Interreg Latvija–Lietuva
European Regional Development Fund
EUROPEAN UNION

Joint management of Latvian – Lithuanian trans-boundary river and lake water bodies (TRANSWAT) LLI-533

Review of Latvian – Lithuanian transboundary lakes' residual time

2022

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Abbreviation

a.s.l. – above sea level

RBD – River Basin District

QE – Quality Element

MS – Meteorological Station

WFD–EU - Water Framework Directive 2000/60/EC

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I INTRODUCTION

In the frame of the “Joint management of Latvian – Lithuanian trans-boundary river and lake water bodies” project (TRANSWAT) LLI-533 financed by the Interreg V-A Latvia–Lithuania Programme 2014-2020, an assessment of the ecological status of Latvian – Lithuanian transboundary lakes is developed. Based on the project results, harmonised Monitoring Programme and Programme of measures for these lakes will be prepared.

The average length of time water remains within the boundaries of an aquatic system (residence time) is one of the key parameters controlling the system’s biogeochemical behavior. The Water Framework Directive (WFD–EU, 2000) considers water quality in its widest and ‘ecological’ sense and requires that a wide range of biological, hydromorphological and physico-chemical quality elements (hereinafter QEs) has to be evaluated to determine the water quality status of water bodies. Water residence time is one of the hydromorphological QEs that need to be evaluated to characterise water quality (Rueda et al, 2006).

Hydrological and meteorological data for the calculation of the residence time of pilot lakes (Ilzu (Garais)/Ilge, Galinu/Salna, Kumpinisku/Kampiniskiai, Lauceses/ Laukesas and Skirnas) as well as results of these calculations, are described in this Report.

II LAKES BASINS OVERVIEW

Project pilot lakes basins belong to two different River Basin Districts (hereinafter RBD): Ilzu (Garais)/Ilge Lake is located in the transboundary Lielupe RBD, but Galinu/Salna, Kumpinisku/Kampiniskiai, Laucesas/ Laukesas and Skirnas lakes are located in the transboundary Daugava RBD. The detailed description of Lielupe RBD has been provided in the report of the ECOFLOW project "Review of hydropower plants influence on water quantity and quality in Lielupe River Basin District" (ECOFLOW LLI249, 2017) The present report includes information from the above mentioned report and description of the Daugava RBD, as well as wide information about lakes' watersheds.

2.1. Lielupe River Basin District and Ilzu (Garais)/Ilge Lake

Lielupe RBD consists of Lielupe river basin entering the Gulf of Riga. Lielupe River basin comprises several large river sub-basins such as Mūsa/Mūša, Mēmele/Nemunėlis, Svēte/Švėtė in Latvia and Lithuania, Iecava and Veciecava in Latvia, as well as numerous medium large and small sub-basins entering the Lielupe River (Fig. 1). The total area of Lielupe RBD is 17 600 km^2, within Latvia – 8849 km^2.

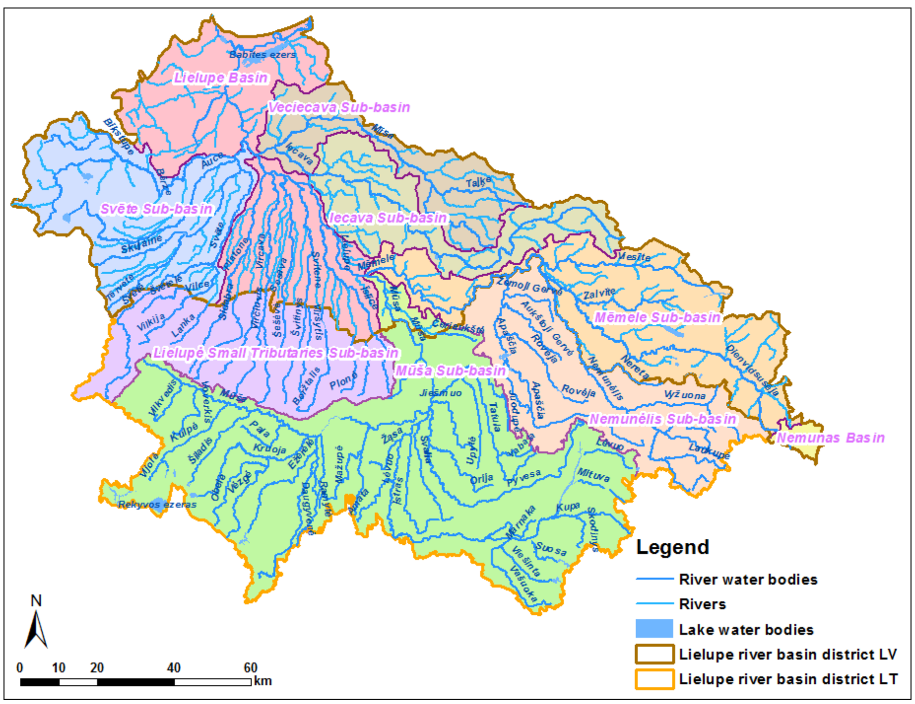

Figure 2.1.1. Lielupe River Basin District (ECOFLOW Project, 2017)

The Ilzu (Garais) / Ilge Lake belongs to the Memele/Nemunelis River Basin that is one of the two large sub-basins of the Lielupe River Basin. The largest part of upper

Lielupe RBD area consists of Mūša-Nemunėlis Plain where average height varies from 40 to 60 meters above sea level (a.s.l.) and of Zemgale Plain with height variation of 30-50 meters a.s.l.
In Latvia the largest part of Lielupe River Basin is situated in the Middle Latvian Lowland, and the elevation downstream from Jelgava city is normally less than 10 meters above sea level (a.s.l.). Exceptions are the Eastern Kurzeme Upland in the most western part of Lielupe RBD and the Augšzeme Upland in the southeastern part, where elevations reach up to 150 meters a.s.l. The Garais/Ilge Lake locates here, in the Augšzeme Upland (Fig.2.1.2).
Climate in the Eastern part of the Lielupe River Basin can be characterized as a transitional between mild Western European and continental Eastern European climate. The Baltic Sea has an impact on the climate here; however, from west to east, the sea has less and less influence on climatic conditions.
The hydrological regime in the basin is characterised by the spring flood, summer and winter low flow periods, and autumn/winter rainfall floods. 42% of water mass rivers and lakes have from snow melting, about 55% from rainfall, and the rest – from groundwater.

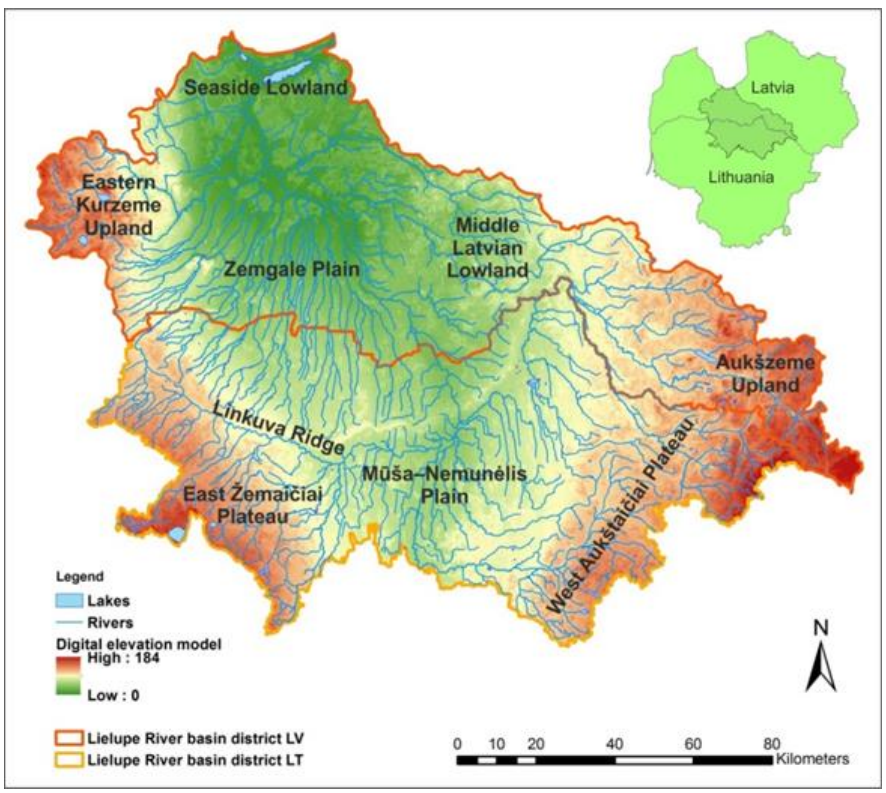

Figure 2.1.2. Topography and hydrography of Lielupe RBD (ECOFLOW Project, 2017)

According to Zilani Meteorological station (hereinafter MS) data, the annual air temperature in the vicinity of Garais/Ilge Lake is +6.6°C, annual amount of precipitation – 670 mm (climate normal data for the period 1991-2020).

Garais/Ilge is a running-water lake with small inflow from the drainage channel in Latvian territory and outflow to Lithuanian territory. Specific water discharge in a lake basin is about 7 l/sec*km^2.

2.2. Daugava River Basin District and Galinu/Salna, Kumpinisku/ Kampiniskiai, Laucesas/ Laukesas and Skirnas lakes

The drainage basin of the Daugava River forms the most part of the Daugava RBD. Daugava River stretches from the Valday Massive in the central part of European Russia to the Gulf of Riga and crosses the northeast of Belarus. Small parts of the river basin is located in the northwest of Lithuania and in the southeast of Estonia (fig.2.2.1).

The length of the basin is 700 km, the maximum width – 225 km. Total area covered by the Daugava basin exceeds 87 900 km², within Latvia – 24 700 km². The mean slope of Daugava River is 0,54 ‰. Most of the river basin is between 50 and 200 m a.s.l. It is a plain with numerous swamps and forests. Latgale and Augszeme uplands have elevation 100 - 200 m a.s.l.

The basin also has more than 5,000 lakes, most of them quite small. Among the largest are lakes Razna and Lubana in Latvia.

Figure 2.2.1. Daugava River Basin

Within Russia and Belarus the Daugava River Basin includes some large sub-basins of Mescha, Kasplja, Dysna and Dryssa rivers. In Latvian territory Daugava River has many tributaries, mostly on the right bank of the river: Dubna, Aiviekste, Ogre, Jugla (that is formed itself by two rivers, Liela Jugla and Maza Jugla). The pilot lakes are located in the Augszeme Upland, their elevation varies from 120 m to 145 m a.s.l. (Fig. 2.2.2.).

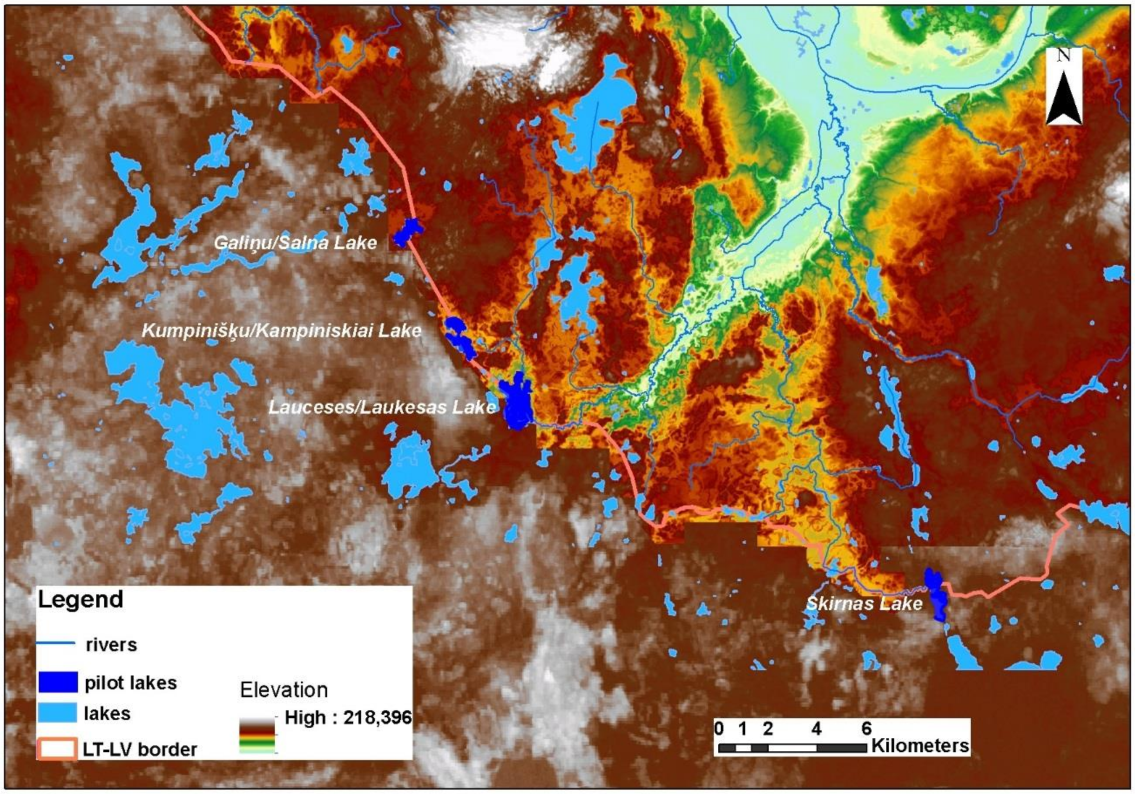

Figure 2.2.2. Topography and hydrography of Daugava River Basin

Rivers and lakes of the Daugava River Basin draw much of their water from snow melting, and have high spring floodwaters. It also floods after heavy rains. In spring, the water level of lakes rises by 0.3 – 0.5 m or more at various places. The icebound period begins in late November or early December and the ice break begins about the end of March.

Climate in the Daugava River Basin as well as in the Lielupe River Basin can be characterized as a transitional between mild Western European and continental Eastern European climate.

In accordance with the Daugavpils MS observations, the annual precipitation in this area is 635 mm, annual average air temperature is +6.6°C (climate normal data for the period 1991-2020). The specific discharge is about 7.0 l/sec*km^2 for lakes Galinu/ Salna, Kumpinisku/Kampiniskiai and Lauceses/ Laukesas, but for Skirnas Lake it is about 6.0 l/sec*km^2.

III DATA FOR LAKE RESIDENCE (RESIDUAL) TIME CALCULATION

A widely used expression to estimate the residence time **T** in reservoirs (Foy, 1992; Sivadier et al., 1994; Straskraba et al., 1995) consists of dividing the volume of water **V** stored in the reservoir by the volumetric flow-rate **Q**:

$$Tf(t) = \frac{V}{Q(t)} ,$$

where Q might be as the total inflow volume (tributary inflow and precipitation), or as the total outflow (water runoff from a reservoir and evaporation from surface).

Meteorological data (amount of precipitation, relative humidity, air temperature) were used that represent an average for the period 1991-2020 (the climatic norm). Taking into account lack of inflow amount data, the results of outflow measurements obtained during the project were used for the residence time calculations. For the calculation of the evaporation volume, the method of Konstantinov (Konstantinov A, 1968) was applied. According to this method, the evaporation volume is calculated using the reference evaporation data (the evaporation pond with surface area 20 m^2), relative humidity and air temperature data (from Zilani MS). Initial data for the Ilzu (Garais)/Ilge Lake residence time calculation is shown in the Table 1.

Table 1. Meteorological, hydrological and lake morphological data (1991-2020)

Name	Lake volume, km^3	Lake surface area, km^2	Outflow annual, m^3/sec	Outflow annual, km^3	Evaporation annual, mm	Evaporation annual, km^3
Ilzu(Garais)/Ilge	0.00208	0.83	0.074	0.002	673	0.00056
Galinu/Salna	0.00207	0.53	0.060	0.002	682	0.00036
Kumpinisku/ Kampiniskiai	0.00264	0.88	0.061	0.002	694	0.00061
Laucesas/ Laukesas	0.01010	1.88	2.42	0.076	711	0.00133
Skirnas	0.00383	0.66	0.024	0.001	694	0.00046

IV. RESULTS AND CONCLUSIONS

The residence time of transboundary lakes in average is the following:

- Ilzu (Garais)/Ilge Lake - 0.72 year or 262 days;
- Galinu/Salna Lake – 0.92 year or 334 days;
- Kumpinisku/ Kampiniskiai Lake – 1.04 year or 379 days;
- Laucesas/ Laukesas Lake – 0.13 year or 48 days;
- Skirnas Lake – 3.17 year or 1159 days.

It differs from season to season. In spring water runoff increases and water mass motion becomes more active. During the low flow period the water particles transport is almost stopped as well as in winter time, when the outflowing creek completely freezes.

This quantification of the lake residence time is approximate. A number of factors such as the timing of stratification, the depth of the thermocline and the variability of the inflows that limnologists usually take into consideration, is missing out in this calculation.

In spite of uncertainties, the result can be used for describing the pollution load in the lakes' water and especially in sediments.

V. REFERENCES

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