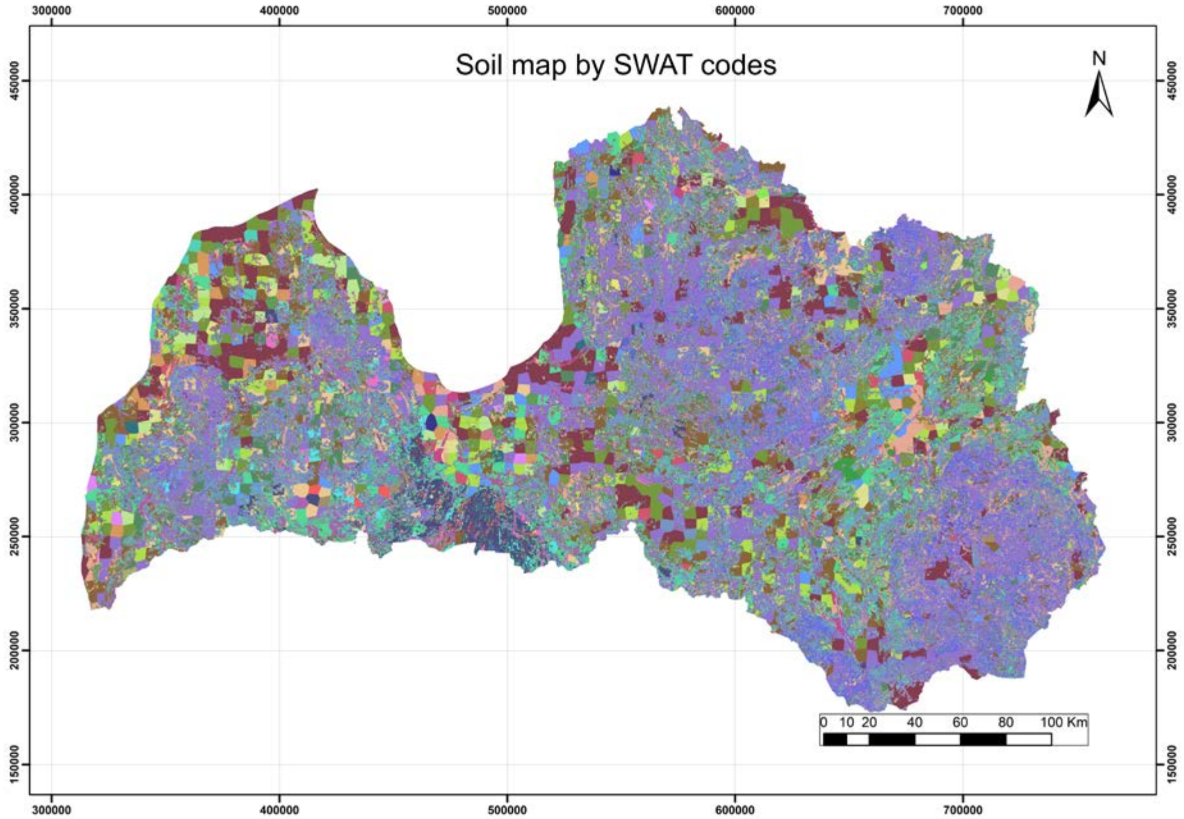
Eiropas Savienības LIFE programmas Integrētais projekts
“Latvijas upju baseinu apsaimniekošanas plānu ieviešana laba virszemes ūdens stāvokļa sasniegšanai”

DATA BASE FOR MODEL IMPLEMENTATION



Prepared within the LIFE GoodWater IP

Action C1 “Development of the water quality and quantity system for the territory of Latvia”

Rīga, 2020

State Regional Development Agency Republic of Latvia

DATA BASE FOR MODEL IMPLEMENTATION

Uldis Bethers, Juris Seņņikovs, Andrejs Timuhins, SIA “Procesu analīzes un izpētes centrs”

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Summary

This document summaries the data base mobilized in January-September/2020 for the development of the water quality and quantity modelling system of Latvia.

Report is written in English, it contains 41 pages, 17 Figures, and 21 Table.

Table of contents

Introduction

This document describes deliverable R1 “Data base for model implementation” of Activity C1 “Development of the water quality and quantity system for the territory of Latvia”. The deliverable is a result of Task T2 “Data identification, mobilization and preprocessing” which has been carried out in first 9 months of the project.

Task T2 includes

- the identification of the data required for the model development;
- mobilization of the data, analysis of their structure, quality control;
- adaptation of software tools (Python scripts) for data transfer to intermediate data format;
- creation of the data base for the implementation of the modelling system.

The respective Chapters of this report describes the data prepared in the following data blocks which are required for model setup:

1. Geospatial data in Chapter 1:
    - Stream network and subcatchments of river stretches according to water bodies defined in the river basin management plans
    - Digital terrain and slope distribution
    - Soil raster
    - Land use including crops for agricultural lands
    - Reservoirs and lakes
    - Surface and subsurface drainage systems
    - Wastewater treatment plants and point pollution sources
    - Livestock production facilities
2. Non-geospatial data for model setup in Chapter 2:
    - Soil, land use and crop growth parameters
    - Reservoir and lake parameters
    - Parameters of agricultural practices
3. Hydrometeorological and water quantity/quality data which form the model input data (former) and data for model calibration/verification (later):
    - Temperature, precipitation and wind data
    - Future climate projections
    - Atmospheric nitrogen deposition
    - River discharge monitoring
    - Water quality monitoring data

Completion of the Task T2 and providing Deliverable R1 marks reaching the Milestone M2 “Data model” of the Activity C1.

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1. Geospatial data

1.1. Digital terrain

The data from Latvian Geospatial information agency (LGIA) was used to create the model terrain for the territory of Latvia. 2x2 m digital elevation model (DEM) was created from this LIDAR data. For the part of Latvia (Gaujas basin) LGIA does not have a full LIDAR coverage yet. The LGIA's topo maps were used for the creation DEM in these parts. The system of developed Python scripts will allow for an updated of DEM with newest data as they become available during the lifetime of the project.

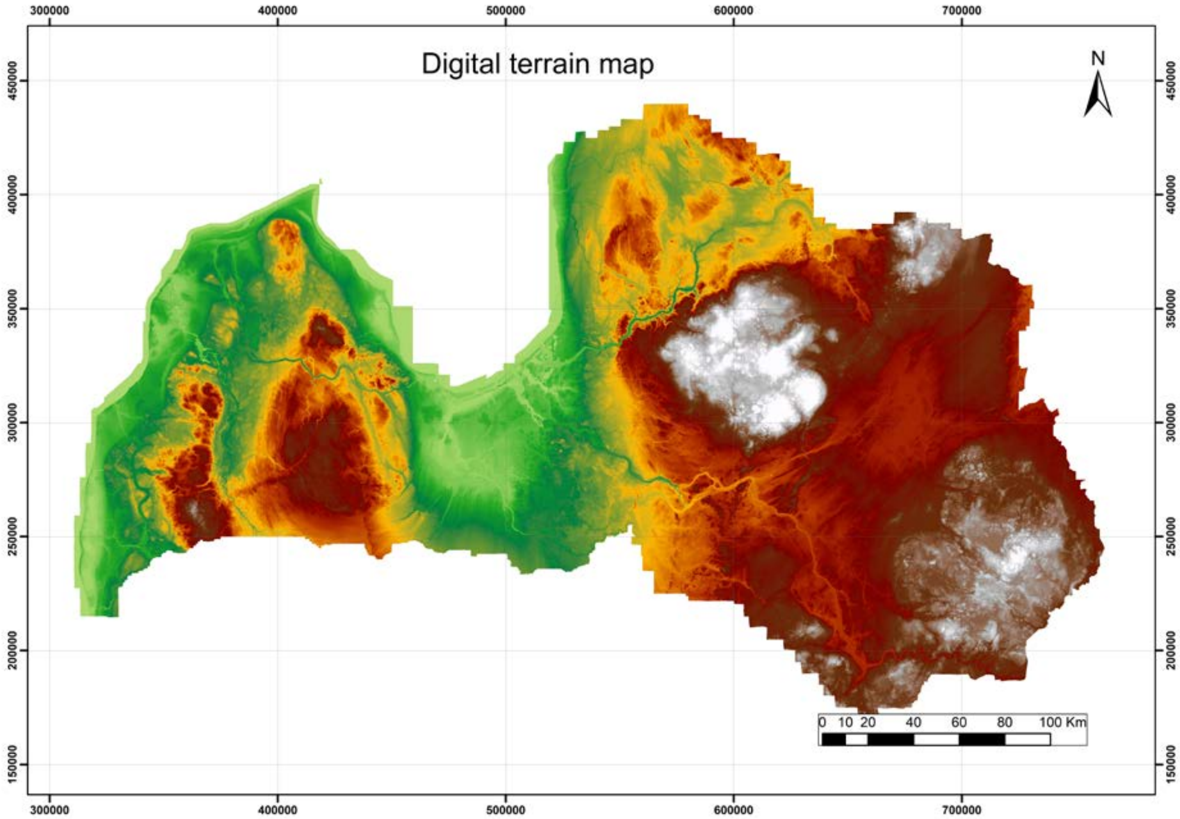

Figure 1: **DEM for the whole modelling domain.**

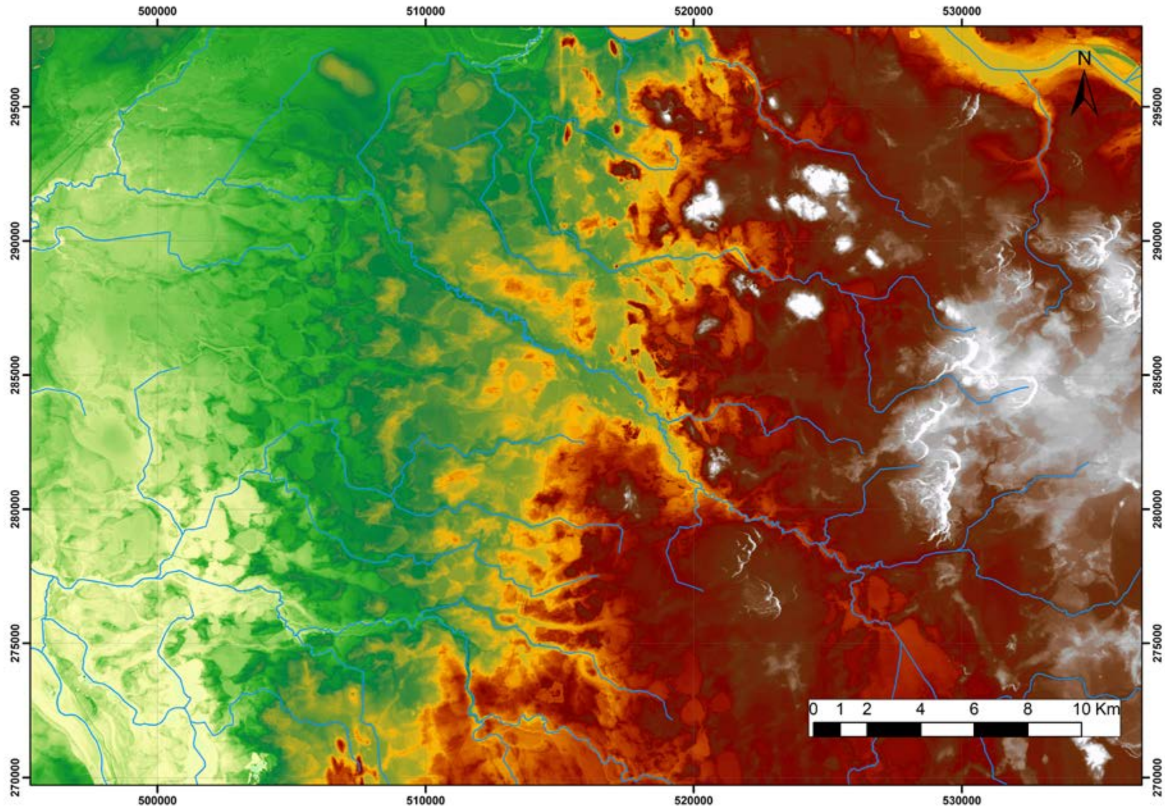

Figure 2: **Zoom of DEM.**

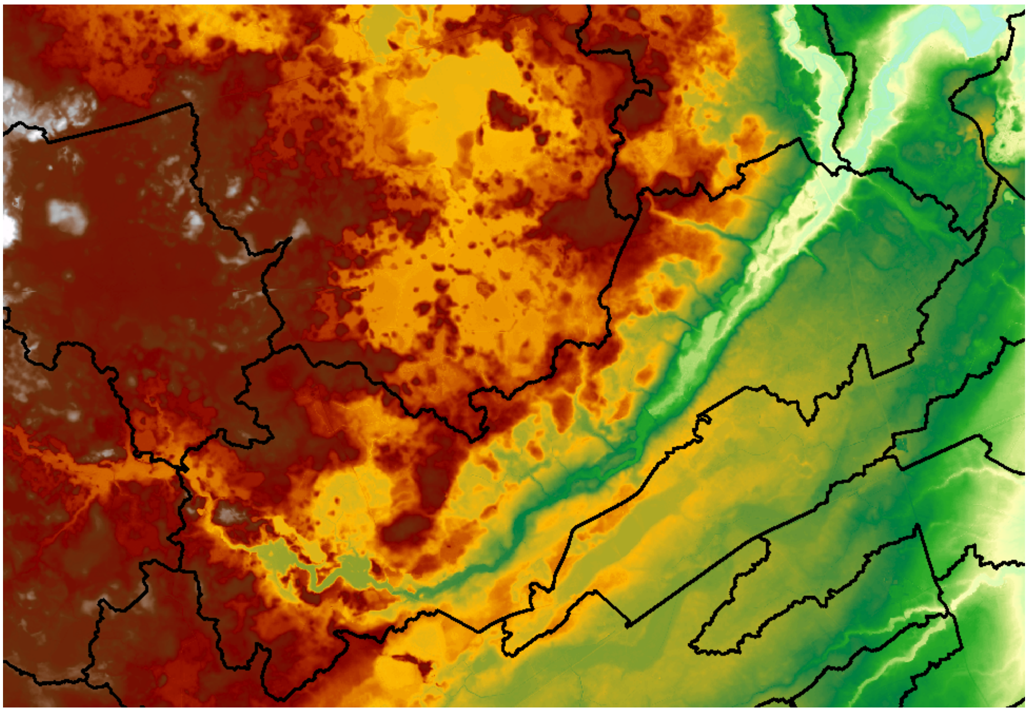

Figure 3: **Zoom of DEM near Sesava; subbasin delineation shown.**

1.2. Surface slope

The slope distribution of Latvia was calculated (see Figure 4) from the DEM in Section 1.1, and four slope classes were established on the 2x2 m raster: 0-2%, 2-5%, 5-10% and 10-100%.

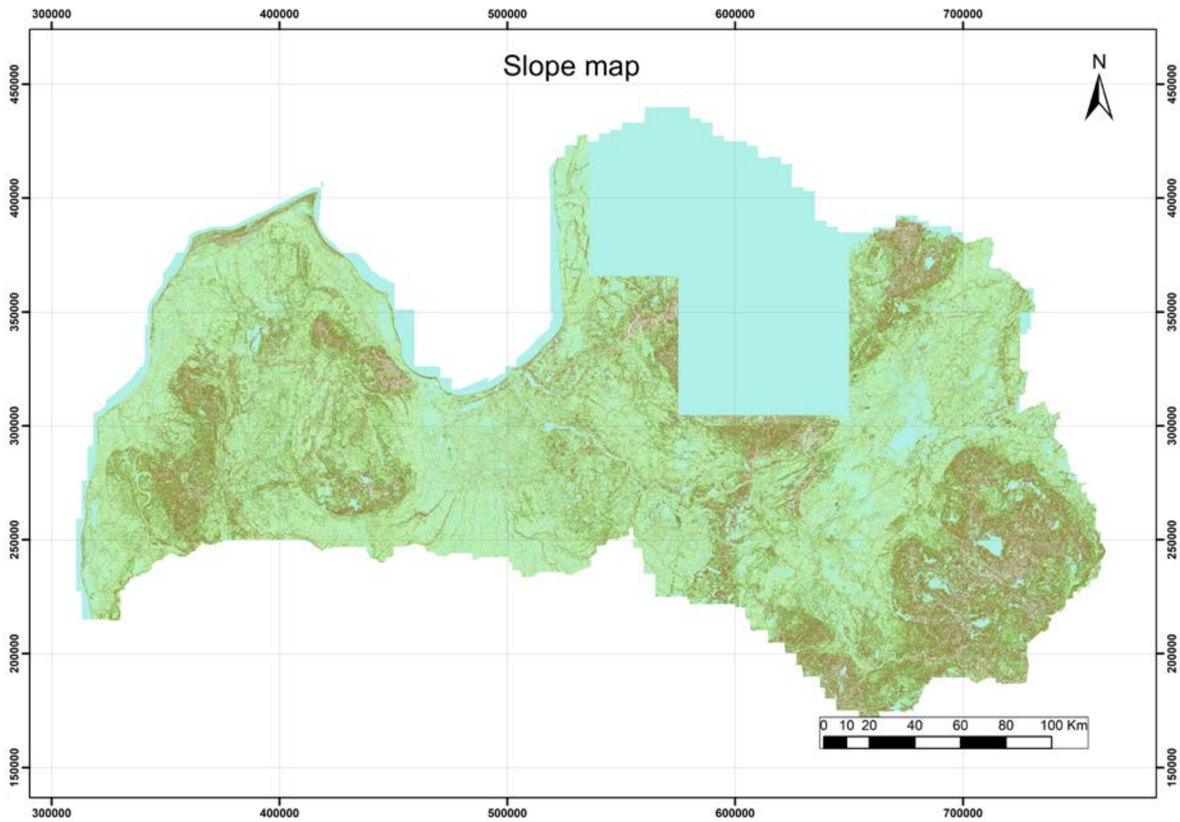

Figure 4: **Slope distribution in Latvia.**

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1.3. Stream network

River network data was created from the geospatial information of water management section classificatory (USIK) and lake water object register by Latvian Environment, geology and meteorology center (LEGMC). The level of detail used in the model contains 3472 river stretches. The data on river slope and width (where available) from river cadaster (LEGMC) was added as attributes of this geospatial data set. The quality control was performed on the conformity of the river network, geospatially joining the river segments as necessary.

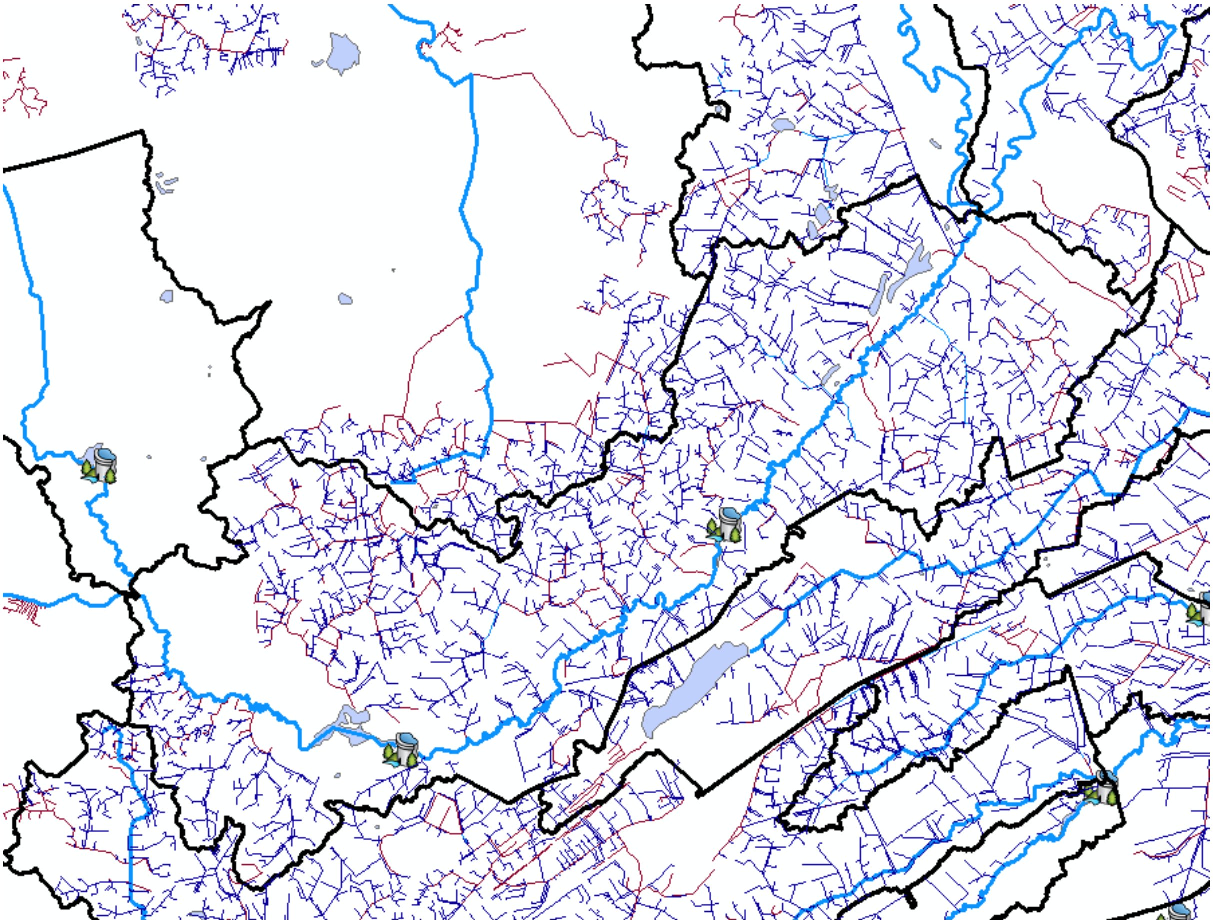

Figure 5: **Stream network and catchments near Sesava.**

1.4. Catchments

The USIK catchment areas (LEGMC) were not consistent; therefore, the delineation of the catchments was performed by the in-house software of "Procesu analīzes un izpētes centrs, SIA" (PAIC). Automated delineation processes used the DEM (Section 1.1) and river network (Section 1.3) and the culvert database from topographic maps of LGIA. After this automated step, the catchments were manually checked to assess compliance with USIK catchment areas.

The model catchments corresponding to stream (including lakes) segments of Section 1.3 were created with the average area of 20 km^2. Further the catchments were aggregated in the next spatial division level - Water objects, i.e., more generalized catchments in which model reporting on water quantity and quality should be made.

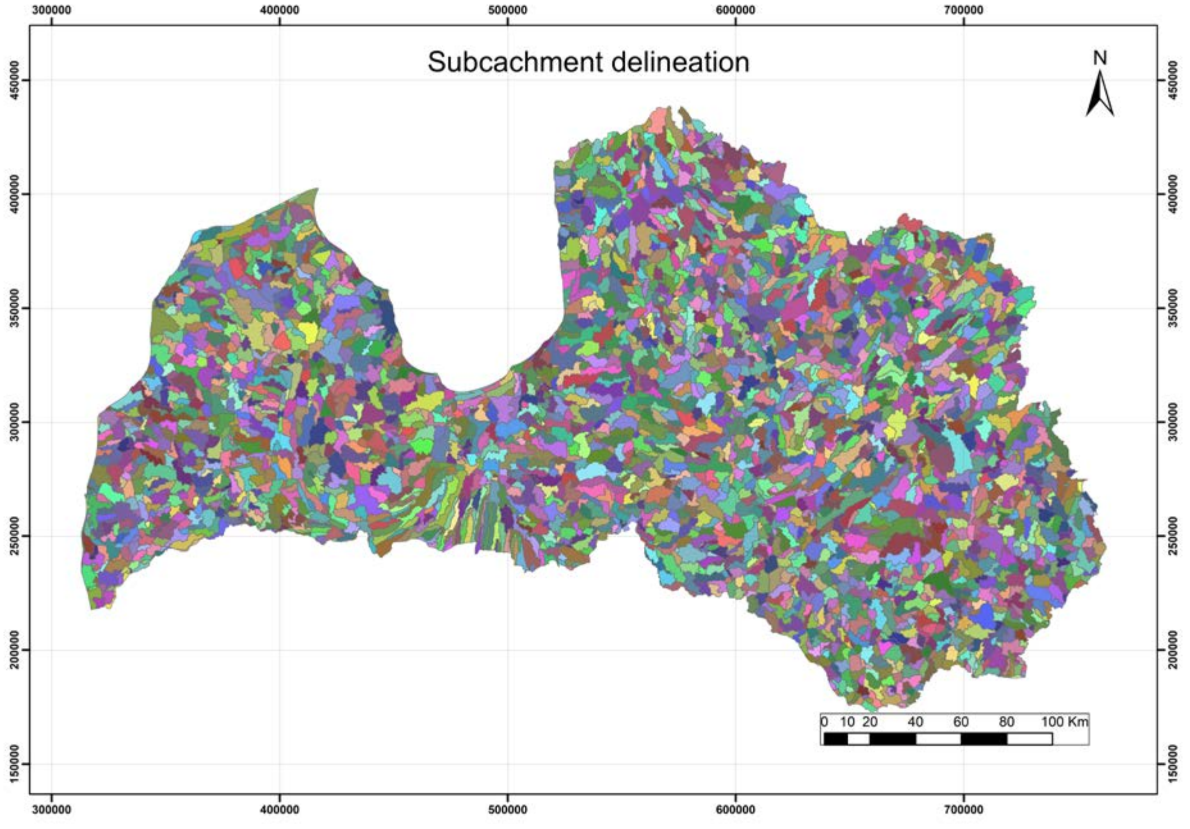

Figure 6: **Delineation of territory of Latvia into catchments.**

1.5. Soil

The data on soils were synthesized from the following data sources:

- Detailed soil map of agricultural lands digitized from soviet mapping of collective farms. Average field size 7 hectares.
- Quaternary geomorphology 1:50000 scale map for identifying soils under forests
- Large scale 1:1000000 soil map of Quaternary deposits for the rest of the territory

The soil maps were aggregated and soil parameters attributed for each of model soil classes by University of Latvia (UL, Raimonds Kasparinskis).

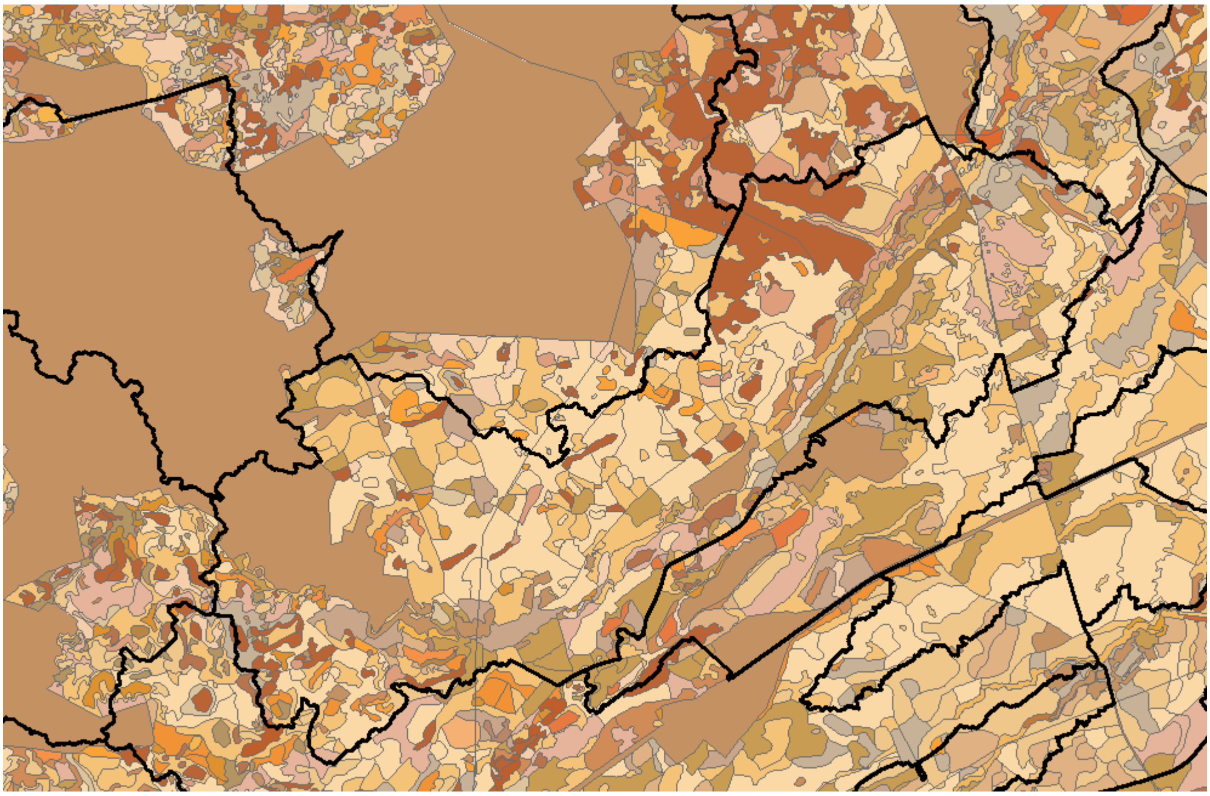

Figure 7: **Soil map near Sesava.**

1.6. Land use

The land use data was synthesized from the following data sources:

- Rural support service (LAD) geospatial databases – fields from registered agricultural use (crops). Crop distribution varies from year to year. Year 2015 was selected as representative year for reference period while 2019 – for the baseline period. Data from the Rural support service and the registered fields for support payments covers most of agricultural land, average of field 4 hectares.
- Forest cadaster geospatial database. National forest cadaster covers nearly all forested areas average size of area 1 hectare.
- Topographic map layers from LGIA digital topographic map.
- Corine 2018 as the most recent Corine land cover map

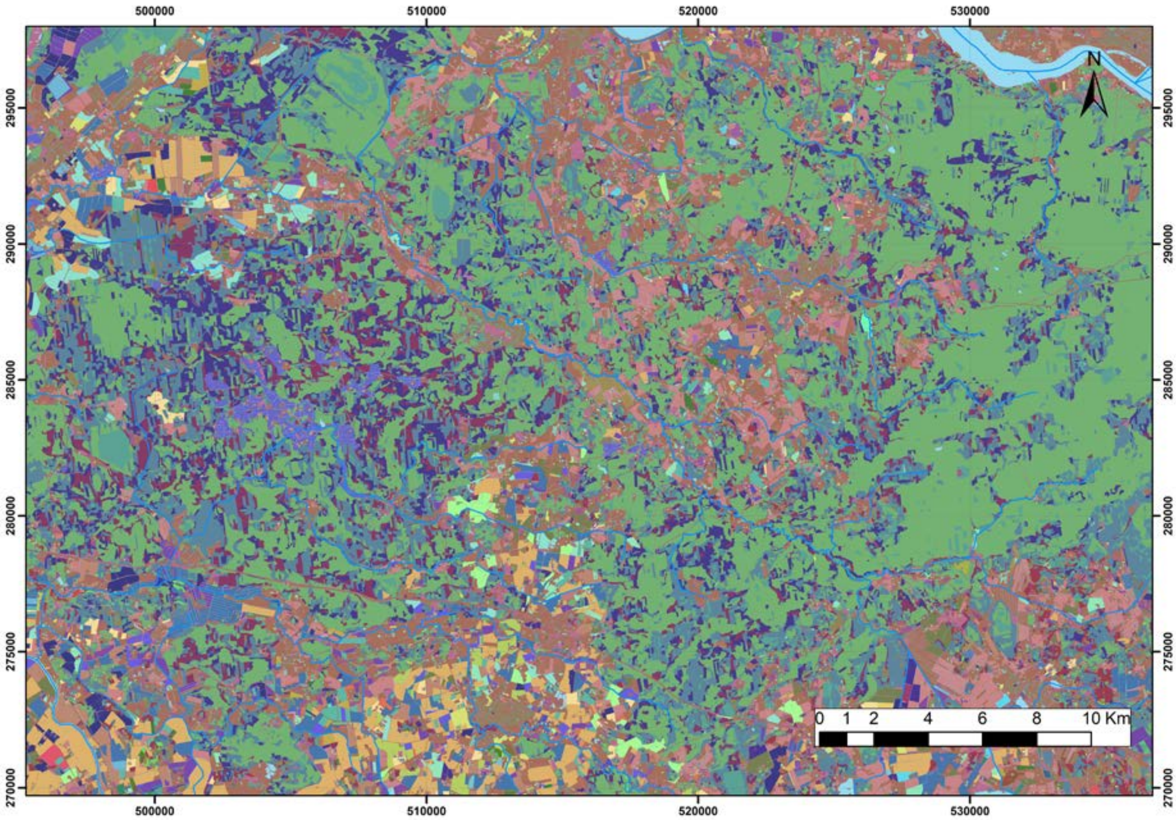

Figure 8: **Land use classes (zoom) as synthesized from all data sources.**

The land use classes (agricultural, forest, wetlands, urban, roads etc) were synthesized for full coverage of territory of Latvia; further the classes were processed and divided according to land cover, e.g. forest type and crops (see also Section 1.7).

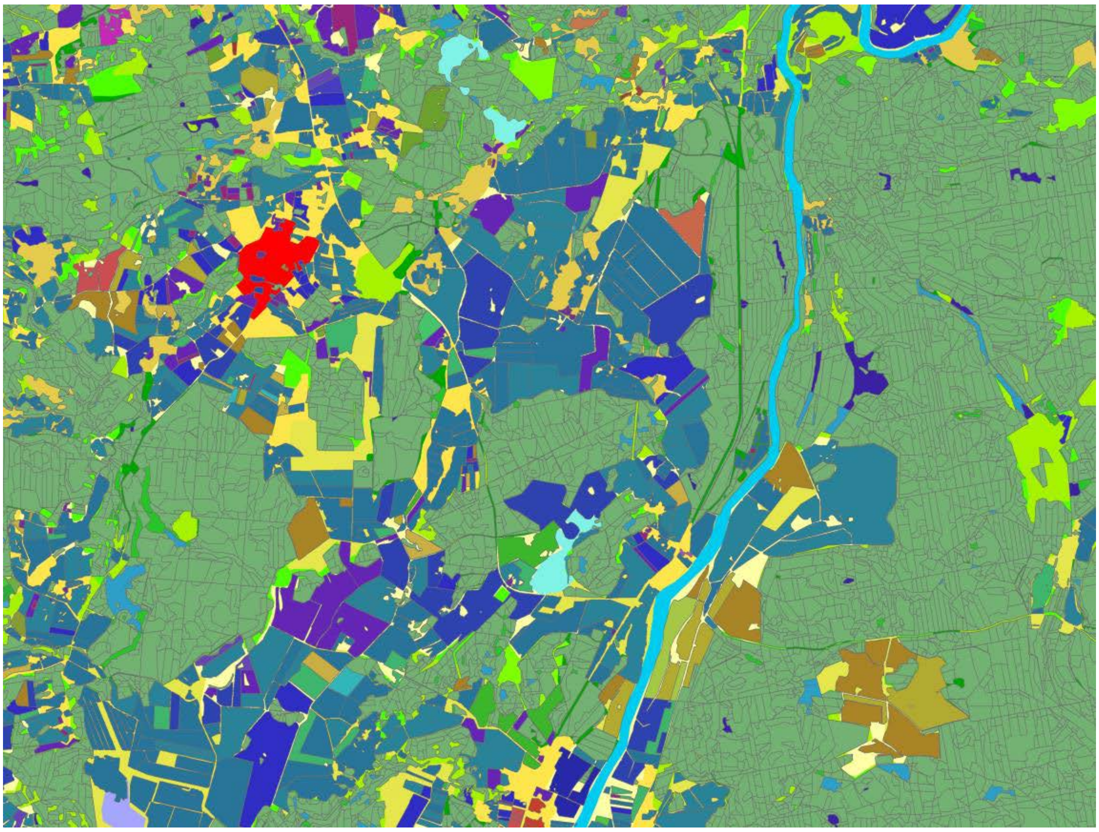

Figure 9: **Processed land cover (Venta downstream Kuldīga).**

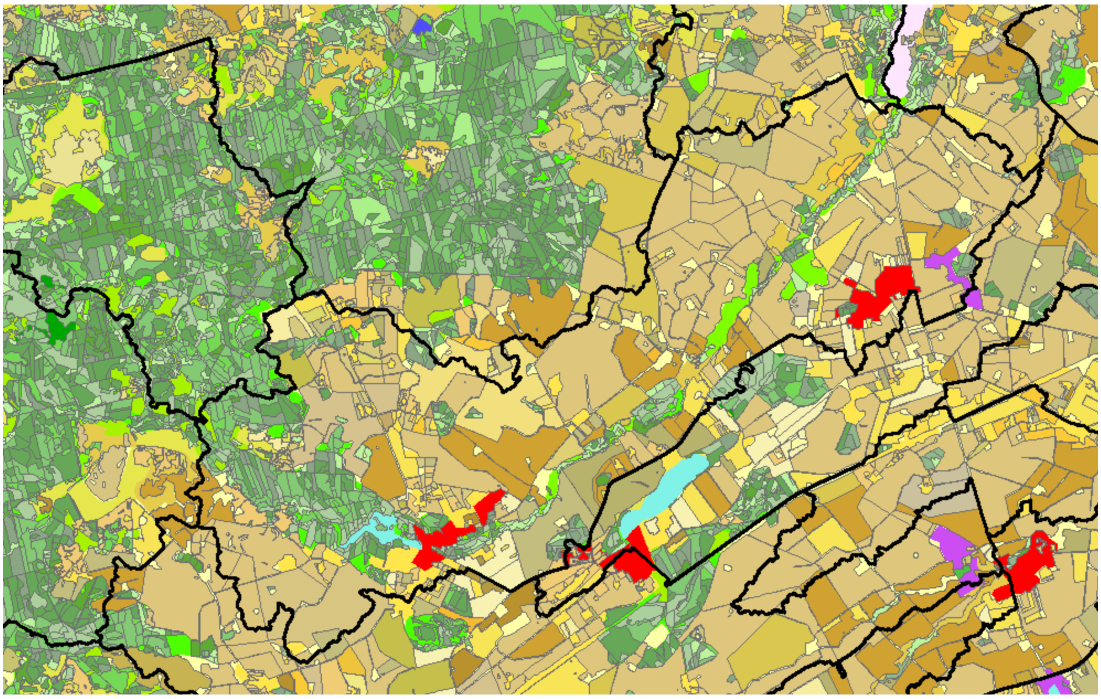

Figure 10: **Processed land use and catchments near Sesava.**

1.7. Crops

The Rural support service geospatial databases were used for distinguishing crops for Years 2015 (representative year for reference period) and 2019 (representative year for the baseline period). The following aggregation was performed:

1. 8 basic classes of agricultural land use were introduced (Table 1).
2. 18 crops were introduced having different agricultural praxis (Table 2).
3. The geospatial subdivision of agricultural land was performed assigning crops from Table 2 to respective elements of agricultural land. Minor crops with the same IDC were substituted by leading crops from Table 2.

Table 1. **Land cover/plant classification (IDC).**

IDC	Description
1	Warm season annual legume
2	Cold season annual legume
3	Perennial legume
4	Warm season annual
5	Cold season annual
6	Perennial
7	Trees/orchard
8	Fallow

Table 2. **List of model crops (plants).**

SWAT CODE	Crop (plant)	IDC	Land use class
GRBN	Grey beans	1	Agricultural
LMIX	Red clover	2	Agricultural
ALPHA	Lucerna	3	Agricultural
BARL	Barley	4	Agricultural
BWHT	Buckwheat	4	Agricultural
CRRT	Vegetables	4	Agricultural
CSIL	Corn	4	Agricultural
OATS	Oats	4	Agricultural
POTA	Potatous	4	Agricultural
SCAN	Summer rape	4	Agricultural
SWHT	Summer wheat	4	Agricultural
CANA	Winter rape	5	Agricultural
RYE	Rye	5	Agricultural
WWHT	Winter wheat	5	Agricultural
BROS	Perrenial grasslands	6	Pasture
WPAS	Mixed grass	6	Pasture
ORCD	Orchards	7	Forest
CLVR	Clover	8	Pasture

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1.8. Point pollution sources

Reported data from around 3500 point source polluters (incl their annual discharge) was acquired from the LEGMC database.

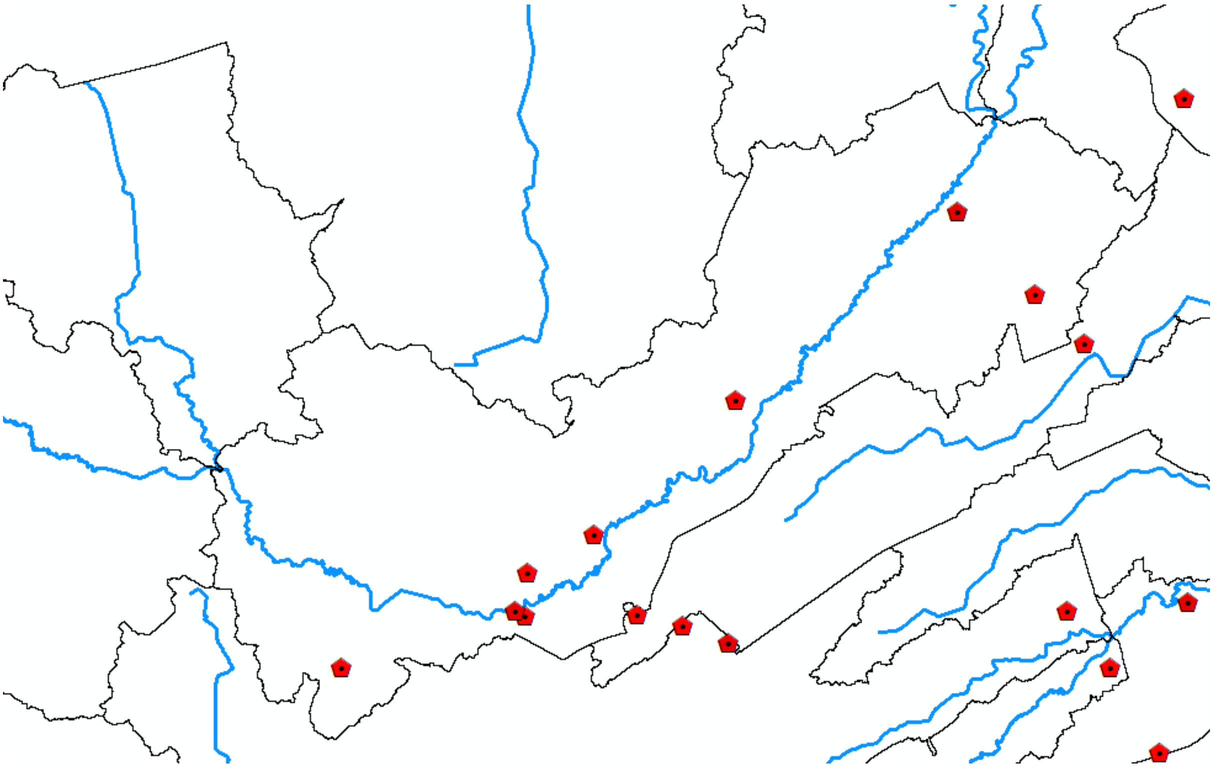

Figure 11: **Processed land use and catchments near Sesava.**

1.9. Other geospatial data

Data from Melioration cadaster which contains detailed information of drainage system for the whole territory of Latvia was integrated in the data model.

Digital maps of surface draining system (ditches, culverts) from the topographic maps of LGIA was used for the delineation of the catchments.

The information about dam location and dam parameters (width, height) from LEGMC were integrated in the data model.

The information about livestock facilities (farms) was obtained from Rural Support service dataset, including the number of standard animals in the facility.

2. Non-geospatial data

2.1. Plant parameters and agricultural praxis

The plant growth parameters were adapted according to Latvian conditions and agricultural praxis for each of the plants defined in Section 1.8 were prepared in cooperation with Latvian University of Agriculture and Latvian Farmers Association. Plant parameters and agricultural operations are summarized further in Tables 4- (so called plant passports). In these Tables:

LU class – land use class

IDC – Land cover/plant classification (taken from SWAT 2012 documentation, p.188)

Base T – Base temperature

Method – Required mineral fertilizer calculation method. Method 1 takes into account soil parameters, manure (livestock amount) and regional statistics for yield. Method 2 makes adjustment only based on manure.

N demand – Mineral Nitrogen demand for standard yield, kg/ha.

P demand – Mineral Phosphorus demand for standard yield, kg/ha.

Table 3. **Meaning of field VALUE**

Operation	Meaning of parameter VALUE
T	type of tillage (for example, ploughing or stubble breaking)
P	amount of PHU required for plant growth
H	-
Phos	fraction of total required mineral Phosphorus amount to be applied
Nitr	fraction of total required mineral Nitrogen amount to be applied
Manure	fraction of total manure amount to be applied
Mowing	-

Management description:

OPNPK – management operation order number

OPTYPE – operation type

- T – tillage operation;
- P – planting operation;
- H – harvest operation;
- Phos – Mineral Phosphorus application;
- Nitr – Mineral Nitrogen application;
- Manure – Manure application;
- Mowing – Mowing, is applied only on pastures.
- Cfert – Continuous fertilization of Nitrogen, used only for WPAS and continued for 90 days

HU – fraction of HU or PHU units when operation is carried out. For operation done after planting till harvest fraction of PHU is used. For period when plant is not planted – fraction of yearly HU.

VALUE – parameter, meaning of which depends on operation, see Table 3.

Table 4: **Management practice and parameters for ALFA**

SWAT code		ALFA		
Plant name		Lucerna		
LU class		Agricultural		
IDC		3		
Base T		4		
Method		1		
N Demand (int)		30		
N Demand (ext)		0		
P Demand		30		
OPNPK	**OPTYPE**	**HU**	**VALUE**	**VALUE_S**
1	T	0.17	4.00	
2	Phos	0.17	1.00	
3	Manure	0.17	0.65	
4	P	0.18	1 441.32	
5	Mowing	0.18		
6	Mowing	0.65		
7	H	1.10		
8	T	0.01	3.00	
9	Manure	0.02	0.35	

Table 5: **Management practice and parameters for BARL**

SWAT code		BARL		
Plant name		Vasaras mieži		
LU class		Agricultural		
IDC		4		
Base T		0		
Method		1		
N Demand (int)		95		
N Demand (ext)		25		
P Demand		42		
OPNPK	**OPTYPE**	**HU**	**VALUE**	**VALUE_S**
1	T	0.05	4.00	
2	Phos	0.05	1.00	
3	Nitr	0.05	0.50	
4	Manure	0.05	0.65	
5	P	0.05	1 736.25	
6	Nitr	0.16	0.50	
7	H	1.00		
8	T	0.01	1.00	
9	T	0.09	2.00	
10	Manure	0.09	0.35	

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Table 6: **Management practise and parameters for BWHT**

SWAT code		BWHT		
Plant name		Griķi		
LU class		Agricultural		
IDC		4		
Base T		4		
Method		2		
N Demand (int)		42		
N Demand (ext)		0		
P Demand		16		
OPNPK	**OPTYPE**	**HU**	**VALUE**	**VALUE_S**
1	T	0.17	4.00	
2	Phos	0.17	1.00	
3	Nitr	0.17	1.00	
4	Manure	0.17	0.65	
5	P	0.18	884.38	
6	H	1.10		
7	T	0.01	1.00	
8	T	0.09	2.00	
9	Manure	0.09	0.35	

Table 7: **Management practise and parameters for CRRT**

code		CRRT		
Plant name		Dārzeņi		
LU class		Agricultural		
IDC		4		
Base T		7		
Method		1		
N Demand (int)		80		
N Demand (ext)		25		
P Demand		30		
OPNPK	**OPTYPE**	**HU**	**VALUE**	**VALUE_S**
1	Nitr	0.09	1.00	
2	Manure	0.09	0.65	
3	Phos	0.09	1.00	
4	P	0.10	686.12	
5	H	1.10		
6	T	0.01	3.00	
7	Manure	0.10	0.35	

Table 8: **Management practise and parameters for CSIL**

SWAT code		CSIL		
Plant name		Kukurūza		
LU class		Agricultural		
IDC		4		
Base T		8		
Method		1		
N Demand (int)		120		
N Demand (ext)		0		
P Demand		64		
OPNPK	**OPTYPE**	**HU**	**VALUE**	**VALUE_S**
1	T	0.12	4.00	
2	Phos	0.12	1.00	
3	Nitr	0.12	0.70	
4	Manure	0.12	0.65	
5	P	0.12	529.55	
6	Nitr	0.23	0.30	
7	H	1.20		
8	T	0.01	1.00	
9	T	0.10	2.00	
10	Manure	0.10	0.35	

Table 9: **Management practise and parameters for GRBN**

SWAT code		GRBN		
Plant name		Lauka pupas		
LU class		Agricultural		
IDC		1		
Base T		8		
Method		2		
N Demand (int)		30		
N Demand (ext)		0		
P Demand		30		
OPNPK	**OPTYPE**	**HU**	**VALUE**	**VALUE_S**
1	Phos	0.04	1.00	
2	Manure	0.04	0.65	
3	P	0.04	593.41	
4	H	1.20		
5	T	0.01	3.00	
6	Manure	0.10	0.35	

Table 10: **Management practise and parameters for LMIX**

SWAT code		LMIX		
Plant name		Sarkanais āboliņš		
LU class		Agricultural		
IDC		2		
Base T		4		
Method		2		
N Demand (int)		30		
N Demand (ext)		0		
P Demand		30		
OPNPK	**OPTYPE**	**HU**	**VALUE**	**VALUE_S**
1	Phos	0.17	1.00	
2	Manure	0.17	0.65	
3	P	0.18	977.37	
4	H	1.10		
5	T	0.01	3.00	
6	Manure	0.08	0.35	

Table 11: **Management practise and parameters for OATS**

SWAT code		OATS		
Plant name		Auzas		
LU class		Agricultural		
IDC		4		
Base T		0		
Method		1		
N Demand (int)		75		
N Demand (ext)		25		
P Demand		32		
OPNPK	**OPTYPE**	**HU**	**VALUE**	**VALUE_S**
1	T	0.05	4.00	
2	Phos	0.05	1.00	
3	Nitr	0.05	0.50	
4	Manure	0.05	0.65	
5	P	0.05	1 578.41	

6	Nitr	0.17	0.50
7	H	1.10	
8	T	0.01	1.00
9	T	0.09	2.00
10	Manure	0.09	0.35

Table 12: **Management practise and parameters for POTA**

SWAT code		POTA		
Plant name		Kartupeļi		
LU class		Agricultural		
IDC		4		
Base T		7		
Method		1		
N Demand (int)		80		
N Demand (ext)		25		
P Demand		30		
OPNPK	**OPTYPE**	**HU**	**VALUE**	**VALUE_S**
1	Phos	0.09	1.00	
2	Nitr	0.09	1.00	
3	Manure	0.09	0.65	
4	P	0.09	1 003.54	
5	H	1.10		
6	T	0.01	3.00	
7	Manure	0.07	0.35	

Table 13: **Management practise and parameters for SCAN**

SWAT code		SCAN		
Plant name		Vasaras rapsis		
LU class		Agricultural		
IDC		4		
Base T		0		
Method		1		
N Demand (int)		150		
N Demand (ext)		50		
P Demand		70		
OPNPK	**OPTYPE**	**HU**	**VALUE**	**VALUE_S**
1	T	0.05	4.00	
2	Phos	0.05	1.00	
3	Nitr	0.05	0.50	
4	Manure	0.05	0.65	
5	P	0.06	1 567.53	
6	Nitr	0.16	0.50	
7	H	1.10		
8	T	0.01	1.00	
9	T	0.08	2.00	
10	Manure	0.08	0.35	

Table 14: **Management practise and parameters for SWHT**

SWAT code		SWHT		
Plant name		Vasaras kvieši		
LU class		Agricultural		
IDC		4		
Base T		0		
Method		1		
N Demand (int)		95		
N Demand (ext)		25		
P Demand		41		
OPNPK	**OPTYPE**	**HU**	**VALUE**	**VALUE_S**
1	T	0.05	4.00	
2	Phos	0.05	1.00	
3	Nitr	0.05	0.50	
4	Manure	0.05	0.65	
5	P	0.05	1 581.62	
6	Nitr	0.17	0.50	
7	H	1.10		
8	T	0.01	1.00	
9	T	0.08	2.00	
10	Manure	0.08	0.35	

Table 15: **Management practise and parameters for CANA**

SWAT code		CANA		
Plant name		Ziemas rapsis		
LU class		Agricultural		
IDC		5		
Base T		4		
Method		1		
N Demand (int)		110		
N Demand (ext)		75		
P Demand		60		
OPNPK	**OPTYPE**	**HU**	**VALUE**	**VALUE_S**
1	Nitr	0.49	0.60	
2	Nitr	0.51	0.30	
3	H	1.10		
4	T	0.01	1.00	
5	T	0.06	4.00	
6	Phos	0.06	1.00	
7	Nitr	0.06	0.10	
8	Manure	0.06	1.00	
9	T	0.02	2.00	
10	P	0.07	1 772.81	

Table 16: **Management practise and parameters for RYE**

SWAT code		RYE		
Plant name		Rudzi		
LU class		Agricultural		
IDC		5		
Base T		0		
Method		1		
N Demand (int)		100		
N Demand (ext)		25		
P Demand		50		
OPNPK	**OPTYPE**	**HU**	**VALUE**	**VALUE_S**
1	Nitr	0.34	0.50	
2	Nitr	0.55	0.25	
3	Nitr	0.67	0.25	
4	H	1.10		
5	T	0.01	1.00	
6	T	0.10	2.00	
7	T	0.21	4.00	
8	Phos	0.21	1.00	
9	Manure	0.21	1.00	
10	P	0.22	1 437.22	

Table 17: **Management practise and parameters for WWHT**

SWAT code		WWHT		
Plant name		Ziemas kvieši		
LU class		Agricultural		
IDC		5		
Base T		6		
Method		1		
N Demand (int)		110		
N Demand (ext)		50		
P Demand		40		
OPNPK	**OPTYPE**	**HU**	**VALUE**	**VALUE_S**
1	Nitr	0.27	0.50	
2	Nitr	0.45	0.25	
3	Nitr	0.57	0.25	
4	H	1.10		
5	T	0.01	1.00	
6	T	0.09	2.00	
7	T	0.20	3.00	
8	Phos	0.20	1.00	
9	Manure	0.20	1.00	
10	P	0.21	1 118.51	

Table 18: **Management practise and parameters for BROS**

SWAT code		BROS		
Plant name		Ilggadīgie zālāji		
LU class		Pasture		
IDC		6		
Base T		8		
Method		2		
N Demand (int)		0		
N Demand (ext)		0		
P Demand		0		
OPNPK	**OPTYPE**	**HU**	**VALUE**	**VALUE_S**
1	Mowing	0.30		

Table 19: **Management practise and parameters for WPAS**

SWAT code		WPAS		
Plant name		Aramzemē sētu stiebrz. vai lopb. zālaugu mais.		
LU class		Pasture		
IDC		6		
Base T		0		
Method		2		
N Demand (int)		50		
N Demand (ext)		0		
P Demand		0		
OPNPK	**OPTYPE**	**HU**	**VALUE**	**VALUE_S**
1	Manure	0.06	0.65	
2	Mowing	0.37		
3	Mowing	0.70		
4	Manure	0.80	0.35	

Table 20: **Management practise and parameters for CLVR**

SWAT code		CLVR		
Plant name		Papuve		
LU class		Pasture		
IDC		2		
Base T		1		
Method		2		
N Demand (int)		0		
N Demand (ext)		0		
P Demand		30		
OPNPK	**OPTYPE**	**HU**	**VALUE**	**VALUE_S**
1	Manure	0.06	0.65	
2	Mowing	0.36		
3	Mowing	0.71		
4	Manure	0.80	0.35	

Table 21: **Management practise and parameters for ORCD**

SWAT code	ORCD
Plant name	Augļi un ogas
LU class	Forest
IDC	7
Base T	7
Method	2
N Demand (int)	0
N Demand (ext)	0
P Demand	0

2.2. Other non-geospatial parameters

The other non-geospatial parameters are the attributes of geospatial data; they were mobilized and preprocessed with the respective geospatial data.

- Soil parameters
- Land use parameters
- Parameters of streams, reservoirs and lakes
- Parameters of livestock facilities and point sources

3. Hydrometeorological, hydrological and water quality data

3.1. Meteorological data

Meteorological observations by LEGMC were extracted as daily values in 23 meteorological stations (green points in Figure 12) for the reference time period of 2006 to 2018, with the following parameters:

- T - Air temperature, °C – daily average (see example in Figure 13)
- TMN - Air temperature, °C – daily minimum (see example in Figure 13)
- TMX - Air temperature, °C – daily maximum (see example in Figure 13)
- PR - Precipitation, mm, daily accumulated
- RH – Relative humidity, % - daily average
- WS – Wind speed, m/s – daily average
- SR – Solar radiation, w/m² - daily accumulated (see example in Figure 14).

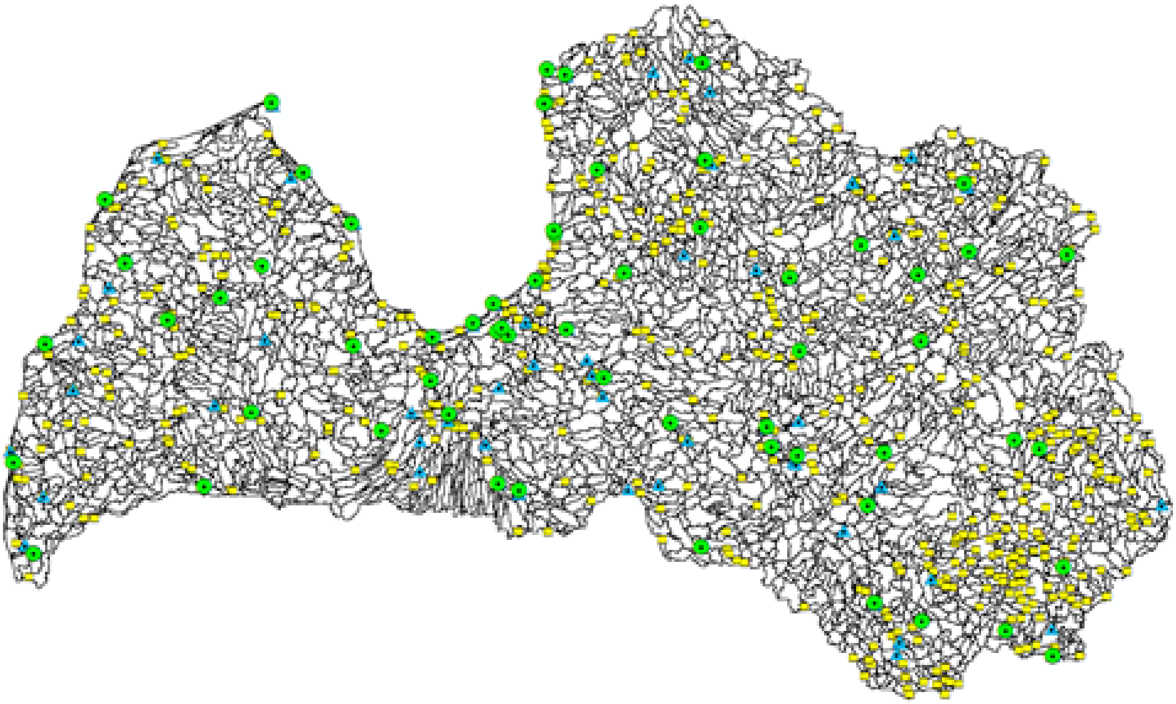

Figure 12: **Location of the observation stations.**

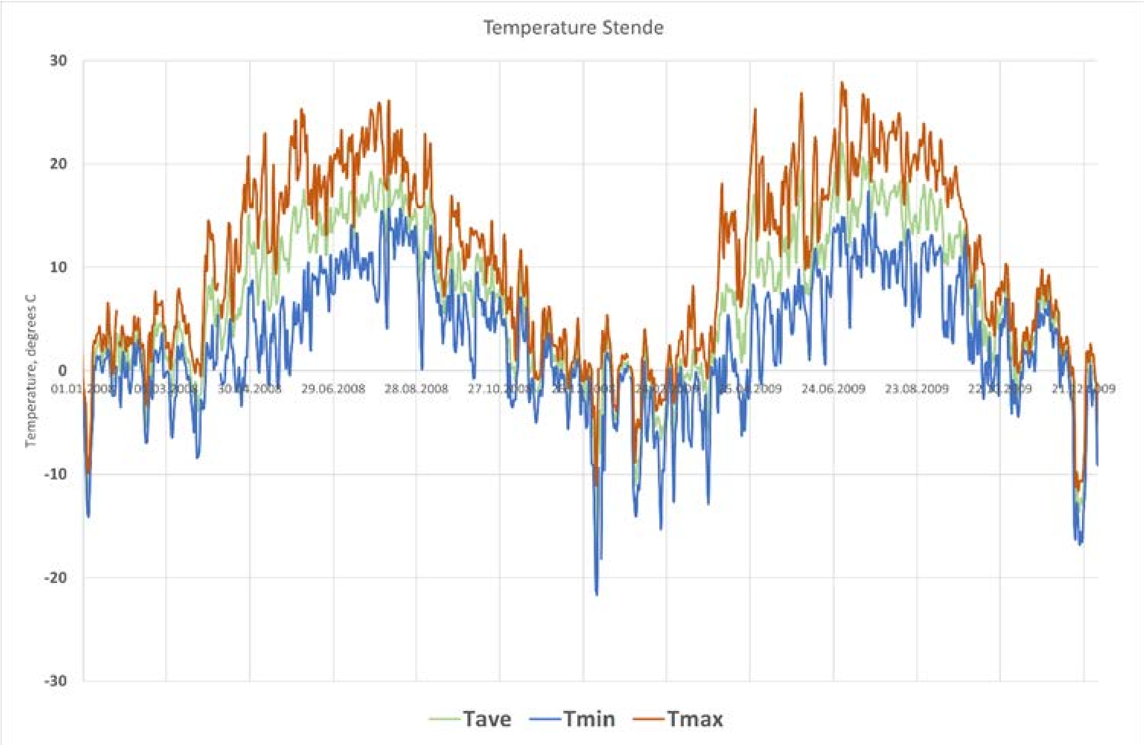

Figure 13: **Parameters T, TMN, TMX for 2 year period in Stende.**

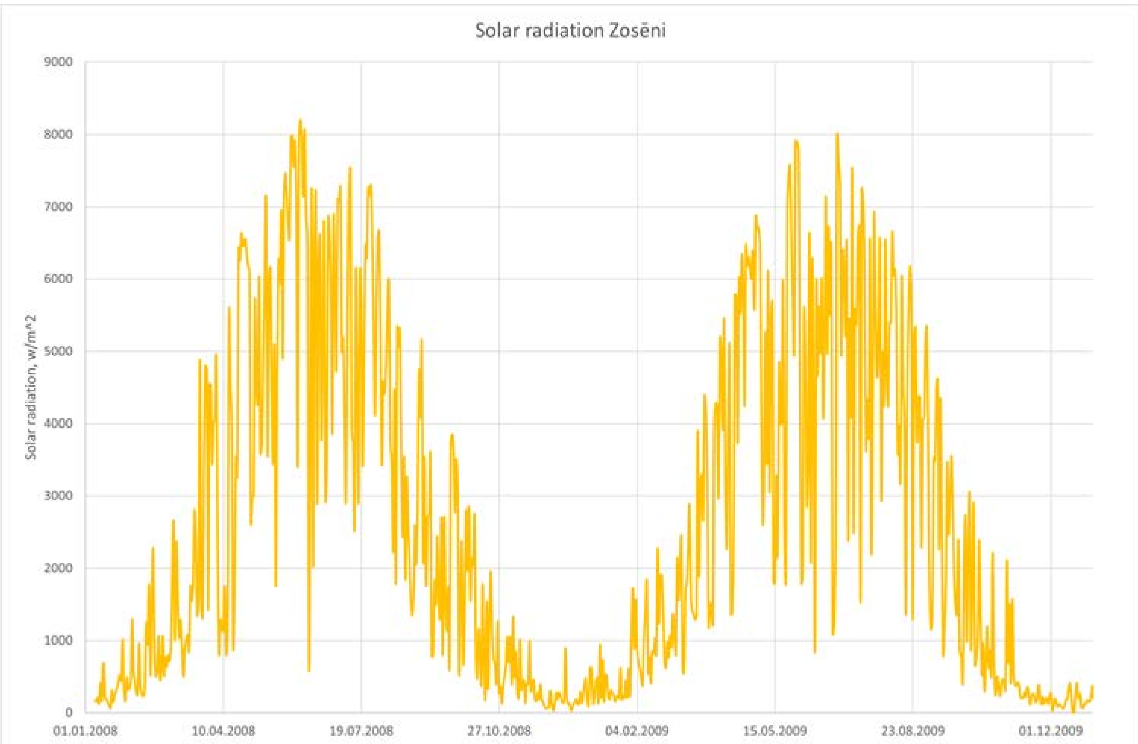

Figure 14: **Parameter SR for 2 year period in Zosēni.**

Future climate projections were obtained as gridded data from LEGMC study, see also Avotniece et al (2017): Avotniece, Z., Aniskevich, S., Malinovskis, E., 2017. Climate change scenarios for Latvia. Latvian Environment, Geology and Meteorology Centre. Report summary. Available at: http://www2.meteo.lv/klimatariks/summary.pdf.

Atmospheric nitrogen deposition data was collected from "EMEP: Co-operative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe" website www.emep.int.

3.2. Water quantity data

Hydrological observations by LEGMC were extracted as daily values in hydrological monitoring stations (blue points in Figure 12) for the reference time period of 2006 to 2018: water level (70 stations) and discharge (48 stations), see example in Figure 15.

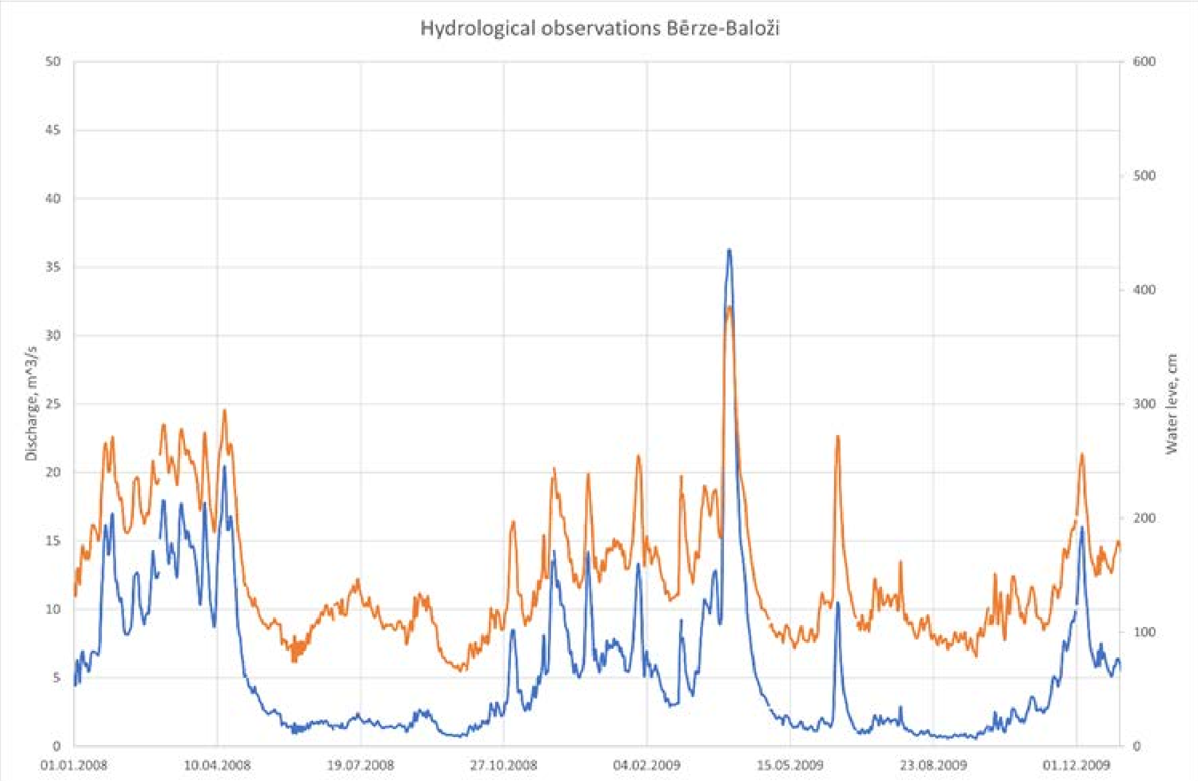

Figure 15: **Waterlevel and discharge for 2 year period at hydrological station Bērze-Baloži.**

3.3. Water quality data

Water quality observations by LEGMC were extracted as daily values in water quality monitoring stations (yellow points in Figure 12) for the reference time period of 2006 to 2018. The scope of data for model calibration and verification contains observations of water quality from 500 measurement points (around 10000 measurements). Measured substances include nitrogen and phosphorus and their forms, and suspended soils see examples in Figures 16-17.

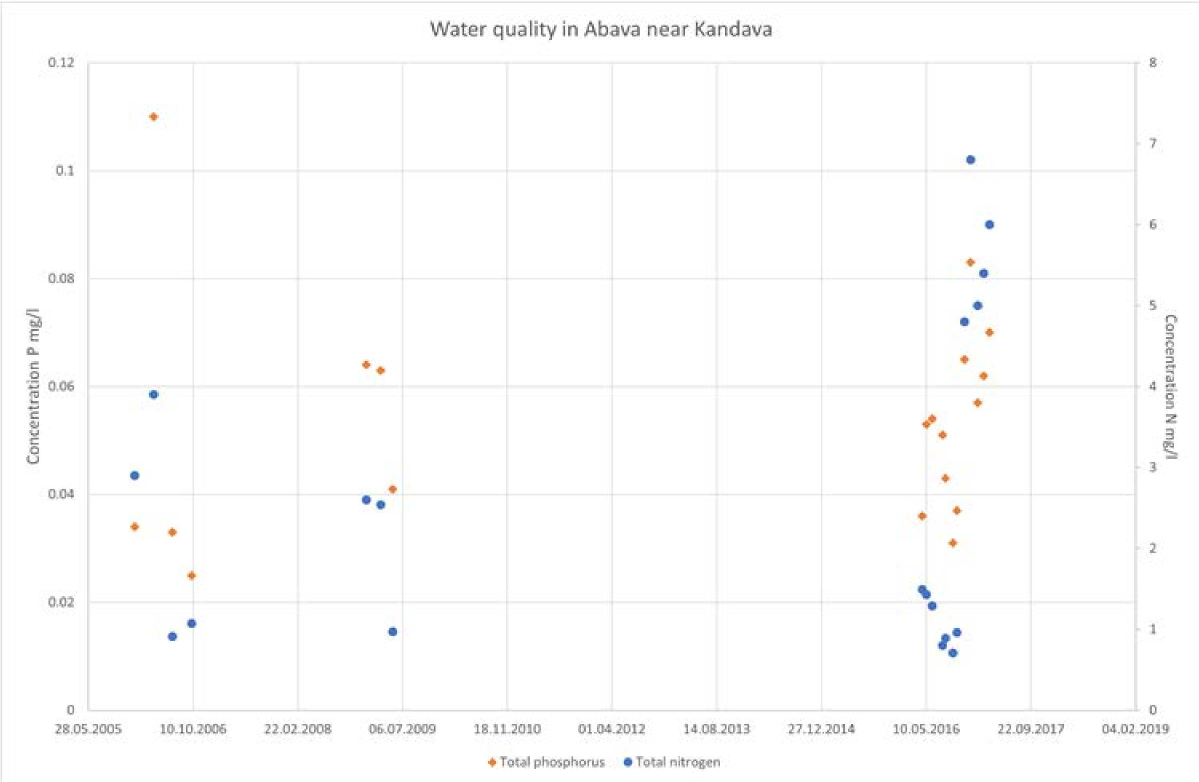

Figure 16: **Total N and P observations for 13 year period at Abava-Kandava.**

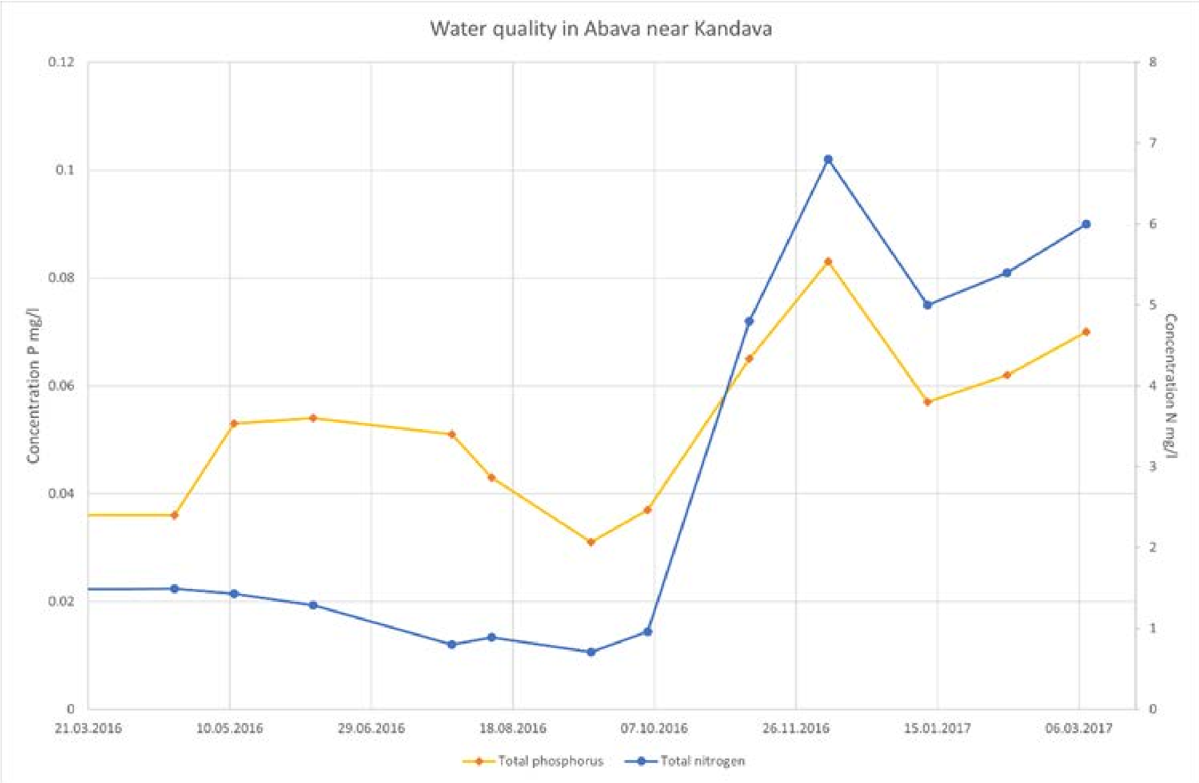

Figure 17: **Total N and P observations for 1 year period at Abava-Kandava.**