Atbilstoši dabas aizsardzības plāna izstrādes laikā lietotajai terminoloģijai - pļavām

time of the survey, it has been established that the grassland has been mown, harvested in a mown grass. Total managed grassland ~ 11,6 ha.

According to the information provided by the municipality, in recent years, grasslands have been mowed in the second half of July or August, depending on weather conditions. At the time of the inspection, it was found that the grasslands have been mown, the mown grass has been collected. The total managed grassland area is 11,6 ha. From 2017, two grassland polygons in Veckuldīga castle mound and grassland in the Venta floodplain at the foot of Veckuldīga castle mound, as well as a grassland polygon near Pārventa park, are managed by an organic farm, observing the rules of biologically valuable grassland management.

Information on grassland management throughout the nature protection plan has not been available since 2010.

The grassland management methodology does not foresee mowing of the specific grassland habitats in the period from the second half of July to August. Such management is not suitable for increasing the diversity of plant species and improving the structure of vegetation needed in the grasslands of Venta valley.

At the time of the study, there is no information on whether initially biologically valuable grasslands have been restored for 3 years in the places specified in Annex 5 of the Nature Protection Plan for nature reserve "Ventas ieleja", mowing them twice and harvesting the cut grass, and after they continued to mow in accordance with the expert's recommendations. Consequently, there is no information on the justification for late mowing in recent years. Compared to the information provided in Annex 5 of the nature protection plan, the mowing has been partially performed (see Map 9) in different places than planned, incl. in part of the grassland habitats it has not been performed (on the right bank of the Venta near Saldus Street, before the territory of the former motorway, before the northern border of the city, on the left bank of the Venta - south of the Veckuldīga castle mound).

**Conclusions**

A total of 6 types of protected grassland habitats have been identified in the area:

- 6120* *Xeric sand calcareous grasslands;*

- 6210 *Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia) (*important orchid sites);*
- 6410 *Molinia meadows on calcareous, peaty or clayey-silt-laden soils (Molinion caeruleae)*; 6430 *Hydrophilous tall herb fringe communities of plain and of the montane to alpine levels*; 6450 *Northern boreal alluvial meadows;*
- 6510 *Lowland hay meadows (Alopecurus pratensis, Sanguisorba officinalis).*

When assessing the inventory data for grasslands, it has to be concluded that the previous grassland management measures have not been sufficiently effective. Grassland quality has largely remained medium to low, with extensive crop species still accounting for a high proportion, and invasive plant species in many areas. Some grasslands are not managed and overgrow with trees and shrubs.

In order to increase the quality of grassland habitats and species diversity, ecological restoration of grasslands is necessary, ensuring the application of appropriate management for each type of grassland habitat.

The enrichment of grasslands with nutrients that promote the spread of nitrophilic and expansive plant species is influenced by the water quality of the Venta river. Pollutants in the water settle on river banks and in flooded areas (floodplains). It is therefore important to reduce the accumulation of nutrients in the river and to mow aquatic plants in the river, collecting the cut material.

#### *3.5.2.2. Forest habitats, status, hazards, conservation and protection measures.*

9010* *Western taiga.* In Latvia a specially protected and priority protected habitat of European interest. The study site identified one habitat locality in the central part of the site, an area of ~ 1,38 ha, or ~ 0,002% of the total habitat area in the country.

These are naturally old forests, as well as new forests developed naturally after the fires. Old forests represent late stages of souccesia and have little or no impact on economic activity. Some of today's old natural forests are affected by humans, but they have many characteristics of natural forests. Natural habitat coincides with (potentially) natural forest habitats (NFH) (Auniņš, 2013).

Prerequisites for the existence of a habitat:

1) *The main contributing factor to the habitat is the burning of forests, ensuring the formation of a different generation structure;*
2) *Many dead and dying trees, other NFH structures and elements;*
3) *There are almost all types of natural disturbances, with the exception of significant effects of flooding and herbivores*;
4) *No economic activity has been carried out or carried out to a small extent*.

The habitat is found in Latvia in area 49633-75000 ha, its total state of protection is identified as unfavourable-bad, development trend unknown (U2x) (Anon, 2019).

A habitat-friendly conservation state is characterised by a typical species composition and the long-term presence of natural structural elements, as well as by natural processes in the forest that encourage the formation of structures specific to such forests (Ikauniece, 2017). The quality shall be increased by the species of protected plants present in the habitat.

In the area of the study, the habitat was identified in a single locality site, represented option 1 of the habitat – typical Boreal class forest stand, dry water or varying humidity conditions. Habitat quality low. It is present in a small area, fragmented, the presence of human economic activity has been identified, leading to a change in the natural structure and vegetation of the forest. The quality of the habitat is increased by the presence of three protected plant species.

The best management of the conservation status of the habitat is non-intervention in the natural forest development process. Felling of trees or bushes in the habitat area is prohibited.

9180* *Tilio-Acerion forests of slopes, screes and ravines*. In Latvia a specially protected and priority protected habitat of European interest. Two sites of protected habitat have been identified in the northern and southern part of the study site. Total habitat area ~ 6,62 ha or ~ 0,1% of the total habitat area in the country.

They are mixed forests with the small-leaved lime *Tilia cordata*, the Norway maple *Acer platanoides*, the wych elm *Ulmus glabra*, the flatter-ulme *Ulmus laevis*, and the ash *Fraxinus excelsior* hills and river valleys on the slopes and ravines. In Latvia, there is a common mixture

of Norway spruce *Picea abies* in the forest of broad-leaf trees. There may also be a relatively high proportion of the grey Alder *Alnus incana* and the aspen *Populus tremula* (Auniņš, 2013).

Prerequisites for the existence of a habitat:

1) *The main determinant for the existence of the habitat is terrain, slope or grave, which creates special light and temperature conditions;*
2) *The erosion results in exposed soil areas;*
3) *Openings are formed, there are many dead trees, fallen deadwood;*
4) *There is a higher humidity and shading, no wind effect;*
5) *Sometimes there are sources, as well as stones and their collections.*

The habitat is present in Latvia in an area of 5605 – 6500 ha, its total state of protection is identified as unfavourable-insufficient, trend unknown.

The habitat is characterised by natural terrain – slope or ravine in a favourable conservation state. The surface is characterised by spring, it is unclosed, with little moss. Exposed soil areas may be formed as a result of a natural erosion process. A typical structure has been established and a natural recovery with broad leaf species is taking place. Protected species are present.

In the area of the study, the habitat was identified in two localities. Habitat quality medium. In the northern part it is found in a larger area, a partial cleaning of undergrowth has been carried out. In the southern part, the habitat is found in a smaller area, in the middle of a glade – grassland – it is located in the immediate vicinity of the residential building block. A total of three protected plant species have been identified in the habitat.

*Figure 48 Thinned shrub and tree floor in the habitat 9180* Tilio-Acerion forests of slopes, screes and ravines (Photo: E. Grolle, 2019)*

The best management of the conservation status of the habitat is non-intervention in the natural forest development process. There are several oaks of considerable age growing in the vicinity of the Veckuldīga castle mound. It is permissible to remove these trees by cutting younger trees and bushes in the vicinity of the trees. Felling of trees shall be permitted by prior assessment of the presence of protected and rare species associated with old trees, as well as by assessing the risk of erosion.

91E0* *Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae.* In Latvia a specially protected and priority protected habitat of European interest. In the area of the study, the habitat has been identified in the northern part of the area in the vicinity of the Veckuldīga castle mound. Second habitat polygon, modified in the central part of the territory, recultivating the territory of the former motorway[80]. The habitat is present in an area of ~ 6,17 ha or 0,05-0,07% of the total habitat area in the country.

[80]The cleaning of the motor track has been performed according to the request of the State Environmental Service, informing the Natural Protection Agency thereof

*Figure 49 The former area of the motor track and its surroundings after arranging: a distance-aligned motor track area, a nearby grassland and a river bank (modified habitat area) (Photo: E. Grolle, 2019)*

They are forests of the rivers of the ash *Fraxinus excelsior* and alder *Alnus glutinosa*, forests of riverside grey alder *Alnus incanae*, stands of white willow *Salix alba* and crack willow *Salix fragilis* along rivers. All subtypes are located on heavy, alluvial sediments rich soils that periodically flood when water levels high in rivers and creeks. At another time when water levels are low, soils are well drained and aerated. High herbaceous plants are common in the stands of the lags. Mostly, these forests are in contact with moist meadows and ravine forests. In Latvia, there may be cases where small, narrow habitat fragments at the foot of the slopes are ecological reasons to be considered as part of a complex of ravines and slopes (Auniņš, 2013).

Prerequisites for the existence of a habitat:

1) *Openings are formed, there are many dead trees, falls;*
2) *Vegetation is affected by flooding, sand areas are formed, micro-relief depressions are accumulated.*

The habitat is found in Latvia in areas of 8731 to 12189 ha, its total state of protection is identified as unfavourable-insufficient, development trend unknown.

The habitat is characterised by natural flood terrain in a favourable conservation state. The forest is flooding. The typical species of leaf trees are present in the cosmic tree, both the wide-leaf forests and the growing species of plants in the flooding areas. A structure of natural forest habitats has emerged, tree trunks densely covered with moss and lichen species.

In the area of the study, the habitat remains in a single locality area, its quality medium. Habitat option 2 is represented on the site: forests of willows, balthalder and snow or their mistaking rivers and flood plains.

The best management of the conservation status of the habitat is non-intervention in the natural forest development process without any economic activity. Felling of trees in the habitat area can lead to changes in the structure and vegetation of the habitat, increasing soil enrichment and the spread of nitrophilic species, contributing to the flushing of nutrients into groundwater. Removing old or ill trees will reduce the presence of essential elements of the structure for biodiversity.

91F0 *Riparian mixed forests of Quercus robur, Ulmus laevis and Ulmus minor, Fraxinus excelsior or Fraxinus angustifolia, along the great rivers (Ulmenion minoris).* A specially protected and protected habitat of European importance in Latvia. The habitat was found in the northern part of the study area near the riverbank of Venta. The habitat is present in an area of ~ 0,7 ha or 0,1-0,2% of the total habitat area in the country.

These are large-leaf forests in river valleys which are subject to regular flooding in the palos or to fluctuations in groundwater levels caused by the floods in the lower areas. These forests have developed into the sediments of river sanez. During flooding periods, the soil may be well drained and may remain wetted. Under the influence of the hydrological regime, the forest crop is dominated by the genera trees of the ash *Fraxinus,* elm *Ulmus*, or oaks *Quercus*. Typical well-developed undergrowth. These forests can form a blend with the confines of the pioneer phase or stable-stage narrow-leaf forests located in the lower places near the rivers (Auniņš, 2013).

Prerequisites for the existence of a habitat:

1) *Openings are formed, there are many dead trees, falls;*

2) *Vegetation is affected by flooding, sand areas are formed, micro-relief depressions are accumulated.*

The habitat is present in Latvia in areas of 447-600 ha, its total state of protection is identified as unfavourable-inadequate, development trend unknown.

The habitat is characterised by natural flood terrain in a favourable conservation state. The forest is flooding. The typical species of leaf trees are present in the cosmic tree, both the wide-leaf forests and the growing species of plants in the flooding areas. A structure of natural forest habitats has emerged, tree trunks densely covered with moss and lichen species.

One habitat locality has been identified in the area under investigation, with good quality.

The best management of the conservation status of the habitat is non-intervention in the natural forest development process without any economic activity.

**Evaluation of forest habitat management measures**

The nature protection plan of the nature reserve "Ventas ieleja" for 2010-2020, in relation to forest habitats, identifies the restriction of economic activity as the main measure. Forests in the study area occupy small areas, no agricultural activity takes place in them. The nature protection plan for landscape cutting states that it is advisable to cut out the view visions rather than continuous areas.

In the study area, in some areas, the floor of trees and shrubs was cut down, for example, in the areas of protected forest habitats in the vicinity of Veckuldīga castle mound, by installing wooden stairs connecting the castle mound territory with the grass along the Venta river. There are few structural elements characteristic of natural forests in forest habitats - crystal, dry matter, etc. (Figure 49).

The most suitable method of forest habitat management for further management is not to interfere in the natural forest development processes, preserving the structural elements - old trees, drywood, fallow trees, sawing trees only in cases when it endangers human safety and is necessary for maintenance.

**Conclusions**

A total of 4 types of forest habitats of European Union significance have been identified in the area:

9010* *Western taiga*;

9180* *Tilio-Acerion forests of slopes, screes and ravines;*

91E0* *Alluvial forests with Alnus glutinosa and Fraxinus excelsior (Alno-Padion, Alnion incanae, Salicion albae);*

91E0* *Riparian mixed forests of Quercus robur, Ulmus laevis and Ulmus minor, Fraxinus excelsior or Fraxinus angustifolia, along the great rivers (Ulmenion minoris).*

Their quality is mostly medium. In the future, the areas of forest habitats to be protected must be maintained at their current level, ensuring their natural development.

In general, the conditions for the use of forests laid down in the nature conservation plan have been met.

In the future, the areas of forest habitats to be protected must be maintained at their current level, ensuring their natural development.

#### *3.5.2.3. Freshwater habitats, status, hazards, conservation and protection measures.*

**3260** ***Water courses of plain to montane levels with the Ranunculion fluitantis and Callitricho – Batrachion vegetation***. For variant 2 of this habitat, the natural rivers and river sections where the current speed is less than 0,2 m/s correspond to the section below the new bridge to the Venta fall.

Habitat 3260 River straits and natural river stages for Option 1, the river flows correspond to the downstream of the Venta fall.

In both phases, the quality of the habitat has been assessed as being medium.

Rivers are a very important habitat for many plant and animal species and serve as a natural migration path for species. Particularly valuable are river streams with rocky or oily soil, which are the only habitat for species that have adapted to life in rapidly running, oxygen-rich waters.

Oxygen-rich water streams significantly accelerate the decomposition of organic substances and consequently water self-cleaning. The water level in the rivers is highly variable due to climatic and meteorological conditions, as well as to the supply of groundwater, the size and nature of the catchment area[81].

*Prerequisites for the existence of a habitat*

- Natural hydrological regime and natural variations in water levels, including floods and floods;
- A natural eutrophication process, preferably ensuring low nutrient concentrations in water[82].

In the Venta section, below the new bridge to the Veckuldīga castle mound, the habitat *River straits and natural river sections* for variant 2 *Natural rivers and river sections* where the current rate is less than 0,2 m/s corresponds to the downstream of the new bridge to the Ventas fall. For habitat option 1, *the river flows* correspond to the downstream of the Venta fall. In both stages, the quality of the habitat has been assessed as being medium, as the degree of swelling is high at both stages (above 30% of the reflected surface of the river), as well as the common species of aquatic plants typical for nutrient-rich waters – the conventional arrowhead *Sagittaria sagittifolia, the* pebble-shaped chock Potamogeton pectinatus *Cladophora glomerata*, fragrant *calamus*, water flowers *Lemna minor, L. trisulca, Spirodela polyrhiza.*

81Auniņš A., 2013.

[82]Urtan A. V. (ref.) (2017). Guidelines for conservation of protected habitats in Latvia. II rivers and lakes. Nature Protection Agency. Sigulda. Page 208

*Figure 50 River straits of the Habitats and natural river links in front of the Veckuldīga castle mound (photograph: L. Grīnberga)*

Habitat Option 1 in a favourable conservation state is characterised by the mistrement of ostrades and yellows with a diverse mosaic of the ground-forming substrate. The water temperature in July and August is below 18 °C. The river barrier with the highest water plants does not exceed 30% of the river mirror surface[83].

[83]Urtan A. V. (ref.) (2017). Guidelines for conservation of protected habitats in Latvia. II rivers and lakes. Nature Protection Agency. Sigulda. Page 208

*Figure 51: High diversity of aquatic invertebrate species (photograph: L. Grīnberga)*

In the favourable conservation status of option 2, sediment accumulation is not detected in more than 5% of the riverbed area. The water temperature fluctuates around 18 °C during the summer months and only temporarily exceeds 20-22 °C[84].

*Figure 52: Habitats River straits and natural river stages slow down the new bridge (photo: L. Grīnberga)*

[84]Urtan A. V. (ref.) (2017). Guidelines for conservation of protected habitats in Latvia. II rivers and lakes. Nature Protection Agency. Sigulda. Page 208

Ensuring a favourable conservation position in Venta within the town of Kuldīga is problematic, since this phase includes both the hasty and slow-flow phases – the heating up of sediment during the slow-stream upstream of the Ventas fall, which contributes to the development of aquatic plants. In addition, upstream and downstream of Ventas fall, the river is wider and shallower, so the denser growth of aquatic plants is forming here. From freshwater management measures in Venta, it is recommended that water plants be regulated by mowing and removal of water plants. Mowing should be carried out on a regular basis, as concentrations of nutrients in water are high, additional nutrients lead to the decomposition of aquatic plants during the autumn and winter season (see Chapter 3.4.2). In addition, it should be noted that Venta is a cross-border river and a high degree of foreclosure is observed in many stages upstream of Kuldīga. These processes cannot be directly influenced by the municipality. Transboundary water pollution transfer is one of the most important problems for inland waters in Latvia (plans for river basin areas 2016-2021, LEGMC, 2015)[85].

*Figure 53 Water plants outside the Ventas fall in autumn 2019*

[85]https://www.meteo.lv/lapas/vide/udens/udens-management -/river-basin-district-management-plani -/river-basin-district-management-plani-and-beach-risk-parvaldiba? id = 1107 & nid = 424

The renewal of straits of Venta has so far been carried out under the following projects:

- The removal of aquatic plants and their roots from the river, the mechanical wedging of the bed and the sands by tractor in 2011 and the manual project "Cross-border cooperation on the management of natural values of the river Venta Basin area";
- In 2016, recultivation of stream habitats was carried out in the project "Protection of Valuable Habitats and Landscapes in the Nature Reserve "Ventas ieleja".

The recovery of high growth levels was driven not only by high concentrations of nutrients but also by climatic conditions. According to the hydrological data collected in this study, the last five years, with the exception of the rain-rich 2017, have shown a low water period with a flow rate below normal. In addition, as of 1987, the number of days in which a stable ice cover is covering Vent in Kuldīga (see also Chapter 3.2.2) has decreased significantly. Consequently, spring ice congestion in Venta is also reduced, which contributes to a natural cleaning of the bed.

Regular mowing of aquatic plants and removal of the mowing mass of plants from the river is necessary in order to reduce the degree of vegetation. Since the upstream and downstream of Venta fall all the conditions are in place for aquatic plants to form particularly dense stands – shallow water, solid ground where to take root, there will be no reduction in areas of aquatic plants even by moving them several times. As mentioned in Chapter 2.1.3.2, the river has been regularly tended and cleaned since the 17 th century. Therefore, mowing of aquatic plants should be carried out on a regular basis.

**Conclusions**

The river corresponds to the protected freshwater habitat 3260 *Water courses of plain to montane levels with the Ranunculion fluitantis and Callitricho – Batrachion vegetation* variation 1 and 2. To the variation 2 of this habitat, corresponds to the section downstream form the new bridge to the Venta fall, but to variation 1 the section downstream from the Venta fall.

In both phases, the quality of the habitat has been assessed as being medium.

Reinforced enrichment of rapids habitats occurs in as the result of eutrophication. The reduction of nutrient runoff is considered to be a priority measure for the protection of species and habitats.

Ensuring a favourable conservation status of the habitat in Venta at the border of the city of Kuldīga is problematic because:

- it includes both the hairy and slow-stream phase – heating up in the slow-stream upstream of the Venta fall, a build-up of sediments that contributes to the development of aquatic plants;
- not only are high concentrations of nutrients, but also climatic conditions are a high level of growth: the number of days when a stable ice blanket is covered in Ventu Kuldīga, and spring ice jams in Venta will also reduce, contributing to the natural cleaning of the bed.
- Venta is a cross-border river, so water quality is affected by the ecological status of the river upstream in Latvia and Lithuania. A high degree of swelling is seen in many phases upstream of Kuldīga, which cannot be affected by the municipality. Transboundary water pollution transfer is one of the most important problems for Latvia's internal waters.

Regular mowing of aquatic plants and removal of the mowing mass of plants from the river is necessary in order to reduce the degree of vegetation.

### 3.5.3. Localities of specially protected species

In total 16 specially protected or rare and threatened plant species have been identified in the area. Of these, the protection of 8 species is determined by Cabinet Regulation No. 396 of 14 November 2000, "Regulations regarding the list of specially protected species and specially protected special species with restricted use", and in Latvia micro-reserves are to be formed for 4 species (Cabinet Regulation No. 940 of 18 December 2012,"Regulations Regarding the Establishment and Management of Micro-reserves, Their Conservation, as well as Determination of Micro-reserves and Their Buffer Zones"). All species are included in the Latvian Red Data Book[86]. Two species are included in the Annexes to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (the 1973 Washington Convention CITES).

[86]Baron V., Hat B., Cinovskis R., Eglite Z., Fatare I., Gavrilova G., Kabucis I., Rerich I., Schmite D., Schulz V., Tobacco L. Latvian Red Data Book. Vascular plants, p. 3. Riga, 2003 – In Latvian

There are 3 specially protected restricted fish species in Latvia[87], 7 fish species are in Directive 92/43/EEC. 3 specially protected species of invertebrates have also been identified in the area of the study.

The inventory of species has been carried out over different periods of time. The chapter provides a description of them, information on threads and measures for conservation and protection.

The location of specially protected species localities is shown in Map 8 "Nature values". The prevalence and growth conditions/ecology of species is based on data from the www.latvijasdaba.lv site.

**Curled rose *Rosa coriifolia***. A specially protected species in Latvia, included in category 3 of the Latvian Red Data Book. The species is rare in Latvia, only in the western part of the country (www.latvijasdaba.lv), with 11 species localities registered in the nature data management system "Ozols".

Individual plant copies or small groups are found on riverbanks, parks, roads and fields. 5 species locality have been identified in the area of the study. The plant is mainly growing in the grassland and shrubs or forest contact bar. The localities are threatened by planting or cutting through the management of grassland or forest habitats. In places where grassland is no longer managed, the plant is threatened by the overgrowing of bushes, creating environmentally unsuitable conditions for the existence of the species.

**Broad-leaved laserwort *Laserpitium latifolium***. The species is included in category 3 of the Latvian Red Data Book. The plant is rare and uneven in Latvia, mainly in Kurzeme and the Daugava Valley in Central Latvia. (www.latvijasdaba.lv), 206 species localities have been registered in the nature data management system "Ozols".

Small groups, occasionally dense stands, form riverbanks, dry meadows and terraces, forest borders and scruffy mixed forests. Common in mostly calcareous soils. 2 species locality have been identified in the area of the study. The plant is growing in the forest area on the slope of the river. Locality threaten the performance of economic activity in forest areas.

[87] 18.11.2000 Cabinet Regulation No 396 "Regulations regarding the list of specially protected species and restricted specially protected species" Annex 2

**Bulbous buttercup *Ranunculus bulbosus*.** A specially protected plant species in Latvia for which micro-reserves are to be formed. The species is included in category 3 of the Latvian Red Data Book. In Latvia it is found unevenly: in Kurzeme, rarely in central Latvia, in the North Wind and in the Daugava Valley, but in the rest of the area there is hardly any occurrence, there are 58 species localities registered in the nature data management system "Ozols".

Individual copies and small groups are found in dry meadows, dunes, dry woodlands and set-aside. (www.latvijasdaba.lv). 2 species localities have been identified in the area of the study. The plant grows in the area of the protected grassland 6210 *Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia) (*important orchidsites)* in the area of the Veckuldīga castle mound. Locality are threatened by intensive grassland management, which has been mown several times over the season.

**Green figwort *Scrophularia umbrosa*.** A specially protected plant species in Latvia for which micro-reserves are to be formed. The species is included in category 1 of the Latvian Red Data Book. Latvia is very rare, only in a short phase of Venta valley, north of the continuous range of the species (www.latvijasdaba.lv), with 13 species localities registered in the nature data management system "Ozols".

Small groups are formed in the flood plains and bankal slopes, in source areas (www.latvijasdaba.lv). The area of the study has identified 9 species localities, mainly in riverside forests and shrubs. Localities threaten by the economic activity in forest areas.

**Quaking-grass sedge *Carex brisoides.*** A specially protected plant species in Latvia for which micro-reserves are to be formed. The species is included in category 2 of the Latvian Red Data Book. Latvia is very rare, north of a continuous distribution area (www.latvijasdaba.lv), with 25 species localities registered in the nature data management system "Ozols".

The plant forms small groups in pine forests and shrubs, uncommon in mixed forests or swamp borders (www.latvijasdaba.lv). 3 species localities have been identified in the area of the study, at the foot of the riverside slope, in wet shrubs. The fields are threatened by the cutting of shrubs as a result of grassland management.

**Sand leek *Allium scorodoprasum*.** The species is included in category 3 of the Latvian Red Data Book. Latvia is rare, only in the western and central part of the country

(www.latvijasdaba.lv), with 20 species localities registered in the nature data management system “Ozols”.

Individual copies and groups grow in meadows, woodlands and river terraces (www.latvijasdaba.lv). 4 species localities have been identified in the study area, in the area of the protected grassland 6210 *Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia) (*important orchid sites).* The localities are threatened by the installation of tourism facilities and by the intensive dismantling of the site, mechanically destroying the species locality or planting the grassland with bushes, creating environmentally unsuitable conditions for the existence of the species.

**Soft downy-rose *Rosa mollis*.** A specially protected species in Latvia, included in category 3 of the Latvian Red Data Book. The species is rare in Latvia, in the western part of the country; the species is located in Latvia on the north-east boundary of the plume (www.latvijasdaba.lv), with 17 species localities registered in the nature data management system “Ozols”.

Individual copies and groups typically grow in open habitats (www.latvijasdaba.lv). The study site identified 4 species localities, both in the area of the protected l grassland 6210 *Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia) (*important orchid sites)* and in the open areas near the old Kuldīga Bridge on the bank of Venta and Māriņsala. Localities are threatened by plants cutting or cutting through grassland management.

**Lesser centaury *Centaurium pulchellum*.** A specially protected species in Latvia, included in category 2 of the Latvian Red Data Book. The species is rare and uneven in Latvia, mainly in the sea and in the middle of the country (www.latvijasdaba.lv), with 32 species localities registered in the nature data management system “Ozola”.

Individual copies and squabbled groups grow in seaside meadows, set-aside and grassy little-travelled rural roads in moderately humid places (www.latvijasdaba.lv). 1 species locality have been identified in the area of the study, at the edge of the field. The locality is threatened by the mechanical destruction of the plant by the management of the site.

**Berry Catchfly *Cucubalus baccifer*.** The species is included in category 3 of the Latvian Red Data Book. There are rarely major rivers in Latvia (Daugava, Gauja, Venta, Lielupa) valleys

(www.latvijasdaba.lv), 84 species localities are registered in the nature data management system Ozols.

Small groups or individual copies grow in the bushes and floodplains (www.latvijasdaba.lv). The area of the study has identified 2 species localities, in the brush of the riverbank floodplains, of which the cutting of scrub has been carried out in one locality. The localities are threatened by the mechanical destruction of the plant, by the management of the site as well as by cutting out the bushes.

**Baltic Marsh-orchid *Dactylorhiza baltica*.** A specially protected species in Latvia, included in category 4 of the Latvian Red Paper, as well as in Annex B to the Convention on International Trade in Endangered Species of Wild Fauna and Plants. In Latvia is often present. Latvia is the richest distribution area of this species throughout its range (www.latvijasdaba.lv), the nature data management system "Ozols" records 780 localities of the species.

Individual copies and groups are most common in meadows, grass swamps and scrubs. Forests are growing much less frequently (www.latvijasdaba.lv). 1 locality of species found in the area of the study, in the area of the protected grassland 6210 *Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia) (*important orchid sites).* The locality is threatened by intensive grassland management, which is mown several times a season.

**Military orchid *Orchis militaris*.** A specially protected species in Latvia for which micro-reserves are to be created. The species is included in category 3 of the Latvian Red Data Book, as well as in Annex B to the Convention on International Trade in Endangered Species of Wild Fauna and Plants. Latvia is rarely present throughout the territory (www.latvijasdaba.lv), with 203 species localities registered in the nature data management system "Ozols".

Individual copies and groups are growing in moderately wet meadows, shrubs, set-aside, uncommon in woodland lakes. As a result of economic activity, the number of locality in Latvia is shrinking (www.latvijasdaba.lv). The site of the study identified 1 species locality, in the shore bush of Venta. The findings are threatened by intensive management of the site, by cutting off the scrub and mechanically destroying the conservation of the species.

**Chives *Allium schoenoprasum*.** Category 3 of the Latvian Red Data Book includes a species. Latvia is rare, mainly in river valleys (especially Daugava). No (www.latvijasdaba.lv) occurs in the northern part of the country, 114 species localities are recorded in the nature data management system "Ozols".

Individual copies and small groups grow in wet meadows, shrubs, avocsnine and chalky rivers, dolomite outcrops (www.latvijasdaba.lv). The area of the study identified 1 species locality, in open area, on the bank of Venta. The findings are threatened by intensive management of the area, as well as the installation of tourism facilities by mechanically destroying the site of the species.

**British yellowhead** or **meadow fleabane *Inula Britannica*.** Category 3 of the Latvian Red Data Book includes a species. Latvia is a rare occurrence, mainly in river valleys (www.latvijasdaba.lv), with 36 species localities registered in the natural data management system "Ozols".

Small groups grow in dry meadows and bankal slopes in river valleys, shrubs, uncommon in flood meadows. Particularly strong populations form chalky, carbonated soils (www.latvijasdaba.lv). In the area of the study, 1 species locality was found, along the bank of Venta, in the vicinity of the tourism trail. The findings are threatened by intensive management of the site, by a regular hatching process, as well as by the installation of tourism facilities by mechanically destroying the conservation of the species.

The section of Venta between the new bridge and the Veckuldīgas castle mound is an important habitat for a number of rare and specially protected species.

Following the river in the autumn of 2019, a specially protected species of snail - **river nerite *Theodoxus fluviatilis*** has been identified here in several localities, both upstream and downstream of the fall of Venta.

*Figure 54: A specially protected species of clams in the river nerite Theodoxus fluviatilis (photo: L. Grīnberga, 2019) is common at the Kuldīgas section.*

In developing the nature conservation plan of the nature reserve "Ventas ieleja", specially protected species of **snails has** been found at the river section, **river cap *Ancylus fluviatilis*** and scallop **- thick perlamutrene *Unio crassus***. Monitoring of species of fish, lamprey and crayfish is being carried out in Venta. Data on monitoring results since 2014 are available.

In 2017, eight sites were surveyed in the nature reserve "Ventas ieleja". A total of 34 species of fish and lamprey have been identified in the area. Monitoring in 2017 identified 24 species of fish and lamprey, including 7 species included in Directive 92/43/EEC: spined loach *Cobitis taenia*, european bullhead *Cottus gobio*, river lamprey *Lampetra fluviatilis*, brook lamprey *Lampetra planeri*, asp *Aspius aspius*, european bitterling *Rhodeus amarus*, salmon *Salmo salmo* of which, the 3-species river lamprey *Lampetra fluviatilis*, the brook lamprey *Lampetra planeri* and asp *Aspius aspius* are specially protected species of limited use in Latvia. The area is characterised by a high biodiversity of fish and is considered to be important for the protection of fish and for the preservation of biodiversity.

In the area of Venta valley, the best sites for river lamprey and salmon spawning and offspring are located. The trend of increasing the density of larger-sized lamprey larvae allows the state of the river lamprey population to be assessed as stable in nature reserve "Ventas ieleja".

Therefore, no immediate measures are required to protect the population of river lamprey (BIOR, 2015, 2017).

**Impacts and threads**

One of the most important factors negatively affecting the nature and landscape values of the study site is the prevalence of invasive species. An invasive species is an alien species whose behavior in local ecosystems is aggressive. It is able to quickly enrich, successfully spread and compete with local species. In the meantime, Regulation No 468 of the Cabinet of Ministers No. 30.06.2008. "List of Invasive Plant Species" includes only one species — Sosnovska hogweed *Heracleum sosnowskyi.* Criteria for the inclusion of species in this list: the species reduces biodiversity, causes economic damage, damage to human health and reduces the quality of recreational resources.

The most common invasive species[88] in the area of the study are the Himalayan balsam *Impatiens glandulifera*, Canadian goldenrod *Solidago canadensis* and the wild cucumber *Echinocystis lobata*. They grow on the riverbank, on the sidelines of paths and roads, abandoned gardens and other unmanaged areas, and spread to grassland and forest habitats.

Himalayan balsam is currently recognised as one of the most invasive plant species in Latvia[89], leading to increased soil erosion and leaching. In order to limit the spread of the species, it is recommended that the blasts be removed or mowed at the beginning of the bloom before the ripe seed.

[88]Nature Conservation Agency list of invasive species, available in https://www.daba.gov.lv/public/lat/dabas_aizsardzibas_plani/dati1/invazivas_sugas/
[89]https://www.daba.gov.lv/public/lat/dabas_aizsardzibas_plani/dati1/invazivas_sugas/

*Figure 55 The Himalayan balsam stand at the edge of the new path (Image taken in autumn, so only the stalks are visible; photos: L. Grīnberga, 2019)*

*Figure 56 Blossoming Himalayan balsam in Vidzeme (photograph: L. Grīnberga, 2019)*

Canadian goldenrods are present almost all over Europe today and are described as one of the most aggressive, widespread alien species. Canadian goldenrod seed is produced in large quantities: in Europe, one plant is able to produce up to 10 000 seeds. Goldenrods are also distributed by humans, for example, by discarding bouquets of flowers and garden plants cut in the fall. With its strong roots system, they compete with other plants and reduce biodiversity. The most effective method to control a species is digging and mowing before the seed is ripened.

*The Figure 57 of Canada's goldenrod makes solid hopes by competing for local plant species (photo: L. Grīnberga, 2019)*

The wild cucumber is found in the area of the study on the beach of Venta. Its stands reduce the diversity of local species by shading other riverside plants. It is recommended that plants be removed or mowed at the beginning of flowering in order to reduce the spread of the species so that they do not allow the seed to be ripened.

*Figure 58 Wild cucumber stand on the beach of Venta, the photograph shows the finished fruit (photograph: L. Grīnberga, 2019)*

**Conclusions**

There are 16 specially protected or rare plant species, including 8 specially protected species, 4 species for which micro-reserves are to be formed. They are all included in the Latvian Red Data Book. In addition, the area is important for the protection of fish and for the conservation of biodiversity. It contains 3 fish species specially protected of limited use in Latvia. 3 specially protected species of invertebrates have also been identified in the area of the study.

The most important sites are plant species for which microreserves are to be developed in Latvia - bulbous buttercup *Ranunculus bulbosus*, green figwort *Scrophularia umbrosa*, quaking-grass sedge *Carex brizoides* and military orchid *Orchis militaris*. The existence of species in the area depends to a large extent on the conservation of suitable habitats, both in terms of area and quality. For the precise determination of the boundary of species localities, which would allow for the setting of suitable management methods, it is necessary to carry out a re-inventory during the vegetation season.

Invasive species occurrs in the area, mostly outside specially protected habitats (ruderal areas). Their presence has a negative impact on the nature and landscape values of the study area. Invasive species reduce biodiversity, cause economic damage, harm to human health and impair the quality of recreational resources. In the further phase of the development of the study, a set of measures should be prepared to limit (management) the spread of invasive species in both protected habitat areas and outside.

The nature protection plan of the nature reserve “Ventas ieleja” for 2010-2020 does not set out management measures for the protection of protected and rare plant species. When developing a nature protection plan for the next management period, it is necessary to include measures for the protection of protected and rare plant species in the plan, as they may differ from the measures imposed on the habitats where the localities have been identified.

The situation of specially protected fish and invertebrate species in the area of the study is considered as good and stable. The state of these species should not be further deteriorated.

## 3.6 The landscape of the river Venta and the riverbanks

“Comprehensive research work has been taking place for a long time in Kuldīga, and rich historical information has been accumulated at various institutions in the town. It is significant that local specialists have been involved in all of the work” - this is how Aija Melluma noted in the introduction of her book “Kuldīga. Times, people, landscape” [90]. This is by far the most extensive study conducted on the cultural landscape of Kuldīga and covers a period of time in about 31 generations. The conclusions made in the work of Aija Melluma have been used in the creation of this chapter.

**Approach to landscape formation**

In 2000, the Council of Europe adopted the European Landscape Convention, which aims to promote the protection, management and planning of landscape areas and to organize cooperation on landscape issues in Europe. In 2007, with the adoption of the Law on the European Landscape Convention, this Convention was ratified by the Saeima of the Republic of Latvia. In joining the Convention, Latvia committed to establish landscape policy and promote the implementation of the measures set out in the Convention. The Convention emphasizes that landscapes are in any territory, it looks at all landscapes in their diversity of origin (natural or man-made) and by assessment (unique or common). A landscape is considered to be a special product of the interaction between nature and humans, in which cultural and natural heritage are organically linked.

In the context of landscape policy, “landscape management” is defined in the European Landscape Convention as follows: “Landscape management - action, from a perspective of sustainable development, to ensure the regular upkeep of a landscape, so as to guide and harmonise changes which are brought about by social, economic and environmental processes”. It outlines the general principles of governance. The landscape of the Venta river and its riverbanks included in the study has very specific goals, they are determined by the natural and cultural heritage, its nature and the public's desire for the further development of the landscape.

The European Landscape Convention does not emphasize the role of the municipality in landscape protection, management and planning, but it follows indirectly that it is the

[90]Mellum Ay “Kuldīga.” Times, People, Landscape”, Jelgava typography, 2017, p. 240

responsibility of the municipality to carry out a landscape assessment, the results of which are included in the landscape plan.

When looking at the landscapes in the study area, the site conditions, the territory, the interaction of different processes (natural and human), their scales and spatial manifestations are taken into account. The most important preconditions for the development of the characteristic landscape of the Venta valley are the cultural and natural heritage, which forms the landscape of the territory.

The landscape framework of the study area is the Venta valley nature complex, which has the status of a nature reserve, thus the natural heritage of the study area is the second of the preconditions for the development of the landscape characteristic of the Venta valley.

River landscapes, taking into account the distribution of certain landscape types, their uniqueness or significance in terms of preserving landscape diversity, in the spectrum of Latvian landscapes need to be singled out as unique landscapes.[91]

The formation of the landscape structure has been determined by the historical development of the territory. An important factor that determines the structure of landscapes at any scale is the geomorphological factor - the shape of the earth and the lithological composition of relief forms (loam, clay, sand, etc.), it refers to the diversity of landscapes, their structure, as well as land use.

**Kuldīga as a pilot area**

The generally accepted time for the formation of Kuldīga is 1242. The sources of history show that soon after, the palace of the Order of Kuldīga was built. The beginnings of the city are described in the book on the architecture and urban construction of Kuldīga.[92]

The most important preconditions for the development of the characteristic landscape of the Venta valley are the cultural and natural heritage, which forms the landscape of the territory. It is a nature complex of the Venta valley, which has the status of a nature reserve and whose landscape structure has been determined by the historical development of the territory.

[91]"Gaujas Nacionālā parka ainavu estētiskais vērtējums", Authors O. Nikodemus, I. Rasa 2005
[92] "Kuldīga. Arhitektūra un pilsētbūvniecība", J. Krastiņš, Kuldīgas district municipality, 2013

### 3.6.1. Major landscape forming elements

The nature of the landscape space of the Venta valley is determined by the river valley with steep or terraced slopes, therefore wide panoramic views open from the main bank of the valley. Landscape assessment and summary of elements is performed taking into account the basic principles for determining landscape values from the aesthetic point of view, based on three criteria: landscape quality, its visibility and accessibility.

Taking into account the available information materials and the time allocated for the research, the characteristic elements and main values of the landscape structure in the Venta valley and its coastal area are summarized and shown on Map 10 “Significant landscape features”.

Landscape assessment and summary of elements is performed by taking into account the basic principles for determining landscape values from an aesthetic point of view, based on three criteria: landscape quality, its visibility and accessibility.

The graphic material contains the following information:

- the most important features of the blue-green structure are: the river Venta and its tributaries: Alekšupīte and Krāčupīte, as well as Pārventa Park, Mārtiņsala, Mākslas dienu Park and the latest of the sites - the left-bank path of the river Venta;
- The area of the study is one of the richest and most interesting areas in Latvia in terms of natural and cultural heritage landscape elements. The most important objects:
    - geomorphologic natural monument “Ventas rumba” – the largest waterfall in Europe (width 240 m, height 1,8-2,2 m);
    - steep bank “Melnā Kolka”;
    - State protected cultural monuments:
        - urban building monument “Historical Center of the city of Kuldīga” (date: 13$^{th}$ -19$^{th}$ century);
        - archaeological Monument “The Old city of Kuldīga”;
        - architectural monument “Red brick vault bridge” (date: 1874),
        - archaeology Monument “Veckuldīga castle mound and the Old Town”;

- The territory, buildings and objects of the UNESCO World Heritage Latvia's national list of the “Kuldīga (Goldingen)”:
    - architectural monument Red brick vault bridge (date: 1874);
    - Venta Canal (date: 17th-19th century);
    - Alekšupīte fall – the highest waterfall in Latvia, height 4,15 m;
    - Venta fall – the largest waterfall in Europe (width 240 m, height 1,8-2,2 m);
  - historic sites and objects:
    - Duke Jacob's channel is also known as the Venta canal;
    - former berth;
    - former ferry;
    - veneer factory “Vulkāns”;
- Accessibility of the site in the context of tourism and recreation infrastructure:
  - walking path of Pārventa Park (0,8 km);
  - Mārtiņsala nature walking path (1 km);
  - the left bank path of the river Venta (2,4 km);
  - cycling route (area crossed by the E11 European route);
  - the Mārtiņsala bathing place with a Blue Flag certificate;
  - “Vikingu placis” fire place.

The recognition of the city is also increased by the fact that the development in this area is oriented towards tourism, incl. the organization of beautiful and traditional and well-attended events, recreation based on natural and cultural heritage, the unifying framework of which is the landscape of the Venta river valley.

**Location of Map 10 “Significant landscape features”**

### 3.6.2. Changes in the landscape

The landscape is in continuous variability and development, its nature is based on natural conditions (the river Venta valley with slopes) and interaction between human activities (urban formation).

**Landscape formation**

The conservation status of Venta valley, including the stage in the city of Kuldīga, has already been established in 1957, with a special conservation status in 1999, the nature conservation status. The exploration of the site has identified nature, including landscape values, and identified the necessary management measures. The site is a protected nature area of European interest (*Natura 2000*).

The initial objective of the establishment of a nature reserve was to ensure the protection of specially protected species and habitats, the preservation of landscapes typical of the territory, as well as the protection of natural and cultural monuments, while maintaining the area for visitor recreation, education and sustainable management (Regulations No 140 of the Cabinet of Ministers' "Individual Protection and Use of Nature reserve "Ventas ieleja") 1. point). As noted in the nature conservation plan of the "Ventas ieleja", the assessment of the land conservation objectives and management measures set out in the previous nature conservation plan (analysis of their descriptions in the nature conservation plan and the state of nature closures in 2010) complicates the assessment of the achievement of the targets set by the lack of easily visible or measurable indicators. However, it is noted that the objectives set out in the previous nature conservation plan have been achieved in general, but most of the management measures have not been realised, with the exception of measures related to the development of tourism and recreational infrastructure. Therefore, the main directions of the territory development - protection of values and development of tourism and recreation are topical and dominate in the research territory also in today's situation.

The management of the open landscape on the banks of the Venta river from traditional agriculture, which was linked to economic objectives such as haymaking or grazing, has changed and is based on nature conservation objectives. The management of the site may be based on ensuring the transparency of the landscape, protecting, preserving or enhancing its

aesthetic and landscape values in the context of tourism and recreational objectives, thus seeking new ideas and solutions to preserve and maintain the significant and distinctive features of the natural landscape and human activities.

**Changes in the landscape**

The most significant changes in construction can be seen along the left bank of the Venta in the section from the old bridge to the new bridge, where the transformation of the agricultural landscape into urban land is observed. Initially, the city's buildings were located on the left bank of the river, slowly expanding along the river bank in a northerly direction. From the 19$^{th}$ century, on the other hand, with the development of industry, the city has expanded and buildings have been located in the city's pastures. Also in the post-war period, the cities boundaries have changed significantly - previously undeveloped agricultural land has been excluded from the city territory, but residential buildings on the right bank of the Venta have been included in the city territory (for cartographic comparison, see subsection 2.1.3. on the Map 1 “Comparison of historical maps”).

Landscape changes have also affected the Venta river, as changing economic conditions (types of use and management of the Venta river and its banks in the pilot area and also outside it – upstream of river) have promoted vegetation formation in the river, promoting coverage of aquatic plants of the river. Thus, today the presence of a water element in the landscape is much less pronounced compared to the situation observed in the 20s - 30s in the 20$^{th}$ century. Coverage of aquatic plants with surface plants is characteristic for the river in the whole study area. The highest degree of coverage of aquatic plants - in the section upstream and downstream of the Venta fall. The high degree of coverage of aquatic plants of the river creates a visual effect that the meadow landscape seems to expand, but thus the water element in the landscape is lost. For more information on factors influencing water quality and coverage of aquatic plants, see 3.4. section.

The outline of the Venta fall has been influenced by both natural processes (flood streams, ice flow) and human activities (rafting, timber floating, systematic cleaning of the river to improve navigation conditions, etc.). Today, the outline of the Venta fall changes minimally, it is mainly influenced by geological processes. Depending on the amount of water in the river, the dolomite waterfall wall may be completely or partially covered with overflowing water. Dolomite

outcrops (vertical walls) can also be seen along the riverbed downstream. Dolomite outcrops are a habitat of European Union importance, they have scientific and landscape (aesthetic) value.

Technical solutions are being searched to illuminate the Venta fall regularly during the dark hours of the day. It should be noted that this had been implemented as one of the events during the Week of Restaurants in Kuldīga in 2019. Light installation should be marked as a positive and future developable initiative.

### 3.6.3. Analysis of visual perception of spatial composition

The analysis of the visual perception of the spatial composition evaluates the view perspectives, the silhouette of Kuldīga Old Town and the most significant viewpoints and perception areas in the pilot area and its visual perception area, which includes Venta water area, riverbank and its panorama with exhibited objects (vertical dominants and urban design). Graphically, the analysis is reflected in Map 11 “Analysis of visual perception of spatial composition”.

#### *3.6.3.1. Silhouette and panorama*

The panorama and silhouette of Kuldīga Old Town - the historical center of Kuldīga - are unique values that form the image of the city. The panorama and silhouette of the Old Town are well visible in the views from the right bank of the Venta. Venta riverbanks are terraced and undeveloped, therefor the variety of views and angles is diverse. The panorama and silhouette of the left bank of the Venta is dominated by the landscape of the Venta river valley with a water mirror and floodplain meadows, steep banks, the Venta fall and Alekšupīte with its waterfall and as well low-rise historical buildings. In the linear composition, some vertical accents - church towers - stand out. The elements and structures of nature (bathing place “Mārtiņsala”, Pārventa park) are mainly exhibited in the panorama of the right bank. The most expressive and characteristic node is the surroundings of the old bridge with a bathing place “Mārtiņsala” and Pārventa park on the right bank, Venta fall and Alekšupīte waterfall, and the construction of Kuldīga Old Town on the left bank of the river.

The panoramic and urban skyline of the old and Venta rivers is a vivacious and culturally valuable area and forms the identity of the site, as well as a basis for the development of tourism and recreation.

### *3.6.3.2. The most important viewpoints, view perspectives and other elements of perception of urban composition*

In order to preserve and increase the landscape values in the pilot area, the most significant viewpoints have been identified, from which the panorama of Kuldīga Old Town buildings and/or the panorama of the Venta riverbank opens.They are indicated and numbered on the Map 11 “Analysis of visual perception of spatial composition”.

The study identifies the most important existing viewpoints - places in public space or simply publicly accessible places for observing the landscape in the Venta valley, which are essential to capture the overall panorama and silhouette of the city. Viewpoints are an area of a few square meters that offers a wide, expressive and engaging view from above ground. The viewpoints are visited specially to enjoy this view and are a resource for recreation and tourism.

**List of major viewpoints**

The first column “No” refers to the serial number with which this point of view is shown on the map.

| No. | Viewpoints | Picture from the landscape (or its immediate surroundings (+/- 20 m)) |
|---|---|---|
| 1. | A view from the new bridge to the Ventas valley downstream of the bridge |  |

2. View from Venta's left bank path to river Venta downstream of new bridge; it is necessary to clean the riverbank vegetation to expose the landscape

3. View from the left bank path to the river Venta and the panorama of the right bank and the potential place for the boat slip

4. A view from the left bank path and a panorama of the right bank;

   It is necessary to clean the riverbank vegetation to expose the landscape

Photos: Jēkabs Aleksands Krūmiņš, 23.01.2019

[93]

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5. View from the blue flag swimming area "Mārtiņsala" to the Venta river, Kuldīga Old Town buildings and the left bank panorama

6. View from Pils Street to river Venta, Venta fall, right bank panorama (Mārtiņsala)


7. A view from the Old bridge to Mārtiņsala, Venta river, Venta fall and the panorama of the left bank

8. A view from Mārtiņsala to the river Venta and a panorama of the building and the left bank of the Kuldīga Old Town

9. A view from the Old bridge to the Venta valley downstream form the Old bridge

10. A view from the castle mill to the Venta valley downstream form the Old bridge

A view from the castle mill to the Venta valley to the Old bridge

11. A view from the Pārventa Park path to the river Venta and the Alekšupīte waterfall

12. A view from the Pārventa park path to the river Venta and a panorama of the building and left bank of the Kuldīga Old Town

13. A view from the walk path of Pārventa park to the river Venta and a panorama of the building and left bank of the Old Town of Kuldīga

14. A view from the area behind Pārventa park to the river Venta and a panorama of the building and the left bank of the Kuldīga Old Town

15. A view from the Mākslas Dienu park to the river Venta, the building of the Kuldīga Old Town (Olds bridge) and the panorama of the right bank

16. A view from the right bank at the end of Tehnikas street to the river Venta, the Old bridge and the panorama of the right bank

17. A view from the right bank at the end of Virka street to the river Venta, the the Old bridge and the panorama of the right bank

18. View from the right bank (steep bank “Melnā Kolka”) to the river Venta and the panorama of the right bank

19. View from the right bank (steep bank Melnā Kolka) to the river Venta and the panorama of the right bank

20. A view from the right bank of the fire place “Vikingu placis” (surrounding the Veckuldīga mound) to the river Venta

The map (Map 11 “Analysis of visual perception of spatial composition”) also highlights viewing perspectives – directions to important objects and areas. Most of these directions are directed from one river bank to the other. The unique location is the Old bridge, from which views of the river and both banks can be seen. In addition to the viewplaces (major viewpoints)

and directions, the analysis also identifies and highlights the following elements relevant to exposing and visual perception of urban composition:

- a panorama of the building of the Kuldīga Old Town (historic center of the Kuldīga);
- Kuldīga Old Town frontal perception area;
- space for optimal perception of the silhouette and panorama of the Kuldīga Old Town;
- the silhouette and panoramic perception of the Kuldīga Old Town from the water surface of the river Venta;
- Kuldīga Old Town urban accents (vertical dolomite support wall next to the Old bridge and Alekšupīte waterfall;
- vertical dominants and their perception directions:
    - The Roman Catholic Church of the Holy Trinity of Kuldīga;
    - The Evangelical Lutheric Church of St. Catherine of Kuldīga;
    - The Evangelical Lutheric Church of St. Anna of Kuldīga.
- Parks and other public space areas as important elements of the cultural composition of the city of Kuldīga and landscape perception sites (including Mākslas dienu park, Pārventa park, Mārtiņsala and Venta river left bank path);[94]
- possible (remote) perception points (or panoramic views) and zones[95]:
    - important viewpoints;
    - perception areas (including from the Old bridge and Venta fall).

The analyzed elements of Kuldīga spatial composition and its perception can be considered as values that should be preserved as important components of the landscape and should also be included in the perspective structure of the public space. Possibilities to more fully exhibit the unique landscape are also to be evaluated. The diversity of the landscape, which includes a set of natural and cultural values, determines that the landscape of the Venta valley is one of the most unique and outstanding landscapes in Latvia in terms of visual aesthetics.

[94]A publicly accessible outdoor area is an area accessible to the public where visitors can stay.
[95]Distant perception points and zones are fundamentally perceived by the overall panorama and city skyline.

**Location of Map 11 “Analysis of visual perception of spatial composition”**

**Conclusions**

The landscapes of the pilot area in the form of natural and cultural heritage reflect history. It can be read in spatial structures and form preconditions for the further development of the landscape.

Historical research shows that landscaping has taken place since ancient times, but the process has not been regular. There have been stable periods during the formation of landscapes, they coincide with the stages of development, but major historical events, political and economic changes have drastically affected people's lives and activities, followed by changes in the landscape.

The time needed for landscape structures to adapt to the new changes is unknown. The last major landscape transformation throughout Latvia, incl. Kuldīga took place after the restoration of Latvia's independence. The stabilization of the landscape took about 25 years. During this period, the landscape of the banks of the Venta river stabilized in a new form, based on the preservation, integrated management and use of cultural and natural heritage for tourism and recreation.

Landscape management and planning in the Venta valley focuses on the integrated management and use of the riverbank and river area for tourism and recreation purposes, based on the preservation of cultural and natural heritage.

The territory has not been managed according to common guidelines; management is performed in a fragmentary manner. The area is large, it primarily requires time-consuming and regular (year-round) management of the territory, in parallel with the daily care and maintenance of the landscaped areas.

# 4 Proposals for the development of the Venta river and its riverbanks

Based on the research and analysis carried out in the study area, proposals have been prepared for the development of the Venta river and its banks in the urban environment, balancing the aspects of nature, cultural heritage and landscape, tourism and recreation.

Proposals are prepared in the following areas:

- freshwater, grassland and forest habitat management, including:
  - measures for the management of grasslands and forest habitats;
  - reduction of the degree of river coverage of aquatic plants, recultivation of streams, cleaning of the bed;
  - protection and management of specially protected and rare plant species;
  - measures to restrict invasive species;
- management of stormwater drainage systems;
- maintenance of the landscape and creation of the riverbank silhouette
- proposals for the further studies.

## 4.1 Management of the freshwater, grassland and forest habitats

Management measures of the habitats of the European Union importance in the study area are divided into two groups: restoration measures and maintenance measures. An overview of the proposed measures is included in Table 3, the breakdown of the place of implementation of measures by types of measures in Map 14 “Habitat restoration measures”, Map 15 “Habitat maintenance measures”, by habitat types in Map 12 “Habitat restoration measures by habitat types” and in Map 13 “Habitat maintenance measures by habitat types”. The indicative time schedule for the implementation of the measures is provided in Annex 3 “Time schedule for the implementation of habitat restoration measures” and Annex 4 “Time schedule for the implementation of habitat maintenance measures”.

*Table 3 Habitat restoration measures*

| Management measures | | | Management measure code on the map[96] | Management frequency |
|---|---|---|---|---|
| **Habitat restoration measures** | Cutting of trees and shrubs | Pine cutting | A.1.1. | Once a year/ several years* |
| | | Leaf tree/shrub cutting, shoot mowing | A.1.2. | Once a year/ first year |
| | Restriction of the spread of invasive species | Invasive species weeding | A.2.1. | Multiple times per season/several years* |
| | | Mulching | A.2.2. | Once per season/several years* |
| | Reduction of soil fertility, restriction of the spread of expansive species | Mowing | A.3.1. | 2 times per season/3 years in a row |
| | | Topsoil removal | A.3.2. | Once a year/ first year |
| | Regenerative grazing/ mowing | Grazing | A.4.1. | 2-3 times per season/3 years in a row |
| | | Mowing | A.4.2. | 2-3 times per season/3 years in a row |
| **Habitat maintenance measures** | Grassland habitats | | | |
| | Extensive grazing | Sheeps | U.1. | 1-2 times per season/every year |
| | Formation of sand fields | - | U.2. | Once every 2-3 years |
| | Extensive mowing | - | U.3.1. | Once a year/ every year |
| | | - | U.3.2. | Once per year/once every 2-3-5 years |
| | | - | U.3.3. | Two times per season/every year |
| | Forest habitats | | | |
| | Non-management, natural development** | - | U.4. | All the time |
| | Freshwater habitats | | | |
| | Mowing of aquatic plants | Manual | U.5.1. | 1 – 3 times per season/every year |
| | | Machinery | U.5.2. | 1 time per every 3 – 5 years |

** Until the spread of trees and shrubs are limited or invasive plant species are eliminated*
*** The use specified in the individual Protection and Use Regulations of nature reserve "Ventas ieleja" (Cabinet Regulation No. 548, 2014) is permitted*

[96] Codes have been adopted in this study to facilitate the elaboration of graphic material, incl. design: A - restoration measures, U - maintenance measures. The codes are shown on the Maps 12-15

**Place for the Map 12 “Habitat restoration measures by habitat types”**

**Place for the Map 13 “Habitat maintenance measures by habitat types”**

**Place for the Map 14 “Habitat restoration measures”**

**Place for the Map 15 “Habitat maintenance measures”**

### 4.1.1 Reduction of the river coverage of aquatic plants, recultivation of stream, reduction of anthropogenic load and riverbed cleaning

**3260** ***Water courses of plain to montane levels with the Ranunculion fluitantis and Callitricho – Batrachion vegetation*****,** recultivation by mowing aquatic plants

Overgrowing of shallow rivers with aquatic plants is typical of most northern, north-western European countries, where rivers flow through lowland areas with high agricultural intensity and population. Mowing of the aquatic plants plants in such rivers has been practiced for decades mainly to reduce the risk of floods.

In Great Britain, for example, regular river management has been carried out for more than 200 years, while in Denmark river mowing and sediment removal began in the 1920s, but became much more intensive in the middle of the 20th century, when the technique of river management began to be used.

In Denmark, mowing takes place in a large number of rivers and usually involves mowing both river and coastal vegetation 2-3 times a year. Mowing is done manually or with machinery, depending on the nature of the river. The cut biomass is transferred to the composting site. The obtained results are not directly comparable with Venta, because the intensity of the Danish river and agriculture is comparable to other region of Latvia - Zemgale, where most of the rivers are straightened and flow through intensively managed agricultural lands.

In Great Britain, there have been positive results in mowing aquatic plants in the autumn, as the plant biomass is lower next spring, so it is possible to mow later in the summer, saving 1/3 of the money for mowing.

In general, the results of various studies show that mowing is effective 2-3 times a year, but not more often, because frequent mowing improves light conditions for young shoots and several plant species develop a stronger root system.

The following section describes the measures aimed at reducing the overgrowth of the river with aquatic plants.

Regular mowing or removal of aquatic plants along with the root system would not only improve the status of the habitat 3260 *Water courses of plain to montane levels with the*

*Ranunculion fluitantis and Callitricho – Batrachion vegetation*, but also the accessibility and aesthetic quality of the shores. Aquatic plants can be cut with a scythe or machinerey, depending on the access and the amount of work planned.

As a matter of priority, it is recommended to create corridors in the densest surface vegetation stands upstream and downstream of the Venta fall in order to improve the flow of the river (see Map 15). Mowing can be done with a hand or a scythe attached to the boat. It is important to keep in mind that the aquatic plants that have been mown or removed from the bed should be placed ashore outside the floodplain in a temporary storage area before being transported to the composting site. Mowing can be done from early July to autumn, depending on the weather and water level. In short stages, it is efficient to mow aquatic plants downstream to make it easier to collect and highlight shore-cut plants.

*Advantages* - mowing can be done for a longer period of time, does not require a large number of people. Relatively inexpensive method.

*Disadvantages* - mowing should be done regularly by hand. Mowing should be done several times during the growing season.

Periodically, mowing can be performed in larger areas (see Map 13) using tractor equipment.

*Advantages* - mowing can be combined with removal of the root system, larger areas are mowed.

*Disadvantages* - a relatively expensive method, requires more people to remove the plants cut, so there is less opportunity to mow regularly. In the case of Kuldīga, plant removal is limited by steep banks.

Bathing waters maintenance. The control of aquatic plants would also be facilitated by the maintenance of bathing areas in the Venta sections away from the shallow section on both sides of the Venta fall. Currently, there are accesses to the river in several places, but it is recommended to mow the surface plants in the bathing areas located in the territory of the municipality and remove them with a rake from the river.

Regular mowing of aquatic plants in small areas should be evaluated when developing the nature protection plan for the next management period of the nature reserve “Ventas ieleja”. In the Nature Protection Plan for 2010–2020, much larger areas are planned for habitat reclamation

(Appendix 5 of the plan), but it has not been possible to implement these measures in full on a regular basis during 10 years. Therefore, the priorities set out in the plan so far may need to be reviewed.

Active recreation in the river. It is recommended to develop boat and raft rental for short, regular trips, which would also promote the cleaning of the bed from aquatic plants.

From the new bridge to the Venta fall, a boat or raft route is possible as a way to return to the Venta fall for those who walk along the Venta left bank path to the bridge. The section of the river is not long (unlike the section downstream form the Venta fall, where there is a fast current, a high degree of coverage of aquatic plants), so it is recommended to base it on a reference.

Downstream from the Venta fall, one way to use the river could be to resume water tourism competitions. However, in order for the competition to be successfully resumed, a municipal initiative is required, for example, by becoming the organizer of the competition. The competition should be held in the spring, when the water level in Venta is high.

In accordance with the provisions of Clause 12 of Cabinet Regulation No. 548 of 16 September 2014 "Individual Protection and Use Regulations of the nature reserve "Ventas ieleja"", these active recreation activities (boating route, water tourism competitions) must be coordinated with the Nature Protection Agency.

Use of common clubrush for basketry. The most common aquatic plant species in the overgrown sections is the common clubrush *Scirpus lacustris*. Given that the removal of cut aquatic plants from the river is hampered by steep banks, it would be easier to do so on a small scale and for a useful purpose[97]. One of the ways to sell the cut common clubrush is to use them for basktery. Both in Latvia and in other countries of the world, this plant species is used in carpets, ornaments, dishes, etc..

Experience of the United Kingdom and Spain:
http://www.rushmatters.co.uk/rush/harvesting/1/; http://www.waveneyrush.co.uk/photo.php; http://www.timjohnsonartist.com/basketmaking/working-with-rush-grasses-bark-and-other-soft-materials/.

[97] Composting of cut material is recommended as a basic use (see earlier in this chapter)

Experience of Latvia: https://www.mammamuntetiem.lv/articles/25490/ka-uzpit-laimes-grabuliti-no-meldriem-fotopamaciba/?accept_cookies=1

Reduction of anthropogenic impact. Nutrients (mainly phosphorus and nitrogen compounds) contribute to the coverage of aquatic plants of the river and the formation of a layer of sludge, so it is important to prevent any introduction of wastewater and other additional nutrients into the water body.

The inflow of wastewater is indicated by whitish water, the smell of wastewater, persistent foam on the surface of the water. Sewage that may be hazardous to the aquatic environment may be discharged into the Venta. Therefore, the following measures should be taken in the study area and adjacent areas:

1) when developing improvement projects or projects regarding the improvement of the stormwater system, attention shall also be paid to the inflow points of municipal or other wastewater (for example, containing oil products) into the drainage system or stormwater collection system, their sources and inflows to Venta, while planning wastewater collection and treatment in accordance with the requirements of regulatory enactments.
2) during the recultivation of shavings site (see location on Map 7), covering it with a substrate that would limit the spread of pollution from shavings site.
3) research of potentially polluted areas in the territory of the former factory "Vulkāns" (see Map 7 for location) and, if necessary in accordance with the requirements of regulatory enactments, monitoring or remediation.

The planned measures are in accordance with the nature protection plan for the nature reserve, "Ventas ieleja" as it includes the measure "Prevention of untreated wastewater discharge into the Venta river" (see also Chapter 3.2.).

### 4.1.2 Grassland habitats maintainance

#### *4.1.2.1. Grazing and mowing – substantiation of the measures*

Latvia is located in the European forest zone, where the final stage of natural succession is the forest. This means that when the area is discovered and there is no natural or artificial disturbance, trees are overgrown and a forest is formed. In the past, the conservation of the area

was provided by a large number of wild herbivores. Nowadays, the specific weight of wild herbivores has decreased considerably, and are artificially maintained in Latvian places. Also natural anxiety - during spring floods and floods or ice congestions, as the more intense changes increase and decrease, thus increasing to the grassland exposure, the economic activity of people is necessary.

There are two main methods of grassland management - grazing and mowing. Grasslands vary in location, moisture levels, important processes and vegetation composition, so they are applicable to different types of management.

"Until the middle of the 20$^{th}$ century, most grasslands were natural grasslands - farmers only mowed and grazed them, but environmental conditions (such as humidity, soil fertility and reactions) and the composition of plant species are shaped by nature. This means that the diversity of plants and animals could be formed and developed in meadows and pastures without hindrance. The unchanged hydrological regime and terrain resulted in a great diversity of microbiotopes, and thus also a great ecological feature, but a variety of uses for invertebrate species, which were found in large numbers in grasslands. Variety of methods for increasing ecological niches and different management - grazing of different livestock families at different densities and mowing at different times" (Rūsiņa, 2017).

Regular mowing and grazing affect the formation of grassland of different structure and plant, animal communities. Both during preparation and selective guaranteeing of plants and excavation of the soil, as well as by improving the characteristic plant species and structures of pastures. A wide strip of contact is formed between the grassland and the forest or shrub, which may be growing as forest species. During grazing, a peculiar process of nutrient transfer takes place -when eating grass nutrientsare takne out, but thenare are returned as manure. Livestock grazing differs when biodiversity changes.

In the case of mowing, the vegetation ir mowed at the same time, thus creating the structure of the most homogeneous grassland and the formation of vegetation. However, the number of species in mowed grasslands is higher and it is more suitable in places where a large proportion of species are reluctant to eat livestock.

### *4.1.2.2. Management of grasslands of European Union importance*

The chapter provides a description of the measures for the restoration and maintenance of grasslands of European Union significance identified in the study area, incl. methods and their justification.

**6120 ** Xeric sand calcareous grassland***

In order to ensure a favorable protection status of the grassland, it is necessary to perform ecological restoration measures:

1) trees and shrubs cutting ir done once in the first year. The cut trees can be dried and burned on the spot, if the binding regulations of the municipality allow it, or another type of use can be chosen. A revised recommendation will be included in the proposals section of this study (to be developed below). After cutting down shrubs and trees, the grassland should be managed according to the most appropriate management method (see below).
2) restriction of expansive and invasive plant species. It is expected that the spread of the expansive plant species will be limited by restoring grassland management, therefore no special measures can be taken. In order to limit the spread of garden lupin, the plant have to be regularly removed and removed from the area before flowering and seeding. The works have to be be performed several times a season, for several years in a row. Covering the plant with a thick, black film throughout the growing season has been suggested as an effective means of limiting the spread of the Canadian goldenrod. The work is to be carried out for several years in a row at the beginning of the season by covering the plants, in autumn - removing the cover and plant residues.

Extensive grazing is the most appropriate maintenance measure for the grassland. The grassland is characterized by sparse, unconnected vegetation, therefore mowing and hay collection is useless, as well as only a small part of the grassland biomass should be removed during mowing. However, if the grassland is intended to be mowed, it shall be mowed once a season from mid-June to mid-July. Low mowing should be used - 3-5 cm above the ground, the cut material should be removed.

Extensive grazing of grassland is the most appropriate management measure. The most suitable livestock for grazing the grass in the area are sheeps, because the area is small, as well as sheeps

are not selective in terms of plant species, thus more green mass is eaten, reducing the fertility of the grassland soil. The recommended number of animals is 0.05-0.3 units per ha, grazing 1-2 times a season. It is recommended that grazing is carried out by setting up a mobile enclosure to allow the intensity of grazing to be adjusted, if necessary by relocating the animals. Grazing intensity must not exceed the limit when the intensively grazed area exceeds 75% of the area of good quality (abundant flowering plants) grassland.

When using other species, temporary grazing of the grass is allowed, creating free areas of open sand. The total area of such exposed sand areas shall not exceed half the grassland area.

If horses are grazed on the grassland (adjacent to the horse pasture), care have to be taken not to tread too much grass.

Creation of sand fields. This measure is applicable if grazing does not result in open areas of sand or if mowing is used as a management method. It is recommended to create squares in places where dense vegetation has formed, expansive species predominate. Sand areas should be at least 1 $m^2$ in size and occupy up to 20-30% of the total grass area. It is recommended to create the plots by removing the topsoil. As a result of such disturbances, it is not possible to develop a dense moss layer, which is not typical for a good quality grassland.

**6210** ***Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia)***

In order to ensure a favorable protection status of the grassland, it is necessary to perform ecological restoration measures:

1) trees and shrubs cutting. In places where the grassland is overgrown with pines, cutting should be done once, in the first year, the cut trees can be dried and burned there. In wetter areas, where the grassland is overgrown with deciduous trees, cutting should be done for several years in a row. Root milling is allowed.

2) reduction of soil fertility. The measure is necessary for the largest number of polygons of protected habitats, where species such as *Dactylis glomerata, Aegopodium podagraria, Anthryscus sylvestris*, etc. are common. These grasslands should be mowed twice a season, removing the hay within two weeks. In places where expansive species form

monodominant stands, it is recommended to remove the fertile topsoil by removing it from the grassland area.

3) restriction of expansive and invasive plant species. Necessary in grasslands where the amount of expansive species exceeds 20%. Measures to reduce expansive plant species are mowing the grassland twice a season, removing the hay within two weeks. In places where expansive species form monodominant stands, it is recommended to remove the fertile topsoil by removing it from the grassland area.

   The Soapwort of the alien plant species *Saponaria officinalis*, found in a small area of the grassland, is expected to be limited by maintenance management of the grassland.

3) regenerative mowing or grazing. Applicable in places that have not been managed for a long time. Extensive grazing is the preferred method for grassland restoration. If grazing is not possible, mowing the grassland twice a season is allowed.

Extensive grazing is the most appropriate maintenance measure for the grassland. Like habitat 6120* *Xeric sand calcareous grassland*, this grassland is characterized by low and sparse vegetation, therefore the most suitable type of management is extensive grazing and the most suitable livestock species - sheep. It is recommended that grazing be carried out by setting up a mobile enclosure to allow the intensity of grazing to be adjusted, if necessary by relocating the animals. The recommended number of animals is 0.05-0.3 units per ha, grazing twice a season. Grazing intensity must not exceed the limit when the intensively grazed area exceeds 75% of the area of good quality (abundant flowering plants) grassland.

In wetter years, when denser vegetation develops, it is allowed to mow the grassland in the period from mid-June to mid-July, after drying, removing the wall from the grassland. Non-grazing areas can be mowed. If it is placed remote, it is recommended to graze it. Mowing should be done low, 3-5 cm above the ground.

The largest number of rare and specially protected plant species has been found in or in the immediate vicinity of these grasslands. In areas where species associated with forest or shrub habitats (broad-leaved Laserwort, green Figwort) are present, shrub cutting and grazing is not recommended. It is allowed to mow the grassland by mowing the protected shrub species or territory after flowering of the protected plants and sowing of seeds - at the beginning and end

of August. In places where rare and protected plant species are found in the grassland, the above-mentioned - late mowing after flowering and sowing of seeds should be preserved. Or it is possbile to preserve uncut strips, which allow the plants to complete the development stage, changing the location of these strips every year.

Places where significant measures for the protection of specially protected species in grasslands are shown in Map 13 “Habitat maintenance measures by habitat types”.

**6410 *Molinia meadows on calcareous, peaty or clayey-silt-laden soils (Molinion caeruleae)***

The habitat is found in a small area, in a complex with another protected habitat, therefore its management have to be carried out in accordance with the habitat, the proportion of which in the territory is higher.

**6430 *Hydrophilous tall herb fringe communities of plain and of the montane to alpine levels***

Management is required only for the grassland habitat in the central part of the territory, which is overgrown with bushes. As the habitat is formed naturally in places where there is an intensive influence of the river current, which keeps the habitat open, it is not necessary to manage the habitat every year. Habitat restoration requires the cutting of trees and shrubs for several years in a row. Root milling is allowed.

Both extensive grazing and extensive mowing every 2-3-5 years are suitable for maintaining the habitat, taking care not to spread large areas of mud during grazing. When grazing, care have to be taken to ensure that all natural values in the habitat are in good status. 20% of the height of the grass should be less than 5 cm, 20% above 15 cm, in autumn at least 5-15 cm. It have to be ensured that during the most intensive period of grass growth (approximately the first half of July) at least 25% of the grassland is ungrazed, with abundant flowering plants. The most suitable livestock for grazing are goats, which are suitable for wet grasslands, as well as areas overgrown with bushes. Grazing of sheep and cattle in such grasslands is not recommended, as sheep often get sick when grazing in wet areas, but cattle can dig up the habitat.

The grassland polygon in the southern part of the territory does not require management. Smooth development have to be ensured.

**6450** ***Northern boreal alluvial meadow***

The habitat is found in a small area, in a complex with another protected habitat, therefore its management have to be carried out in accordance with the habitat, the proportion of which in the territory is higher.

**6510** ***Lowland hay meadows (Alopecurus pratensis, Sanguisorba officinalis)***

In order to ensure a favorable conservation status of the grassland, ecological restoration is required:

1) reduction of soil fertility. The grassland should be mowed twice a season, harvesting the hay within two weeks.

2) restriction of expansive plant species. Measures to reduce expansive plant species are mowing the grassland twice a season, removing the cut hay within two weeks. In places where expansive species form monodominant stands, it is recommended to remove the fertile topsoil by removing it from the grassland area.

3) regenerative mowing or grazing. The most recommended method is to mow the grassland three times a season, removing the hay immediately.

The most suitable type of management for the maintenance of these grasslands is extensive mowing or a combination of mowing and grazing, temporarily grazing in the aftergrass. By applying only grazing, over time, habitats typical of pastures are introduced into the habitat, the structure changes and the grassland no longer meets the criteria of the habitat “Moderately wet meadows”. When mowing the grassland twice a season or grazing in the distance, it is not possible to form new, dense vegetation until spring, which can form a layer of manure and limit the germination of plant species.

The most appropriate management for plant diversity is seasonal mowing between mid-June and mid-July and remote moderate grazing using mobile paddocks or re-mowing the grassland. Mow 5-7 cm in height. It is recommended to dry the hay in a meadow, put it in rickstands and transport it open trasport, promoting the sowing of the species. As the grassland is characterized by relatively high and dense vegetation, the most suitable livestock species for grazing are cows and horses. The recommended livestock unit per ha is 1-2.5.

#### *4.1.2.3. Management of other grassland habitats*

There are open areas in the territory that do not meet the minimum quality criteria for protected grassland habitats, however, their management is an essential condition for preserving the river landscape and ensuring biodiversity. Such open areas are mostly cultivated grasslands that have developed after the destruction of the natural ground cover through construction or the establishment of fields and vegetable gardens. The long-term appropriate management of such areas can contribute to the development of natural grassland structures and plant communities. Suitable methods for the management of open areas, which are necessary for the maintenance of protected grasslands. Mowing should initially be done twice a season to reduce the proportion of tall grass species. The cut material in the grassland have to be dried and removed. As such grasslands generally have higher soil fertility and need to increase species diversity as soon as possible, grazing is not, at least initially, the most appropriate form of management. After mowing the grasslands in this mode for several years in a row, it is recommended to place the grass obtained from nearby grasslands in the mowed areas, allowing the grass to dry and the seeds to fall off, then harvesting the wall. This will facilitate the sowing of more diverse seed material.

The nature protection plan of the nature reserve "Ventas ieleja" for 2010–2020 plans measures for the management of biologically valuable grasslands. The measures for the management of grassland habitats of European Union importance proposed in the study have been developed on the basis of the guidelines "Guidelines for the Conservation of Protected Habitats in Latvia" (Rūsiņa, 2017) and detail the measures included in the plan and methods for protection and conservation of grassland habitats.

### 4.1.3 Maintainance of the forest habitats

There is no need for special management of forest habitats of European Union significance, allowing them to develop naturally, preserving the elements of the existing structure - old trees, windfallen, decaying trees, fallen deadwood.

Areas of forest habitats of European Union importance have to be preserved in their current extent by taking measures necessary for the maintenance of the existing infrastructure and viewpoints, as well as for the preservation of nature values. The exposure of large oaks in

Veckuldīga castle mound should be evaluated separately. Tree cutting in the castle mound is allowed for the attenuation of large trees, as well as for the maintenance of existing viewpoints and infrastructure objects. It shall be performed in accordance with the procedures specified in Cabinet Regulation No. 548 of 16 September 2014 "Individual Protection and Use Regulations of the nature reserve "Ventas ieleja"" (Clause 11.7.3). Before performing the above-mentioned maintenance measures, it is necessary to involve a dendrologist in the survey of trees, as well as to involve a certified forest habitat expert in order to assess the impact of the planned measures on protected forest habitats.

### 4.1.4 Protection and management of sites of specially protected and rare plant species

The sites of specially protected and rare plant species (Table 4) (hereinafter - the sites) have been inventoried in different time periods, they do not contain up-to-date information on the boundaries of the species sites. Therefore, in order to ensure species-appropriate management, incl. their preservation and protection, an inventory of all localities have to be made in the study territory, their actual boundaries have to be specified. By surveying the territory, it is possible to identify new locality.

The inventory shall be performed by a species and habitat expert certified in accordance with the procedures specified in regulatory enactments.

During the study, taking into account the available information, other management measures for the protection of the species in the sites were also recommended (Table 4). If necessary, in the process of inventorying localities, the expert may recommend other or specify the management measures recommended in this study.

*Table 4 Recommendations for the protection and management of sites of specially protected and rare plant species*

| Nr.[98] | Nosaukums latviešu valodā | Nosaukums latīņu valodā | Apsaimniekošanas pasākumi |
|---|---|---|---|
| 1. | Rosa coriifolia Fries | *Rosa coriifolia* | 1) Plant inventory and site specification |

[98] Numurs ArcGIS materiālos

| | | | |
|---|---|---|---|
| | | | 2) Shrub cutting and grassland management in the vicinity of the plant site |
| 2. | Broad-leaved Laserwort | *Laserpitium latifolium* | 1) Plant inventory and site specification<br>2) No economic activity in the area of the locality |
| 3. | Bulbous Buttercup | *Ranunculus bulbosus* | 1) Plant inventory and site specification<br>2) Mowing the grassland once a season, after flowering |
| 4. | Green Figwort | *Scrophularia umbrosa* | 1) Plant inventory and site specification<br>2) No economic activity in the area of the locality |
| 5. | Quaking-grass *sedge* | *Carex brizoides* | 1) Plant inventory and site specification<br>2) Preservation of shrub strips in the areas of existing locality |
| 6. | Sand Leek | *Allium scorodoprasum* | 1) Plant inventory and site specification<br>2) Tūrisma objektu izvietošana ārpus aizsargājamās augu sugas atradnes<br>3) Shrub cutting and resumption of grassland management |
| 7. | Soft Downy-rose | *Rosa mollis* | 1) Plant inventory and site specification<br>2) Preservation of existing open areas in the vicinity of locality |
| 8. | Lesser Centaury | *Centaurium pulchellum* | 1) Plant inventory and site specification<br>2) Preservation of open area in the vicinity of the plant locality |
| 9. | Berry Catchfly | *Cucubalus baccifer* | 1) Plant inventory and site specification<br>2)Preservation of shrubs in and around the locality |
| 10. | Baltic Marsh-orchid | *Dactylorhiza baltica* | 1) Plant inventory and site specification<br>2) In the area of the locality, the mowing of the grassland shall be performed after the flowering of the plant. When mowing, the hay should be dried on site, allowing the seeds to sow, then harvested. |
| 11. | Military Orchid | *Orchis militaris* | 1) Plant inventory and site specification<br>2) Preservation of the shrub strip in the section along the bank of the Venta, where the species has been found Gradual cutting of shrubs is allowed, restoring the grassland. |
| 12. | Chives | *Allium schoenoprasum* | 1) Plant inventory and site specification<br>2) If necessary, in the case of dense vegetation, mowing of the grass in the |

| | | | |
|---|---|---|---|
| | | | area of the site after flowering of the plant<br>3) Installation of tourist objects outside the area of the plant locality |
| 13. | Meadow fleabane | *Inula britannica* | 1) Plant inventory and site specification<br>2) Mowing once a season after flowering<br>3) Installation of tourist objects outside the area of the plant locality |

The nature protection plan of the nature reserve "Ventas ieleja" for 2010-2020 does not include special measures for the protection of species, but with regard to grasslands, measures for biologically valuable grasslands are planned and the short-term forest management objective B1 emphasizes the protection of protected plant species. Measures for the protection of specially protected and rare plant species are aimed at increasing the biodiversity of grasslands and forest habitats and thus do not contradict the nature protection plan.

### 4.1.5 Restriction of invasive species

The most common invasive species in the study area are Indian Balsam *Impatiens glandulifera*, Canadian Goldenrod *Solidago canadensis* and Balsam-apple *Echinocystis lobata*, as well as ashleaf maple *Acer negundo*. Invasive species are able to spread rapidly and compete with native species. The above species are easily distinguishable from other herbaceous and woody species, so their distribution can be studied, for example, in the framework of students scientific work. After the research, it is necessary to prepare an informative material for the city residents with recommendations for restricting invasive species. The following recommendations are currently available at the website: https://www.daba.gov.lv/public/lat/dati1/invazivas_sugas/.

For the time being, in order to limit the entry of alien species into natural habitats, residents should be informed that waste from gardens should not be thrown into bushes, riverside, etc., but a compost pile should be installed in the area of private property. The dumping of bio-waste in natural habitats not only contributes to the spread of alien species, but also creates unnecessary additional nutrients that change the composition of natural species.

The control of invasive species should be carried out as a matter of priority along the Venta river left ban path, where Canadian Goldenrod and Indian Balsam stands can be observed. It is recommended to mow them several times a year, preventing flowering and seed ripening.

When planning the cutting of bushes and trees, priority Canadian Goldenrod should be cut, especially along the Venta left bank path and in the vicinity of Veckuldīga castle mound. It is particularly important to reduce the number of females of this plant so that the spread of the species through seeds does not continue. New plants (up to 1,5 m) tall are best to pull out or dig out.

Control of invasive species must also be carried out through the management of grassland habitats. To limit the spread of Indian Balsam *Impatiens glandulifera*, it is recommended to pull it out or cut it at the beginning of flowering before the seeds are ripe. For the control of Canadian Goldenrod *Solidago canadensis*, the most effective method to control the species is to dig and mow before the seeds ripen. Covering the plant with a thick, black film throughout the growing season (mulching) is also an effective way to control the spread of the Canadian Goldenrod. The work has to be performed twice a season, for several years in a row - the first time by covering the plants, the second time - by removing the cover and plant residues. The species is common in the habitat 6120* *Xeric sand calcareous grasslands*. In order to reduce the spread of Balsam-apple *Echinocystis lobata*, it is recommended to pull them out or mow them at the beginning of flowering so that the plants do not manage to ripen the seeds. In order to limit the spread of garden Lupin *Lupinus polyphyllus* in the habitat 6120* *Xeric sand calcareous grasslands* the plant have to be regularly removed and removed from the territory before flowering and seeding. The works have to be performed several times a season, for several years in a row.

The nature protection plan of the nature reserve “Ventas ieleja” for 2010-2020 indicates that the presence of invasive species may cause significant damage to the quality of habitats.

## 4.2 Management of stormwater drainage systems

**Integrating sustainable stormwater management (SUDS) elements or "green" solutions in the urban environment**

The integration of SUDS elements into the urban environment provides an opportunity to reduce the risk of flooding of areas during heavy rains, relieving conventional networks. The main goal of green solutions is to reduce surface water runoff from areas in a cost-effective way, bringing it closer to the natural situation when stormwater returns to the natural cycle (entering groundwater or surface watercourses and water bodies) and there is no constant need to discharge large amounts of stormwater from areas. This minimizes the risk of flooding associated with stormwater. In addition, these solutions also reduce stormwater pollution, ensuring that environmental quality objectives are met.

Green solutions can be integrated both in the already built-up areas of Kuldīga city and in the new development areas. In the built-up parts of the city it is possible to create local, small green solutions, as well as various technical solutions for water collection and reuse, relieving the existing conventional storm drainage networks. It is also possible to create an overflow to the rain sewerage networks in order to reduce the risks of flooding of the adjacent areas due to the excessive amount of stormwater entering the object. For example, in rain gardens, which can be located in both public and private areas, artificially created soil layers slow down the flow of stormwater and temporarily maintain water, as well as purify water from pollution. As the water flows through the different soil layers, it is treated and then led to a nearest water body through a drain. In addition to the stormwater management function, rain gardens complement the landscape, perform air purification and microclimate control.

When developing projects that intend to integrate green solutions in specific areas, it is necessary to involve not only engineers who perform calculations to determine the necessary technical parameters (e.g. volume) of green solutions and their connection with existing conventional stormwater networks and their capacity at appropriate rainfall intensity, but also landscape architects to make these solutions as easy to manage as possible and to look attractive even in waterless periods. Taking into account the results of stormwater drainage system modeling, it would be possible to decide in which parts of Kuldīga city priority should be made improvements to the stormwater drainage system to prepare for rainfall with a probability of at

least once every 2, 5 or 10 years and preferably less frequent rainfall - even once a hundred years.

In the future, when solving stormwater management issues at the local level, it is possible to use the graphical part scheme “Water flow direction along the terrain model for the city of Kuldiga” included in the chapter “Stomwater drainage system in Kuldiga” to locally choose solutions that follow natural surface water runoff directions.

**Pipevalks**

The location of Pipevalks, which has historically been built into the underground, can be determined by geophysical survey methods. It is desirable to preserve the above-ground sections of the Pipevalka by taking advantage of the green corridor. In the surface sections of the watercourse, it is desirable to clean the bed and remove bank cover, thus improving the aesthetic functions and ensuring that the watercourse can effectively perform the functions of rainwater collection, surface water drainage, as well as water infiltration. In addition, for example, small artificial cascades can be created to facilitate water aeration and purification.

It is necessary to evaluate the rainwater management solutions of the implemented Jelgavas Street reconstruction project in order to find out the possible causes and connection with the cases of flooding of the basements of private houses observed in the adjacent territories.

## 4.3 Cleaning of riverbank vegetation, exposing the landscape and creating riverbank silhouettes

Proposals for the development of the banks of the Venta river in the urban environment for the regulation of riverbank cover, landscaping and riverbank silhouettes have been prepared taking into account the conclusions and proposals of other experts involved in the study, including measures not to affect biologically valuable territories and specially protected habitats or cultural heritage objects, etc.

The viewpoints are visited especially to enjoy this view and they have a recreational and tourism value. In order for the viewpoints to retain their value, it is necessary to monitor their overgrowth with bushes and trees and provide the necessary measures for the opening (adjustment) of the view that are most suitable for the specific location.

Suggestions and recommendations for further action:

- The existing most important viewpoints identified in the study (see Map 11) are special areas of a few square meters, from which there is an expressive view and they are visited especially to enjoy this view. The set of proposed viewpoints can be assessed as optimal to cover all the main exhibited values of the pilot area. These viewpoints are a recreational and tourism resource and are included as components of the nature trail or old town sightseeing tourism offer.
- In order to better display landscape values and emphasize that the path is placed along the riverbank and in order to maintain or increase the aesthetic value of the viewpoints, they should be managed. It is also desirable to improve the level of amenities and accessibility of these viewpoints, for example, to provide the opportunity to sit down by installing comfortable benches to enjoy the view, increase the level of comfort, install a waste bin and bicycle stand, etc.
- Viewpoints are mostly located in areas with good visibility and most of them do not require additional management measures to expose the views. In some places, however, the planned viewpoints are covered with trees and shrubs. It is recommended to expose the views with the gentlest methods possible, preserving the naturalness of the landscape. In these cases, the presence of a landscape architect or dendrologist is recommended (if necessary, a geologist as well) to evaluate the most suitable methods for forming trees and shrubs for each site to reveal the view. For a partially obscured view, it is recommended to use the technique of raising the height of the tree crown, or selecting individual branches to be cut.
- In the section of the Venta left bank path from Pils Street to Vienības Street (see Map 16) it is necessary to perform riverbank vegetation maintenance, including thinning of trees by cutting damaged or dangerous trees (for example, dead ashes, trees that were broken during the storm or parties, etc.) and by cutting down the most valuable shrubs and trees (invasive species and small self-seeded seedlings). A similar approach to riverbank care can be applied to the rest of the Venta left bank trail to the new bridge.

- Additional recommendations for the section of the left bank of the Venta river from Pils Street to Vienības Street:
    - In order to reduce or prevent the risk of erosion during and after trees cutting, it is recommended that operations be carried out gently and gradually over a number of years, cutting a small number of trees and shrubs each year and strengthening ground cover vegetation if necessary. It is desirable to preserve the largest trees, the root system of which helps to strengthen the river slope, preventing the formation of landslides. In this way, there would be no drastic change in environmental conditions, contributing to changes in ground cover vegetation.
    - In the case of the installation of new viewing platforms at this stage of the path, it is desirable to install them as platforms on the water and to provide a wooden staircase for crossing the slope, which would connect the viewing platform to the walking trail. Such a platform can also be designed as a boat dock at the same time.
- In order to more fully exhibit the scientific and aesthetic value of dolomite outcrops, it is recommended to cut new trees in the dolomite outcrop wall below the Venta fall (on both sides).
- In Venta, it is recommended to regulate the coverage of aquatic plants by mowing and removing aquatic plants from the river in order to increase the aesthetic value of the landscape in the most expressive and characteristic node around the old Venta bridge. See also Map 15 “Habitat maintenance measures”.
- Recommendations for the management of Veckuldīga castle mound:
    - On the Veckuldīga castle mound, further maintenance measures should be done in accordance with regulations of the nature reserve “Ventas ieleja” and Cabinet of Ministers Regulation No. 548 (2014).
    - According to the opinion of a certified forest habitat expert, expressed during the development of this study, tree cutting in the castle mound is allowed for the shading of large trees, as well as for the maintenance of existing viewpoints and infrastructure objects. It shall be performed in accordance with the regulations of

the Cabinet of Ministers No. 548 (2014). Prior to performing the above-mentioned maintenance measures, it is necessary to involve a landscape architect or dendrologist in the survey of trees, as well as to involve a certified forest habitat expert in order to assess the impact of the planned measures on protected forest habitats.

    - In order to restore the characteristic vegetation and thus also increase the value of the landscape in the vicinity of Veckuldīga castle mound, etc. areas where necessary, the spread of invasive species shall be limited. Linear landscape structures (mainly roads and watercourses) play an important role in the spread of invasive species, ensuring the connection of infested sites and, consequently, the entry of seeds into new areas.

- In the preservation of the expressiveness of the landscape of the Venta valley, grassland management also plays an important role. Grassland management measures are included in 4.1.2. subsection and Maps 12-15. This includes the management of open areas that do not meet the minimum quality criteria for protected grassland habitats, as they are an essential condition for maintaining the river landscape.

## 4.4 Infrastructure development of Venta valley riverbanks

Landscape management and planning in the Venta valley focuses on the integrated management and use of the riverbanks and river area for tourism and recreation purposes, based on the preservation of cultural and natural heritage.

The territory has not been managed according to pre-established guidelines, management has been performed in a fragmentary manner. The area is large, it primarily requires time-consuming and regular (year-round) management of the territory, in parallel with the daily care and maintenance of the landscaped areas.

It is important to plan resources, including human resources and finances, for quality and purposeful management of the site. When planning infrastructure development measures, it is recommended to determine the priority locations and the sequence of works, as well as to estimate the amount of annual maintenance expenses. It is recommended to separate regular

management works (clearing dry and dangerous trees along the edges of paths, mowing and collecting grass, cleaning existing paths in winter, waste collection, etc.) and prioritize proposals for improvement solutions according to the importance of the work. (eg installation of additional benches and waste bins (appropriate style), restoration of the surface of nature paths, etc.).

The main recommendations for the development of infrastructure on the riverbanks of the Venta valley are the following:

- It is recommended to base the management and planning of landscapes on the natural and aesthetic value of the landscape structure and landscape elements of the nature reserve "Ventas ieleja", including to take into account management measures for the preservation of values. Equally important is the preservation and active use of cultural heritage and its excellence in terms of world cultural heritage, finding applications for today's values.
- It is recommended to improve the ability to move along the riverbanks. In addition to the existing routes, it is recommended to create new nature path for recreation, tourism (preferably including the educational function) and daily business connections, primarily in places where there are already nature trails or a path (tracks) along the riverbank:
    - on the left bank of the Venta, below the Old bridge to the recreation place "Vikingu placis" (in the vicinity of Veckuldīga castle mound) - it is approximately the former nature trail "Venta līkumi route";
    - on the right bank of the Venta below the Old bridge to the site of the former ferry;
    - when evaluating the location of the nature path, it is recommended to envisage their connection with the possible demonstration sites of the historical use of the river.
- Proposals for new nature path routes for tourism and recreation, as well as a Map 16 "Recommendations for the exposure and use of the Venta Valley landscape". During the planning and creation of a new nature path, it should be done in two stages. The first stage is planned from the Mārtiņsala and Old bridge to the former ferry site. The second path leads to the side of the Kuldīga Old Town up to the Veckuldīga castle mound and the Krāčupīte crossing point, this route creates further activities, including forest on the other

side of the Krāčupīte. Due to factors, it is difficult to install the path along the rirverbank in some points, alternative route locations are shown.

- It is advised to imporove management of the territory. Mārtiņsala needs better pavement, a new wooden footbridge to Veckuldīga castle mound, and safe crossing of Krāčupīte.
- It is recommended that the energy-efficient lighting of the appliance is installed by the naturfe path so that it is also available 24 hours a day. The possibility to illuminate the Venta fall and the surroundings of the Old bridge and the riverbanks should be evaluated. If light installations are placed directly in the river, a consultation with an ichthyologist is necessary.
- - When planning landscapes in this area, primarily develop a plan for the construction of Pārventa Park facilities in order to redistribute tourism flows on the Pārventa side and partially relieve the territory of Mārtiņsala. Within the framework of the project, it is recommended to create a system of greenery, adapting it to natural conditions. Respect the uniqueness of the place and cultural-historical and landscape values, the connection of the park with the adjacent territories. The created viewpoints should be saved.It should be considered to develop a Mākslas dienu park facilities and to improve recreational opportunities on the left bank of the Venta trail, for example, to supplement it with cognitive elements, benches and bicycle stands and other types of facilities.
- When planning the landscape it is necessary to take into account spatial composition – see Map 11 “Analysis of visual perception of spatial composition”. While preserving the panorama of the city, the new (large-scale) development plan it is necessary to realize a visual impact analysis. Thus, it would be possible to assess whether the urban structure should be designed to preserve and characterize urban landscapes.
- In the pilot area, the development of construction plans or the improvement of recreational infrastructure should include conditions for the preservation of the unique natural and cultural heritage of the place. Including the requirements that the elements of the development have to be designed according to the individual design and stylistically coordinated.

**Location of Map 16 “Recommendations for the exposure and use of the Venta Valley landscape”**

## 4.5 Further research

Based on the information and conclusions of the study, this section provides suggestions for further research.

**Research in the field of engineering geology, mapping - research content, scope, cooperation opportunities**

Ther is no detailed information available for the study area on engineering geological conditions, including geological structure (especially Quaternary sediments), geomorphological structure, hydrogeological conditions, including groundwater levels and flows, as well as exogenous geological processes and ravine formation. For the rest of the territory of Kuldīga city, which also affects the study area and its management, no aggregated information is available on the groundwater level, its changes, drainage systems, the impact of construction on groundwater level and flow changes.

Currently, a range of issues is emerging that require such information. This is mainly related to the management of the Venta valley, including the selection of viewpoints and the removal of overgrowth to expose the views, the creation of paths, the creation or construction of individual facilities in the Venta valley, the drainage of rainwater and the reduction of erosion risks.

As the study area is affected by water runoff from the entire city territory, the need for accurate information on land reclamation and stormwater drainage is topical. Land reclamation issues can be solved in a complex way, evaluating both the pre-existing land reclamation system, changes in the groundwater level, flow directions, etc. factors.

In view of the above, in order to successfully implement the management measures of the Venta valley, as well as to make decisions on construction solutions in the entire territory of the city, it is recommended to create an engineering geological information map. Its availability would allow to evaluate the stability of the steep banks of the Venta valley, the factors of natural and anthropogenic origin influencing it, choosing optimal management solutions.

Engineering geological research provides ideas about the geological and geomorphological structure of the territory. Explaining the regularities of geological development, the course of geological processes and possible development, gives an opportunity to compare different territories, as well as to assess the construction conditions at each research site. During the

research, the classification of soil types is used, the composition and physical properties of the soil are determined, as well as the hydrogeological conditions are clarified.

The main task of engineering geological mapping is to study and display the engineering geological conditions of the territory in the topographic base. Maps and map descriptions describe and assess the engineering geological conditions of a specific area. The scale of engineering geological mapping also changes depending on the purpose.

Methods

Several groups of methods are used in engineering geological research, for example, engineering geological mapping, field research works, laboratory research of soil samples, geotechnical field inspection (*in-situ*), as well as monitoring or stationary observations.

Field research works are performed by special technical means to a certain depth, determining the geological structure, composition, physical condition, etc. of the research point. The most important methods used in field research are drilling, excavation, soil sampling and geophysical surveys (microseismics, electrofiling, vertical electrical probing, etc.).

As a result of laboratory research, certain soil characteristics are obtained - soil composition (mineral, chemical and granulometric composition), structural features (texture and structure), physical properties (moisture, soil and particle density, porosity, relative density, Aterberg boundaries, etc.), water properties (water permeability and moisture content), mechanical properties (compressibility, deformability, strength, etc.), special properties (frost resistance, abrasiveness, etc.).

It is recommended to include the following set of works in engineering geological research:

1) collection and analysis of historical research materials. On the basis of the obtained material, a cartographic material and an overview of the engineering geological conditions shall be developed, detailing the territories and information necessary for the complete engineering geological characterization of the territory. It is then possible to gradually supplement this material by clarifying the information for those areas where data are not available or are inconsistent.

2) identification of further work to be performed by compiling a work program in addition to obtaining the necessary information

3) acquisition of necessary information and gradual supplementation of information:

- territory survey works;
- installation of research developments (installation of engineering geological wells, excavation of shafts, cleaning of outcrops);
- geophysical surveys;
- laboratory research of soil and groundwater samples;
- soil field studies (static and dynamic sounding), in areas where there is a risk of erosion, or planned activities that may affect soil stability;
- hydrogeological research;
- laboratory research of soil and groundwater samples;
- chamber material processing, preparation of maps and sections;
- preparation of a report.

The obtained information will be used:

1) For the decision-making process in selection of city development directions and development territories;

2) Improving the rainwater management system in the city by evaluating various solutions, including “green” solutions;

3) In the work of the construction board, evaluating construction proposals and construction project solutions;

4) Implementation of Venta valley management measures.

Regarding the research object - Venta valley and the need for engineering geological information, it is recommended:

1) to carry out a detailed geological mapping of the territory, which would allow to provide with basic information in the long run any decisions related to the management, protection and use of the Venta valley. Based on the results of geological mapping, measures in erosion risk areas can be specified and used in the long term, whenever the potential impact of a management measure, construction, landscaping or other activity on the stability of slopes needs to be assessed.

2) within the framework of geological mapping on both banks of the river in the entire slope area to specify groundwater discharges or unauthorized discharges of wastewater, including rainwater;

3) to evaluate the possibilities to perform these works in cooperation with the specialists and students of the Faculty of Geography and Earth Sciences of the University of Latvia, thus involving the students in real mapping work during the internship;

4) with the involvement of an expert in the relevant field of geology, it is recommended to carry out observations of erosion development at least once a year, performing detailed surveys, surveys and assessment of the overall condition at the same time of year. Based on the observations, it is possible to determine the main causes of erosion processes, which allows to create an appropriate management and protection system;

5) to combine the mapping process with topographic surveying (mapping), which would allow to map all the ravines and serve as a reference point for monitoring their development.

Priorities:

1) Research territory - Venta river valley;

2) The area of the former water runoff Pipevalks territory, incl. area in Jelgavas Street;

3) The historical center of Kuldīga.

An expert in the field of engineering geology shall be involved in the performance of such research, who shall:

1) compile and analyze the materials of previously performed, separate, local engineering geological research works, which are stored in the State Geological Fund;

2) compile a program of further work;

3) supervise the process and results of engineering geological mapping.

After the local government administrative reform, it is recommended that the local government assess the need to include a specialist with basic knowledge in the field of engineering geology in the composition of local government employees.

**Study for the assessment of fishery resources**

No research on fishery resources has been carried out in the study area. Industrial fishing for lamprey takes place in accordance with the limit of lamprey fishing gear in Venta specified in Annex 6 to Cabinet Regulation No. 796 of 23 December 2014 "Regulations on Limits for Industrial Fishing and Procedures for Their Use in Inland Waters": not closer than 50 m from the Venta fall - pass No. 1 (3 fish baskets) and pass Nr. 2 (3 fish baskets), from the right bank, not closer than 500 m from the Venta fall, fish baskets in two groups - pass Nr. 3 (6 fish baskets).

In order to obtain information on fishery resources, to substantiate lamprey fishing opportunities closer to the hub and to characterize the composition of ichthyofauna, the impact of fishing on fishery resources, substantiated recommendations for future exploitation of fishery resources and requirements for river fishery exploitation. Exploration is subject to a permit (license). The procedure for issuing a license is determined by Cabinet Regulation No. 192 of 15 March 2005 "Procedures for Issuing Permits (Licenses) for Fishing for Special Purposes and for the Purposes of Scientific Research".

Professional research of fishery resources is performed by the Scientific Institute of Food Safety, Animal Health and Environment "BIOR" https://bior.lv/lv.

**Modeling of stormwater drainage system**

In order to identify the necessary maintenance measures and the most rational actions regarding the development of the stormwater drainage system network in Kuldīga city, it is necessary to perform modeling of the stormwater drainage system. Such modeling makes it possible to identify specific risk areas where flood risks of different intensities could occur in the near future. In parallel with the modeling, the current general technical condition of stormwater runoff systems (including stormwater drainage network systems) should be described, also by conducting field surveys of the system. Based on the results of the research, specific recommendations would be developed for the improvement of the regulation of Kuldīga city regulatory enactments and the development of the stormwater drainage system.

Hydrological modeling uses both special modeling programs, such as the US Environmental Protection Agency's (US EPA) free software Storm Water Management Model (SWMM), and

various modeling modules integrated into the most popular design programs, MicroStation (manufactured by Bentley Systems). AutoCAD Civil3D (manufactured by Autodesk), etc.

The issue of establishing a catchment management plan for the Alekšupīte, ŪSIK code 3638:01 catchment or a part thereof shall also be considered. This plan should consider development scenarios, necessary centralized (ditch cleaning, widening, development of centralized sustainable stormwater drainage solutions on municipal property) and decentralized measures (limiting maximum runoff by building or other binding regulations), local sustainable stormwater drainage. It is recommended to look at the costs of maintenance and development of the drainage system, as well as the mechanism of their coverage and distribution.

# 5 Recommendations for study on the development of rivers and riverbanks in the urban environment

Recommendations for similar research for the development of rivers and riverbanks in the urban environment have been developed based on the research carried out in the pilot area and the experience gained.

A similar study using the research method of this research is possible in other cities with similar urban planning situation:

- small or medium-sized town;
- historic urban environment;
- the city is crossed or adjoined by watercourses.

The duration of the study depends on the amount of materials initially available and the task set. For the optimal study at least 6 months have to be planned, planning that the primary data collection will take place during the vegetation season.

The study covers the following topics:

- review and evaluation of different researches and studies conducted so far;
- review of the historical situation (period to be defined);
- changes in the landscape over time (definable period of time);
- geological, geomorphological, hydrogeological, engineering geological characteristics, exogenous geological processes;

- hydrological characteristics of the river;
- flood risk analysis (if applicable) or stormwater system characterization and problem definition;
- description of the ecological status of the river;
- characterization of ecosystems and natural values, ecosystem services;
- landscape characteristics (the area to be considered).

**Preparatory phase**

In order to carry out a similar study in terms of content, it is necessary to define the existing problems in the urban environment, which are related to the use of rivers and riverbanks or to the study area. Define the aim of the research and set tasks, indicating the results to be achieved.

It is important to identify the current situation, available materials, including the information that is monitored.

It is necessary to identify all the parties involved in the management of the site, clarifying their roles, including:

- local government (incl. municipal utility service providers, real estate department, etc. municipality organizations);
- management organizations of specially protected nature territories (if applicable);
- state environmental institutions;
- fishery resources management institutions (responsible organization);
- cultural heritage management institutions;
- research organizations (if applicable) that carry out or have carried out research in the area;
- river basin district management authorities, organizations for co-operation of public authorities with NGOs (eg advisory council);
- and other.

When preparing a terms of reference for the research, it is necessary to specify the result to be achieved.

**Initial phase of study**

At this stage, it is necessary to identify the areas in which the study requires the involvement of experts, as well as the main sources of information and data holders. When planning the

involvement of experts, it is necessary to develop the terms of reference of the expert, the content of the deliverables - the expected result of the work.

Before starting work for a successful work organization, it is advisable to provide a joint meeting of the experts involved to prepare a timetable that clearly indicates the stages of the study and their interrelationships, indicating each expert's involvement, specific tasks and expected results at each stage. At the start-up stage, the content of the required information, the way to obtain it, the formats and the division of responsibilities for collecting, analyzing and processing the information have to also be agreed with the experts.

Ensure regular exchange of information between the experts involved.

**Carrying out the research - summarizing the current situation**

- Graphic design platform/database. Successful research requires the provision of a graphic design platform/database, such as ArcGis, which is accessible to all experts involved and to the client and serves to gather and analyze information.
- Data collection, compilation and analysis. Depending on the structure and voulme of the input data available to the researchers, sufficient time for data collection, analysis and processing should be planned.
- Data and information sources to be used in the development of the study:
    - data and information of information systems and archives managed by various state institutions: real estate cadastre (The State Land Service);
    - information on the research carried out in the territory in the field of engineering geology (geology, hydrogeology, modern exogenous processes) and relevant graphic materials (State Geological Found, The Latvian Environment, Geology and Meteorology Center);
    - data obtained within the framework of the state water program: hydrological, physical - chemical and biological quality data (The Latvian Environment, Geology and Meteorology Center);
    - information of the nature data management system “Ozols”: specially protected nature territories, habitats of European Union importance, localities of specially protected species (Nature Conservation Agency);

- cultural monuments (National Cultural Heritage Administration);
- reviews, surveys or reports of previous projects or studies;
- publications;
- information on museum expositions and collections.

- Development of conclusions.

**Carrying out research - developing solutions**

- based on the prepared conclusions, a section of solutions and proposals is developed;
- define the field of activities for which proposals have to be prepared;
- identified areas of overlap;
- identified areas where the proposed solutions can lead to conflict situations;
- identification of opinion of the experts involved on the solutions they propose;
- in case of conflicting solutions, discuss with the experts involved one of the best solutions to be proposed.

Possible areas where conflicts may arise are, for example:

- protection of habitats and exposure of landscapes (restoration of historical form);
- exogenous geological processes (erosion) and offer of a new viewpoints (landscape);
- the provision of sustainable stormwater solutions and the issue of ownership (private ownership);
- restoration of historical uses of the river and requirements specified in the regulations for the protection of specially protected nature areas;
- location of facilities (benches, lighting, trails, etc.) and impact on landscape quality and natural values;
- and other, taking into account the specific conditions of the site.

**Research results and next steps**

At the end of the study, a large amount of data is collected and processed. In order to maintain the continuity of the research and continue the updating of the collected data, it is necessary to

develop and maintain a data management system. The database should contain layers of information, including: geology, geomorphology, hydrogeology, nature values, ecosystem services, landscape layers, polluted and potentially polluted sites, degraded areas and sites, effluent discharges, pollution sources, etc.

The main groups of measures to ensure management are:

- determination of responsible local government authority for the implementation of the sudy;
- attraction of financial resources for the implementation of specific projects;
- further planning, such as the development of a thematic landscape plan, the development or renewal of a nature protection plan;
- development of construction (improvement) plans;
- coordination and organization of the implementation of the planned measures: in revealing views, habitat management, attraction of specialists, creation and maintenance of facilities;
- cooperation with stakeholders, incl. coordination with state institutions (in the case of Latvia - the Nature Conservation Agency, The State Environmental Service of the Republic of Latvia, the National Cultural Heritage Administration), non-governmental organizations, landowners;
- regular accounting of the measures taken, compilation of results, evaluation of results - monitoring. If necessary, adjust the content of future measures.

The existence of the database will ensure the further management of the territory: convenient and fast flow of information, possibilities of updating the information, determination of responsibility.

The database should be created on the basis of the map design system used in the research (for example, ArcGis) and its results should be made public.

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# Attachments

## Annex 1 State cultural monuments in the city of Kuldīga

| Go away. No. | Name | Typological group | Value group | Date | Location |
|---|---|---|---|---|---|
| 7435 | Historic center of the city of Kuldīga | Urban construction | National importance | 13-19th century | Kuldīga municipality, Kuldīga; the city's oldest part on the left bank of Venta, including the old bridge formed by development along the streets of Ventspils, Liepājas and Jelgava |
| 1231 | Kuldīga Old Town | Archaeology | National importance | None | Kuldīga municipality, Kuldīga; center |
| 1232 | Veckuldīga castle mound and Old Town | Archaeology | National importance | None | Kuldīga municipality, Kuldīga; between the river Veckuldīga and Venta |
| 1233 | Medieval Palace of Kuldīga | Archaeology | National importance | None | Kuldīga municipality, Kuldīga, Pils Street 1 |
| 6346 | Two residential buildings | Architecture | National importance | 18th century middle | Kuldīga municipality, Kuldīga, Mountain Street 13; Kuldīga municipality, Kuldīga, Kalna Street 15 |
| 6347 | Bridge over Venta | Architecture | National importance | 1874. | Kuldīga municipality, Kuldīga, Kalna Street |
| 6348 | Residential building | Architecture | National importance | 1850. -1870. | Kuldīga municipality, Kuldīga, 1905 Street 12 |
| 6349 | Residential building | Architecture | National importance | 1630. 2nd half | Kuldīga municipality, Kuldīga, Baznīcas Street 7 |
| 6350 | Duke pharmacy, now residential building | Architecture | National importance | 16-17th century | Kuldīga municipality, Kuldīga, Baznīcas Street 10 |
| 6351 | Saint. Catherine Lutheran Church | Architecture | National importance | 1645., 1748., 1808., 1866., 1905., 1968. | Kuldīga municipality, Kuldīga, Baznīcas Street 33 |
| 6352 | Urban waters with equipment | Architecture | National importance | 13th century, 1807, 20th century. 30ties | Kuldīga municipality, Kuldīga, Baznīcas Street 36 |
| 6353 | Residential building | Architecture | National importance | 1800.-1820. | Kuldīga municipality, Kuldīga, Jelgavas Street 1 |
| 6354 | Residential building | Architecture | National importance | 1800.-1820. | Kuldīga municipality, Kuldīga, Kalnu Street 14 |
| 6355 | Residential building | Architecture | National importance | 18th century end | Kuldīga municipality, Kuldīga, Liepājas Street 17 |
| 6356 | Peter's bell tower | Architecture | National importance | 1783. | Kuldīga municipality, Kuldīga, Peter Street 3 |

| Go away. No. | Name | Typological group | Value group | Date | Location |
|---|---|---|---|---|---|
| 6357 | House of the guard of the Kuldīga Palace | Architecture | National importance | 1735. | Kuldīga municipality, Kuldīga, Pils Street 4 |
| 6358 | Saint. Trinity Catholic Church | Architecture | National importance | 1640. | Kuldīga municipality, Kuldīga, Raiņa Street 6 |
| 8544 | Residential building | Architecture | National importance | 20th century beginning | Kuldīga municipality, Kuldīga, Pils Street 5 |
| 8686 | Old Town Hall | Architecture | National importance | 17th and 18th century, 1806. | Kuldīga municipality, Kuldīga, Baznīcas Street 5 |
| 8687 | Residential building | Architecture | Local importance | 19th century 2nd half | Kuldīga municipality, Kuldīga, Baznīcas Street 9 |
| 8722 | Kuldīga St. Anna Lutheran Church | Architecture | National importance | 1899. -1904. | Kuldīga municipality, Kuldīga, Dzirnavu Street 12 |
| 8724 | Residential and household building | Architecture | Local importance | 1828. -1839., 19th century 70ties | Kuldīga municipality, Kuldīga, Liepājas Street 3a |
| 8937 | Residential building | Architecture | Local importance | 18th, 19th, 20th century (beginning) | Kuldīga municipality, Kuldīga, 1905 Street 1 |
| 8941 | The house of Virka manor | Architecture | Local importance | 18.gs., 19.gs. II. p., 20.gs. S. | Kuldīga municipality, Kuldīga, Virkas Street 27 |
| 8950 | German gymnasium, now a teaching institution | Architecture | Local importance | 1869. | Kuldīga municipality, Kuldīga, Mountain Street 19 |
| 9000 | Šarlotenrue manor chapel | Architecture | Local importance | 19th century | Kuldīga municipality, Kuldīga, Ziedu Street 15 |
| 9105 | Bridges over the river Alekšupīte (6) | Architecture | National importance | 17th century, 19th century, beginning of 20.gs. | Kuldīga municipality, Kuldīga; Historic Center of the City of Kuldīga (Raiņa Street, Mucenieku Street, Pasta Street, Skolas Street, Kalna Street and Baznīcas Street) |
| 9163 | General courthouse | Architecture | National importance | 18th century (beginning), 19th century II half | Kuldīga municipality, Kuldīga, Church Street 34 |
| 9265 | Residential building | Architecture | National importance | 18th century II half | Kuldīga municipality, Kuldīga, Baznīcas Street 17 |
| 3615 | Altar | Art | National importance | 1660. -1663. | Kuldīga municipality, Kuldīga, Baznīcas Street 33; St. Katrīnas Lutheran Church |
| 3616 | "Kuldīga coat of arms" tab | Art | National importance | 1791. | Kuldīga municipality, Kuldīga, Baznīcas Street 33; St. Katrīnas Lutheran Church |

| Go away. No. | Name | Typological group | Value group | Date | Location |
|---|---|---|---|---|---|
| 3617 | Organ murals (10) | Art | National importance | 17th century 2nd half | Kuldīga municipality, Kuldīga, Baznīcas Street 33; St. Katrīnas Lutheran Church |
| 3618 | Organ Prospectus | Art | National importance | 1691. -1692. | Kuldīga municipality, Kuldīga, Baznīcas Street 33; St. Katrīnas Lutheran Church |
| 3619 | Organ | Art | National importance | 1882. | Kuldīga municipality, Kuldīga, Baznīcas Street 33; St. Katrīnas Lutheran Church |
| 3621 | Interior decorating | Art | National importance | 17th century 20th century (beginning) | Kuldīga municipality, Kuldīga, Baznīcas Street 33; St. Katrīnas Lutheran Church |
| 3622 | Pulpit | Art | National importance | 1659-1663 18th century (beginning) | Kuldīga municipality, Kuldīga, Baznīcas Street 33; St. Katrīnas Lutheran Church |
| 3623 | Organ | Art | National importance | 1927. | Kuldīga municipality, Kuldīga, Dzirnavu Street 12; St Anna Lutheran Church |
| 3625 | Stained-glass (3) | Art | National importance | 1939. | Kuldīga municipality, Kuldīga, Dzirnavu Street 12 St. Anna Lutheran Church |
| 3626 | Door set | Art | National importance | 19th century (beginning) | Kuldīga municipality, Kuldīga, Jelgava Street 2 |
| 3627 | Door set | Art | National importance | 19th century II half | Kuldīga municipality, Kuldīga, Jelgava Street 16 |
| 3628 | Door set | Art | National importance | 19th century II half | Kuldīga municipality, Kuldīga, Jelgava Street 24 |
| 3629 | Door set | Art | National importance | 19th century II half | Kuldīga municipality, Kuldīga, Jelgava Street 27 |
| 3630 | Door set | Art | National importance | 19th century II half | Kuldīga municipality, Kuldīga, Jelgava Street 29 |
| 3631 | Door set | Art | National importance | 19th century II half | Kuldīga municipality, Kuldīga, Jelgava Street 32 |
| 3632 | Door set | Art | National importance | 19th century II half | Kuldīga municipality, Kuldīga, Mountain Street 13 |
| 3633 | Door set | Art | National importance | 19th century beginning - II half | Kuldīga municipality, Kuldīga, Mountain Street 14 |
| 3634 | Door set | Art | National importance | 18th century (end) 19th century (beginning) | Kuldīga municipality, Kuldīga, Mountain Street 15 |
| 3635 | Tab | Art | National importance | 1632. | Kuldīga municipality, Kuldīga, Liepājas Street 1 |
| 3636 | Door set | Art | National importance | 19th century (beginning) | Kuldīga municipality, Kuldīga, Liepājas Street 17 |
| 3638 | Cara Gate | Art | National importance | 1871. | Kuldīga municipality, Kuldīga, Liepājas Street 31; Kuldīga Orthodox Church |

| Go away. No. | Name | Typological group | Value group | Date | Location |
|---|---|---|---|---|---|
| 3641 | "Our Lady" icon | Art | National importance | 1871. | Kuldīga municipality, Kuldīga, Liepājas Street 31; Kuldīga Orthodox Church |
| 3649 | Dome murals | Art | National importance | 1871. | Kuldīga municipality, Kuldīga, Liepājas Street 31; Kuldīga Orthodox Church |
| 3650 | Fireplace | Art | National importance | 19th century (beginning) | Kuldīga municipality, Kuldīga, Pils Street 5 |
| 3651 | Altar | Art | National importance | 18th century 1818.-1820. | Kuldīga municipality, Kuldīga, Raina Street 6; St Trinity Catholic Church |
| 3654 | Organ | Art | National importance | 18th century 60ties. 1897. | Kuldīga municipality, Kuldīga, Raina Street 6; St Trinity Catholic Church |
| 3657 | Pulpit | Art | National importance | 17th century (end), 18th century (beginning and II half) | Kuldīga municipality, Kuldīga, Raina Street 6; St. Trinity Catholic Church |
| 3665 | Side altar (2) | Art | National importance | 1777. | Kuldīga municipality, Kuldīga, Raina Street 6; St. Trinity Catholic Church |
| 8946 | Door set | Art | Local importance | 19th century (middle) | Kuldīga municipality, Kuldīga, 1905 Street 1 |
| 8955 | Door set | Art | Local importance | 19th century (middle) | Kuldīga municipality, Kuldīga, Alunāna Street 4 |
| 8956 | Door set | Art | Local importance | 19th century (middle) | Kuldīga municipality, Kuldīga, 1905 Street 14 |
| 8957 | Door set | Art | Local importance | 19th century (middle) | Kuldīga municipality, Kuldīga, Baznīcas Street 20 |
| 9009 | Goddesk balustrade | Art | National importance | 18th century (middle) | Kuldīga municipality, Kuldīga, Raina Street 6A |
| 9029 | Door set | Art | Local importance | 19th century (middle) | Kuldīga municipality, Kuldīga, Liepājas Street 20 |
| 9030 | Door set | Art | Local importance | 19th century (middle) | Kuldīga municipality, Kuldīga, Upes Street 1 |
| 9031 | Door set | Art | Local importance | 19th century (middle) | Kuldīga municipality, Kuldīga, Dzirnavu Street 6 |
| 9032 | Door set | Art | Local importance | 19th century (beginning) | Kuldīga municipality, Kuldīga, Virka Street 1 |
| 9033 | Door set | Art | Local importance | 19th century (middle) | Kuldīga municipality, Kuldīga, Sand Street 23 |
| 9034 | Door set | Art | Local importance | 19th century (middle) | Kuldīga municipality, Kuldīga, Ventspils Street 12 |
| 9035 | Door set | Art | Local importance | 19th century (middle) | Kuldīga municipality, Kuldīga, Raina Street 7 |
| 9036 | Door set | Art | Local importance | 19th century (middle) | Kuldīga municipality, Kuldīga, Liepājas Street 16 |

| Go away. No. | Name | Typological group | Value group | Date | Location |
|---|---|---|---|---|---|
| 9037 | Door set | Art | Local importance | 19th century (middle) | Kuldīga municipality, Kuldīga, Liepājas Street 36 |
| 9038 | Door set | Art | Local importance | 19th century (middle) | Kuldīga municipality, Kuldīga, Liepājas Street 38 |
| 9039 | Door set | Art | Local importance | 19th century (middle) | Kuldīga municipality, Kuldīga, Mucenieku Street 1 |
| 9040 | Door set | Art | Local importance | 19th century 70ties | Kuldīga municipality, Kuldīga, Strauta Street 3 |
| 9044 | Door set | Art | Local importance | 19th century (beginning) | Kuldīga municipality, Kuldīga, Jelgava Street 33 |
| 9045 | Door set | Art | Local importance | 19th century (middle) | Kuldīga municipality, Kuldīga, Liepājas Street 25 |
| 9046 | Door set | Art | Local importance | 19th century (middle) | Kuldīga municipality, Kuldīga, Rumbas Street 13 |
| 9047 | Door set | Art | Local importance | 19th century (middle) | Kuldīga municipality, Kuldīga, Ventspils Street 37 |
| 9048 | Door set | Art | Local importance | 19th century (middle) | Kuldīga municipality, Kuldīga, Ventspils Street 31 |
| 9049 | Door set | Art | Local importance | 19th century (middle) | Kuldīga municipality, Kuldīga, Skrunda Street 12 |
| 9050 | Door set | Art | Local importance | 19th century (middle) | Kuldīga municipality, Kuldīga, Jelgava Street 25 |
| 9051 | Door set | Art | Local importance | 19th century (middle) | Kuldīga municipality, Kuldīga, Baznīcas Street 30 |
| 9052 | Door set | Art | Local importance | 19th century (middle) | Kuldīga municipality, Kuldīga, Jelgava Street 2 |
| 9053 | Door set | Art | Local importance | 19th century (middle) | Kuldīga municipality, Kuldīga, Skrunda Street 14 |
| 9054 | Door set | Art | Local importance | 19th century (beginning) | Kuldīga municipality, Kuldīga, Liepājas Street 14 |
| 9055 | Door set | Art | Local importance | 19th century (middle) | Kuldīga municipality, Kuldīga, Kalna Street 11 |
| 9056 | Door set | Art | Local importance | 19th century (beginning) | Kuldīga municipality, Kuldīga, Ventspils Street 23 |
| 9093 | Door set | Art | Local importance | 19th century (middle) | Kuldīga municipality, Kuldīga, Mountain Street 23 |
| 38 | Baltic teachers' seminar | History | National importance | 1886. -1915. | Kuldīga municipality, Kuldīga, Liepājas Street 31 |
| 9154 | Needle factory | Historical event site | National importance | Mid 19th century – 1991. | Kuldīga municipality, Kuldīga, Kalpaka Street 1; Liepājas Street 37; Kalpaka Street 4; Kalpaka Street 2; Liepaja Street 39, Kalpaka Street |

## Annex 2 Experience of Latvian cities in project implementation

In addition to the situation analyzed in Chapter 1 regarding the situation in the  cities with rich historical urban environment and which are stannding nex to the river (Jelgava and Valmiera cities), other cities with a similar situation are also considered during the proposal development phase. In compiling this experience, attention is paid to the experience of municipalities in creating accesses to rivers, planning the opening of views and planning walking pathes (promenades) along the river.

**Expierence of the Bauska city**

Significant sights in Bauska are the Bauska Castle, rivers Mēmele and Mūsa and Lielupe, Bauska Old Town and other objects. A small area, which includes the downstream of Mēmele and Mūsa, the beginning of the Lielupe, Bauska Castle and the Castle Park, belongs to the nature park “Bauska”, which is a protected nature territory of European significance *Natura 2000*. The cdownstreamt of Mūsa and Mēmele and Bauska Castle are included in the list of Latvian landscape treasures.

A trail has been created in the Bauska Nature Park. It starts from Bauska's old town on the left bank of the Mēmele, behind the intersection of Dambja and Rūpniecības Streets, continues on the peninsula along the Bauska castle mound, the open-air stage and leads to Ķirbaksala along the bridge. From Ķirbaksala, the trail continues along the right bank of the Mūsa and returns to the city at the intersection of Brīvības Boulevard and Uzvaras Street. The length of the trail is about 2 km. From November to May - the trail is available partly, because the bridge connecting Ķirbaksala with the castle mound territory is removed for the winter season.


*Figure 59 Nature trail in Bauska (Source: Bauska Tourism Information center)* https://www.tourism.bauska.lv/allfiles/files/Bauskaspilsetasplans_internetam_2016_oktobris.pdf

According to the information provided by the Bauska Tourism Information Center (in February 2020), the trail was installed using the existing trail network, expanding it. Therefore, in order to install the trail, it was not necessary to cut down significant amounts of trees and shrubs during the construction. The pavement of the trail is installed in part of the territory, in the rest there is a ground cover. An information stand has been set up in Ķirbaksala, a picnic place has been set up. A wooden frame has been installed on the slope next to the castle ruins, where visitors can take photos with the castle ruins in the background, an environmental object symbolizing the beginning of the Lielupe has been installed in Ķirbaksala.

In 2015, the municipality has started mowing aquatic plants in the Mēmele, Mūsa and Lielupe sections, as rivers are covered with aquatic plants. River overgrowth is caused by elevated concentrations of plant nutrients (phosphorus, nitrogen) in the waters. Aquatic plants are mowed with a mower - amphibian. In 2019, mowing of aquatic plants is performed with equipment purchased by Bauska municipality. Before that the municipality outsourced services from legal entities. Aquatic plants with amphibians are cut, collected and brought ashore.

When managing the territory of the castle mound, the municipality faces the need to follow the slope of the castle and, if necessary, strengthen it, especially on the bank of the Mēmele. When a place for the photography on the slope the castle mound was created, it was taken into account that the area where bushes and trees should be cut down cannot be too large to avoid the formation of ravines and landslides.

The trail, Bauska castle mound and Castle Park are visited by both city guests and it is also popular among residents for daily visits.

Bauska municipalitie is currently developing a local landscape and green infrastructure plan, which will also include the city of Bauska.

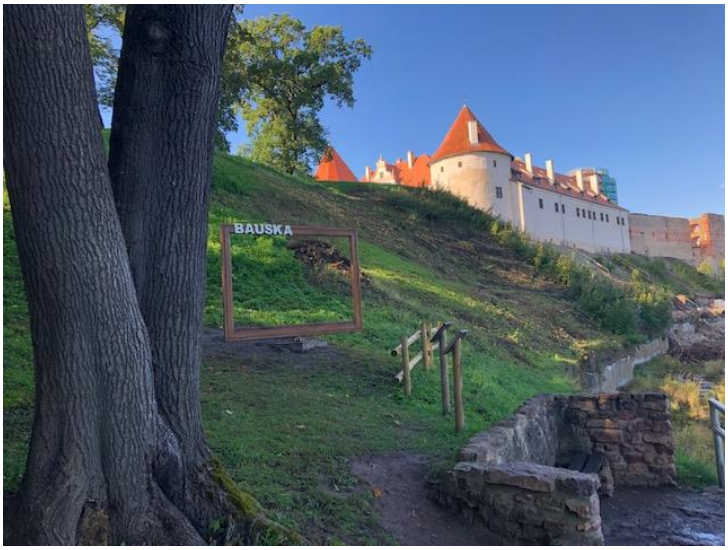



*Figure 60 Foreground – utilities on the slope, background – slope next to the castle where periodic slope strengthening works are maintained (Source: Bauska Tourism Information center)* https://www.tourism.bauska.lv/images/tourism/big/1195.jpg

**Expierence of the Cēsis city**

Cīrulīši nature trails have been created on the western edge of the city of Cēsis on the banks of the Gauja. Ir is located in the Gauja National Park - a protected nature territory of European significance *Natura 2000*. The territory also includes the Cēsis Nature and Cultural History Park (specially protected nature area established by the municipality).

Several routes have been created on Cīrulīši nature trail. The walking routes marked on them provide extensive information on the development of the valley from the Ice Age to the present day. The trails are interesting with their diversity of terrain and nature and offer active recreation (Nordic walking, cycling route).

Cēsis municipality is currently developing a spatial development plan for the Gauja River. The long-term goal of its development: "by implementing the spatial structure, measures and projects proposed in the planning document, to make the section of the Gauja River accessible to the widest possible public in the territory of Cēsis district, while respecting and preserving natural values on the Gauja bank, to promote the preservation of Latvian landscapes".

According to the information provided by the Development and Construction Department of Cēsis Municipality, issues regarding the accessibility of the Gauja, exposure of river views, including taking into account the relief and other natural factors, will be addressed by implementing the Gauja River Spatial Development Plan. Currently, overgrowth aby the plants along the banks of the Gauja has been identified as a problem, which is expanding over the years. The landscape has changed since the beginning of the 19$^{th}$ century, so it is necessary to carry out a landscape assessment and prepare recommendations for landscape improvement, which would also assess the accessibility of the watercourse to various target groups. In Cēsis it is necessary to develop a unified opinion on how the banks of the Gauja will be used for water tourism, bathing places, nature trails, bicycle paths.

Since 2017, the grasslands of Rucka manor park in Cēsis have been managed by grazing (sheep, horses). The municipality evaluates this solution positively, because together with the visit to Rucka manor, where the art and residence center operates, animals and grazing of the park is a popular, interesting object for residents and guests, as well as the grassland in the park is successfully managed. It should be noted that the park is located in the city and by introducing such a type of management, foreign experience in the management of manor parks is demonstrated in Latvia.

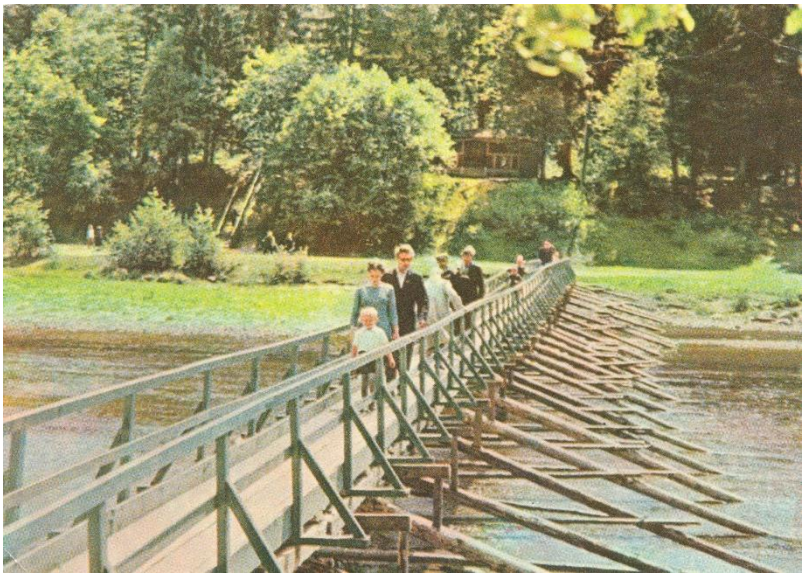
**Expierence of the Ogre city**

In the management of the Venta valley, in order to ensure the movement of residents and visitors, to improve the connection of the two banks of the river, it is importatn to cross the

river. As river water levels are often low, especially in summer, the installation of a footbridge or bridge to pontoon structures should be considered.

The footbridge connecting Ogre and Pārogri is built on pontoons in the city of Ogre.

Wooden footbridges are one of the most historically significant components of the Ogre landscape. The first footbridges in Ogre were built in the second half of the 19th century, because the guests of Ogre resort wanted to go for walks on the other bank of the Ogre River - in Pārogre. The footbridges were also used to sunbathe, sit and stand on them, watching both the scenery and the daily life of the crowded swimming pool.



*Figrue 59 Historical foot-bridge across Ogre river*
http://www.ogresnovads.lv/lat/pasvaldiba/jaunumi/?page=5&doc=27032

Every year, at the end of the flood season, the foot-bridge across Ogre river is built and taken off in the fall to be rebuilt next spring. After the construction of the arched pedestrian bridge over Ogre river in 1966, no footbridges were built. They were renewed in 2017 within the framework of the Latvian Environmental Protection Fund co-financed project[99].

The total length of the restored wooden footbridge is 108 meters, width – 1,5 meters. Stairs will be installed on the shores to get to the footbridge.

[99] Project name "Laipas – Ogres upes un tās krastos augošo aizsargājamo biotopu un peldu kūrorta cildināšana, godinot Latvijas valsts pastāvēšanas simtgadi"

The cost of creating the footbridge was almost 167 thousand euros (166,983 EUR, including 42,645 ERU granted by the Latvian Environmental Protection Fund, but 124,338 EUR - by the municipality, 2017 prices). The cost of installing a pontoon footbridge after dismantling – 7800 EUR (2018 prices).

*Figure 60 Example of a pontoon footbridge, Latvia (Ogre city): http://www.ogresnovads.lv/lat/pasvaldiba/projekti/zinas__jaunumi/?page=0&doc=33797*

**Conclusions**

Unlike Kuldīga, Bauska sightseeing and visiting objects, where a nature trail has been created, are located in a relatively more compact area, concentrated at the confluence of rivers Mēmele and Mūsa, at the beginning of the Lielupe near Bauska castle mound. Sights in Kuldīga are located in a wider area on both banks of the Venta. However, when planning the development of tourism objects in Kuldīga, the following experience of Bauska municipality can be taken into account:

- When planning new pathes and placing environmental objects, it is necessary to take into account natural conditions, incl. the existing location of the terrain and pathes. Open, steep slopes should be monitored and, if necessary, reinforced.

- For water crossing, plan objects (in the case of Bauska - a bridge to Ķirbaksala) that are open during the tourist season, but during the rest of the year (from November to April), they can be dismantled.

- To reduce river coverage of aquatic plants river should be mowed.

Evaluating the experience of the city of Cēsis, the following can be recommended for the planning and implementation of landscape development in the Venta valley:

- To provide information about the developmnet of the Venta river valley, processes, natural and cultural heritage values.

- Plan different pathes, both in length and content and the activities to be performed on them.

- Introduce grazing for grassland management, as this not only makes grassland management cheaper than mowing, but also creates new places for visitors (e.g. families, children, etc.) who are interested in animals.

In order to solve the crossing of the Venta river, the experience of the city of Ogre can be taken into account. When designing a footbridge over the Venta, the choice of its solutions must also include issues of environmental accessibility, so that the object can be used by all groups of society (families with children, people with special needs). The operation of the footbridge is planned in the summer season, in the winter season it can be dismantled.

# Annex 3 Time schedule fot the habitats restoration measures

*The timing of the events is indicative. This shall be specified during the implementation, taking into account meteorological conditions, intensity of vegetation development, results of measures implemented in previous years or in the period (same year)*

| Management measure code on the map* | Measure | Regularity: times per year | Year of implementation | January | February | March | April | May | June | July | August | September | October | November | December | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Organizational measures: work with landowners (information, agreement), conclusion of contract (s) for the implementation of measures (farms, other service providers, private persons) | As necessary | 1st year | | | | | | | | | | | | | |
| A.1.1. | Cutting of trees and shrubs | Once a year/ first year | 1st year | | | | | | | | | | | | | |
| A.1.2. | Leaf tree/shrub cutting, shoot mowing | Once a year/ several years** | 1st year | | | | | | 15.06. - 25.06. shoot mowing | | from 15.08 shoot mowing | until 15.09. shoot mowing | | | | Cutting can be started 15.08. - 15.09. |
| | shoot mowing | | 2nd year | | | | | | 15.06. - 25.06. | | from 15.08. | until 15.09. | | | | |
| | shoot mowing | | 3rd year** | | | | | | 15.06. - 25.06. | | from 15.08. | until 15.09. | | | | |
| A.2.1. | Restriction of the spread of invasive species: nvasive species weeding | Multiple times per season/several years** | 1st year | | | | | | | | | | | | | At least 3 times a season, taking into account the growth intensity of the species |
| | | | 2nd year | | | | | | | | | | | | | At least 3 times a season, taking into account the growth intensity of the species |
| | | | 3rd year** | | | | | | | | | | | | | At least 3 times a season, taking into account the growth intensity of the species |
| A.2.2. | Restriction of the spread of invasive species: mulching | Once a year/ several years** | 1st year | | | | | | | | | | | | | To control the Canadian goldenrod in habitat 6210. Where the plant has spread, the plants are covered with a membrane at the beginning of the season, in autumn - the cover and plant residues are removed. |
| | | | 2nd year | | | | | | | | | | | | | |
| | | | 3rd year** | | | | | | | | | | | | | |
| A.3.1. | Reduction of soil fertility, restriction of the spread of expansive species: mowing | 2-3 times per season/3 years in a row | 1st year | | | | | | 01.06. - 20.06. | | from 15.08. | until 10.09. | | | | |
| | | | 2nd year | | | | | | 01.06. - 20.06. | | from 15.08. | until 10.09. | | | | |
| | | | 3rd year** | | | | | | 01.06. - 20.06. | | from 15.08. | until 10.09. | | | | |
| A.3.2. | Reduction of soil fertility, restriction of the spread of expansive species: topsoil removal | Once a year/ first year | 1st year | | | | | from 25.06. | | | | | | | | |
| A.4.1. | Regenerative grazing/ mowing: grazing | 2-3 times per season/3 years in a row | 1st year | | | | | | | | | | | | | Grazing ensures that the intensively grazed area does not exceed 75% of the area of good quality (abundant flowering plants) grassland. The number of grazings is also determined by the meteorological conditions and the intensity of the grass. |
| | | | 2nd year | | | | | | | | | | | | | |
| | | | 3rd year** | | | | | | | | | | | | | |
| A.4.1. | Regenerative grazing/ mowing: mowing | 2-3 times per season/3 years in a row | 1st year | | | | | | 15.06. - 25.06. | | 01.08. - 31.08. | | | | | The number of mowing timer per season can be determined taking into account meteorological conditions, grass growth intensity: 3 times mowing in seasons when grass grows intensively (wet, warm summer), 2 times - in seasons when grass growth intensity is (dry and/or cold summer)<br>If mowing 3 times, mowing 2 times: 20.07. - 31.07., mowing for the 3rd time 25.08.-10.09. |
| | | | 2nd year | | | | | | 15.06. - 25.06. | | 01.08. - 31.08. | | | | | |
| | | | 3rd year | | | | | | 15.06. - 25.06. | | 01.08. - 31.08. | | | | | |

* Codes have been adopted in this study to facilitate the elaboration of graphic material, incl. design: A - restoration measures, U - maintenance measures. The codes are shown on the Maps 12-15

** until the spread of trees and shrubs is limited or invasive plant species are destroyed, in year 3 or 2 (if the result is achieved in year 2) - consultations with a certified species and habitat expert on the transition to maintenance measures, if necessary - specification of further management measures

# Annex 4 Time schedule for habitat maintenance measures

*The timing of the events is indicative. This shall be specified during the implementation, taking into account meteorological conditions, intensity of vegetation development, results of measures implemented in previous years or in the period (same year)*

| Management measure code on the map* | Measure | Regularity: times per year | Year of implementation | January | February | March | April | May | June | July | August | September | October | November | December | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Organizational measures: work with landowners (information, agreement), conclusion of contract (s) for the implementation of measures (farms, other service providers, private persons) | As necessary | 1st year | | | | | | | | | | | | | |
| U.1. | Extensive grazing | 1-2 times per season/every year | Every year | | | | | | 15.06. - 25.06. | | 01.08. - 31.08. | | | | | Grazing: sheep<br>Grazing ensures that the area of intensive grazing does not exceed 75% of the area of good quality (abundant flowering plants) grassland |
| U.2. | Formation of sand fields | Once every 2-3 years | 1st year | | | | | | | | | | | | | Sand fields are formed only if necessary - if the animals are not sufficiently swollen. This is done in summer - July, simulating when natural animals may have swelled. |
| | | | 3rd or 4th year, etc | | | | | | | | | | | | | |
| U.3.1. | Extensive mowing | Once a year/every year | Every year | | | | | | from 15.06. | unitl 15.07. | | | | | | |
| U.3.2. | Extensive mowing | Once ayear/once every 2-3-5 years | 1st year | | | | | | from 15.06. | unitl 15.07. | | | | | | |
| | | | 3rf, 4th or 6th year, etc. | | | | | | from 15.06. | unitl 15.07. | | | | | | |
| U.3.3. | Extensive mowing | Two times per season/every year | Every year | | | | | | 15.06. - 25.06. | | 01.08. - 31.08. | | | | | |
| U.5.1. | Mowing of aquatic plants: manual work | 1-3 times per season/every year | Every year | | | | | | | | | | | | | The number of mows depends on the intensity of plant growth. The mowing time is also chosen taking into account the water level |
| U.5.2. | Mowing of aquatic plants: machinery | Once in a 3 – 5 years | 1st year | | | | | | | | | | | | | The mowing time should be chosen according to the water level |
| | | | 4th-6th year | | | | | | | | | | | | | |
| In polygons where remediation measures are carried out, maintenance measures are carried out after the implementation of remediation measures. In these landfills, maintenance measures shall be initiated after consultation with a certified expert on species and habitats, and further management measures shall be specified, if necessary | | | | | | | | | | | | | | | | |