PROLINE-CE

WORKPACKAGE T1, ACTIVITY T1.1

PEER REVIEW OF LAND USE AND WATER MANAGEMENT PRACTICES

D.T1.1.1 Country Reports About the Implementation of Sustainable Land Use in Drinking Water Recharge Areas

SLOVENIA

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1. Introduction

This report is about the Status quo reports for Slovenia about legislation regarding water management and actual land use activities and their relation to water management with evaluation of gaps and SWOT analysis.

2. Water supply resources, protection and management policy on national and regional level

2.1. Water management

- Which water resources (groundwater, surface water-lakes, reservoirs…) are used for water supply and in which rate?

In Slovenia groundwater (97 %) and surface water (3%) is used for water supply. More precise distribution of drinking water is shown in Figure 1.

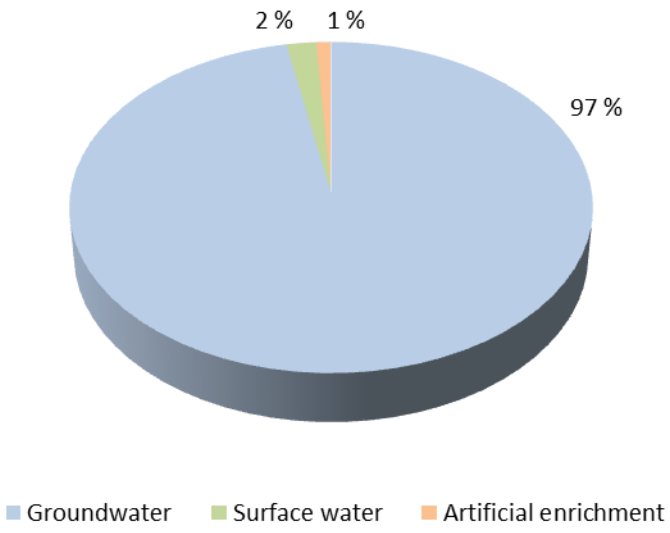


Figure 1: The percentage of abstracted water quantities in the public water supply system in 2014 (SURS, 2014a)

- For which purpose is this water used?

This water is used for drinking water supply for households and some industries – those, which do not have own water supply. Figure 2 presents percentages of different water uses for all granted water rights for water abstraction (surface and groundwater) in Slovenia.

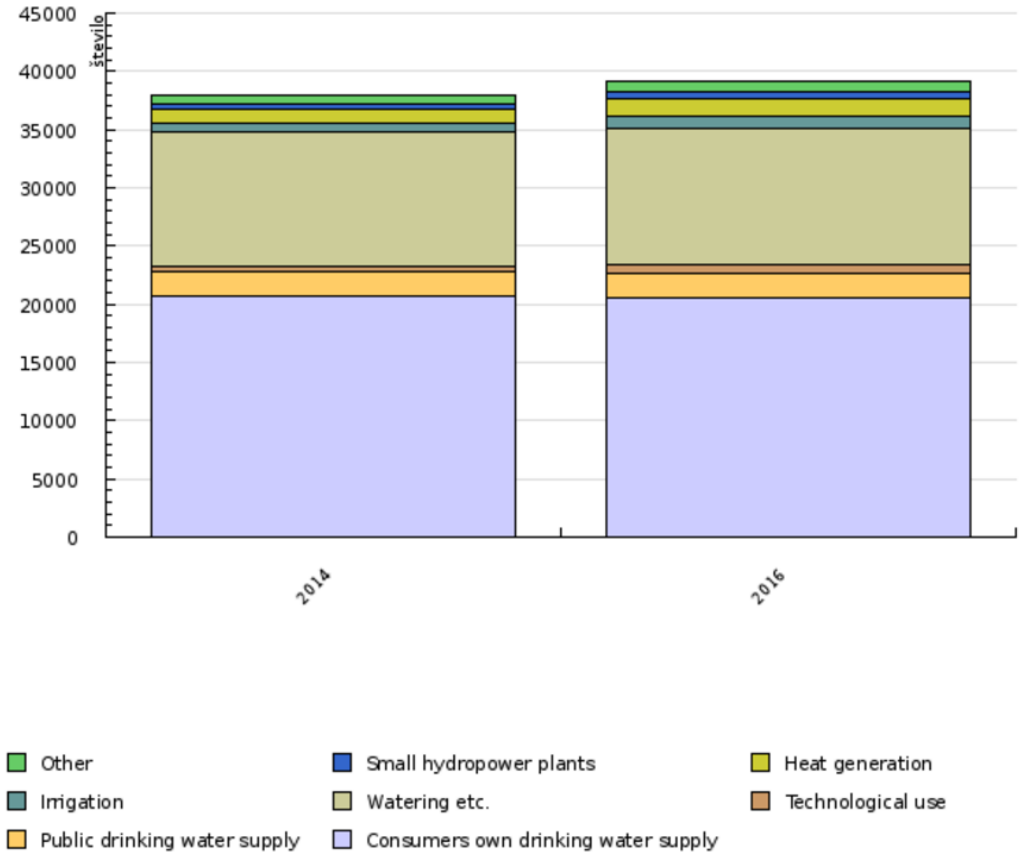


Figure 2: The number of licences granting a right to use water from water intake (water permits and concessions) by type of use (ARSO, 2016)

Table 1: Water consumption without losses from the public water supply in Slovenia

	2013	2014
	m^3 (1.000)	
Total	118.327	117.205
hauseholds	78.558	78.606
activities of business entities	33.033	32.096
delivered uncharged water	6.736	6.503

- Who controls and manages water policy?

Water policy is controled till 2015 by the Slovenian Water Agency and after 1.1.2016 by Slovenian Water Agency, both are bodies of the Ministry of the Environment and Spatial Planning.

- Who controls and manages drinking water policy?

Drinking water policy is controled and managed by the Slovenian Water Agency, which is a body of the Ministry of the Environment and Spatial Planning and by the Ministry of Health of the Republic of Slovenia.

- The legal and administrative organization of water policy?

The Ministry of the Environment and Spatial Planning is responsible for the legal and administrative organization of water policy.

- The legal and administrative organization of drinking water policy?

The Slovenian Water Agency and the Ministry of Health of the Republic of Slovenia are responsible for the legal and administrative organization of drinking water policy.

- Who manage and coordinates the implementation of state policy in scope of water?

The Slovenian Water Agency manage and coordinates the implementation of state policy in scope of water.

- Please provide a list of legislation related to water management, their protection and management of floods/droughts (land use legislation/polices, Water management legislation/policies, groundwater and surface water management plans and other legislation)

General:

- Waters act (Official Gazette of the Republic of Slovenia 62/2002)

Surface waters:

- Rules on determining and classification for water bodies on surface water (Official Gazette of the Republic of Slovenia 63/2005, 26/2006, 32/2011)
- Decree on surface water status (Official Gazette of the Republic of Slovenia 14/2009, 98/2010, 96/2013, 24/2016)
- Rules on surface water status monitoring (Official Gazette of the Republic of Slovenia 10/2009)

Groundwater:

- Rules on determining water bodies of groundwater (Official Gazette of the Republic of Slovenia 63/2005)
- Decree on groundwater status (Official Gazette of the Republic of Slovenia 25/2009)
- Rules on groundwater monitoring (Official Gazette of the Republic of Slovenia 31/2009)

Drinking water:

- Rules on drinking water (Official Gazette of the Republic of Slovenia 19/2004, 35/2004, 26/2006, 92/2006, 25/2009 in 74/2015)

Drinking water protection zones:

- Rules on criteria for the designation of a water protection zone (Official Gazette of the Republic of Slovenia 64/2004, 5/2006, 58/2011, 15/2016)

Floods:

- Rules on methodology to define flood risk areas and erosion areas connected to floods and classification of plots into risk classes (Official Gazette of the Republic of Slovenia 60/2007)
- Decree on conditions and limitations for constructions and activities on flood risk areas (Official Gazette of the Republic of Slovenia 89/2008)
- Decree on establishment of flood risk management plans (Official Gazette of the Republic of Slovenia 7/2010)
- Government decision number 35500-1/2013/5 of 14th February 2013 on Areas with Potential Significant Flood Risk
- Flood Risk Management Plan – proposal December 2015

Water monitoring for determining impact of the activity or operation of the plant:

- Rules on surface water status monitoring (Official Gazette of the Republic of Slovenia 91/2013)
- Rules on groundwater status monitoring (Official Gazette of the Republic of Slovenia 53/2015)
- Decree on the emission of substances and heat when discharging waste water into waters and the public sewage system (Official Gazette of the Republic of Slovenia 64/2012, 64/2014, 98/2015)
- Decree on the emission of substances in the discharge of meteoric water from public roads (Official Gazette of the Republic of Slovenia 47/2005)

and several other decrees on the emission of substances from particular activity.

Water management plan:

- Decree on the water management plan in the Danube and Adriatic river basin districts (Official Gazette of the Republic of Slovenia 67/2016)

Procedure for Slovenian River Basin management plans is parallel with all listed legislations and the plan must be in line with them.

2.2. Drinking water protection zones

In this chapter only short answers are provided for each question. More information about drinking water protection zones delineation can be found in Appendix 1 (Žvab Rožič and Čenčur Curk 2016).

- Which are the criteria for determining water protection zones?

The surface of the water protection zone should not be smaller than the natural recharge area.

General criteria for determination of the size of inner protection areas are:

(1) The size of the protection areas is determined according to the type of surface- or ground-water body and characteristics and their recharge area and on the basis of residence (retention) time of pollutants, dilution of pollutants from the site of input to the capture or the time for action.

(2) Residence time and dilution of pollutant from the input point to the capture depends on the water velocity through the aquifer, which is determined on the basis of water inflow time estimates from any point in the recharge area to the point of capture.

(3) Time of the water inflow shall be calculated on the basis of measurements and model calculations. Time is the sum of the inflow of pollutants to the capture from the input point to the groundwater flow (travel time through the unsaturated zone) and the flow of pollutants within the groundwater (travel time in the saturated zone).

(4) The time for action is determined on the basis of estimates of time of implementation of possible intervention measures and the measures dealing with the effects of pollution before the pollutants arrive to the capture.

Methodology for detailed determination of drinking water protection zones depends on the water source type (surface water (surface water, lake) / groundwater (aquifer type: porous, fractured and karst aquifer)).

- What limitations and restrictions have been declared within the water protection zones?

Prohibitions, restrictions and protective measures for interventions in the environment depending on the protection level in the inner zones are defined for particular intervention

type: residential buildings, non-residential buildings, transport infrastructure, pipelines, communication and power lines, complex industrial facilities, other civil engineering facilities, the implementation of construction work, unpretentious facilities, simple facilities, maintenance of facilities, fertilization of agricultural land, fertilization of non-agricultural land, use of plant protection products on agricultural land. Limitations and restrictions are good practices and are therefore explained in the report T.1.2.1.

- Who controls and manages legal acts for determination of drinking water protection zones?

Ministry of the Environment and Spatial Planning controls and manages legal acts for determination of DWPZ.

- What is the procedure of drinking water protection zones implementation?

Expert grounds for delineation of drinking water protection zones are prepared by water experts (mainly from the Geological Survey of Slovenia). Ministry of the Environment and Spatial Planning prepares a DWPZ draft ordinance, which is forwarded to all the mayors of municipalities in the area where the water protection zone applies. Based on the comments, the entire material with all annexes is prepared and goes to public hearing. At the same time all the material is forwarded in interdepartmental coordination to all the ministries and to the Government of the Republic of Slovenia. Then the comments from the public hearing are coordinated. The procedure is adopted by the Government of the Republic of Slovenia with issuing a Decree for a particular drinking water source.

DWPZs are designed based on the field investigations and desk studies. How DPWZ are transferred to the space and how are DWPZ considered in the spatial planning procedures?

a. Who are parties with whom DPWZ are discussed (e.g. local communities, water managers, land owners, any other party)?

DPWZ are discussed with municialities and all involved parties.

b. Are borders of DWPZ negotiated and agreed?

DWPZ borders are agreed.

c. Are interdictions, limitations and measures negotiated?

Interdictions, limitations and measures are not negotiated. They are defined in the Decree on the water protection area for particular drinking water source.

d. Are there any coordination during this process?

Yes. As it is decribed in the answer about procedure.

e. To what extent should boundaries of DWPZ, which were proposed based on investigations, be accepted (or can they be changed to some extent after their proposal) and what is the procedure for accepting proposed DWPZ?

Agreed DWPZ are proposed by experts and can be changed only in very small extent in the proceedure of the decree acceptance.

f. How are DWPZ borders are considered in the space and in the spatial planning process?

DWPZ are presented as protected area with their limitations regarding spatial planning. Prohibitions, restrictions and protective measures are declared in particular ordinance for particular drinking water source.

g. Are borders of DWPZ drawn so that they are following land plot (cadastral / parcel) borders?

Borders are mostly following cadastral / parcel borders, but it is not necessary (e.g. in case of large parcels).

h. Are borders of DWPZ drawn so that only design criteria are considered, no matter what are the ownership relationships in space?

DWPZ are designed that natural criteria are considered. There are some exeptions in cities, e.g. Ljubljana, where industrial zones already exist and inner DWPZ is divided into two subzones with different limitations.

i. Is the list of plots (cadastral parcels) positioned on the DWPZ prepared and is it publicly available or even published in the official documents?

The cadastral parcels are listed in Appendix to the Ordinance. Graphical presentation of the cadastrial parcels and DWPZ are available in the on-line GIS portal of the Slovenian Environment Agency.

j. Who is exercising control over the surface of DWPZ and how?

Implementation of DWPZ ordinance is supervised by the inspectors responsible for water. Notwithstanding of this, practices on agricultural land and forest are inspected by inspectors responsile for agriculture and forestry; prohibitions and restrictions for construction of buildings perform building inspectors, prohibitions and restrictions directly on capture are inspected by health inspectors.

k. How are the breaches of the requirements defined for DWPZ penalized?

Penalties are defined in the Decree of particular drinking water source and have to be paid by the company and the responsible person of the legal entity or by idividual person.

2.3. Floods/droughts management

- In which way is the management of floods and droughts regulated in your country?

Floods

Slovenian flood management is in compliance with EU Floods Directive. Transfer of provisions of Directive 2007/60/EC is implemented within the framework of the Water Act (2002) and its amendments and the regulations thereunder. Implementing regulations summarize the main provisions for the implementation of the Directive, namely:

- Rules on methodology to define flood risk areas and erosion areas connected to floods and classification of plots into risk classes (Official Gazette of the Republic of Slovenia 60/2007), which provides for the preparation of warning maps and methodology for the determination of flood hazard and risk maps and classifying,

as well as the

- Decree on conditions and limitations for constructions and activities on flood risk areas (Official Gazette of the Republic of Slovenia 98/2008), which can be considered partly as the transfer of provisions of the Flood Directive and partly already as a measure for reducing the vulnerability of flood and erosion related to the field of spatial planning,

and a key instrument for:

- Decree on establishment of flood risk management plans (Official Gazette of the Republic of Slovenia 7/2010). On the basis of this Decree a document named Preliminary flood risk assessment (2011) was prepared and later the 61 Areas with Potential Significant Flood Risk (APSFR) (2013) were identified. Decree on establishement of flood risk management plans (Official Gazette of the Republic of Slovenia 7/2010) provides that flood hazard and

flood risk maps must be prepared for the APSFR. Next step was to prepare Flood Risk Management Plan (2015), which is key document imposed by the European regulations. At the moment there are still flood hazard and flood risk maps for some of the 61 APSFR missing and Flood Risk Management Plan is in validation.

Drought

Drought is not implemented direct in Slovenian legislation, except in Protection against Natural and Other Disasters Act (Official Gazette of the Republic of Slovenia 51/2006, 97/2010), where drought (and also flood) is considered as natural disaster.

According to the Water Framework Directive (Article 13) each country, where droughts are significant, has to prepare Drought management Plan.

Slovenian Environment Agency is very active in drought management, because it was leading the Drought Management Centre for Southeastern Europe – DMCSEE, which will now continue within new project DriDanube, Drought Risk in the Danube Region. Slovenian Environment Agency and GWP Slovenia were also in the team, which was preparing Guidelines for preparation of the Drought Management Plans - Development and implementation in the context of the EU Water Framework Directive (GWP-CEE 2015), which were issued by the Global Water Partnership Central and Eastern Europe (GWP-CEE). Slovenia prepared also Slovenian guidelines for drought management and its implementation. Drought Management Plan will be part of the Slovenian River Basin Management Plan (RBMP) 2015-2021. Measure PS3 from the Slovenian RBMP is "Preparing of the selection of indicators for the proclamation of different intensity levels and thresholds for drought". Proclamation of droughts enables determination of periods, in which intervention measures for water management are valid.

Slovenian Environment Agency publishes short-term warnings for drought (1-7 days) with information about drought indexes on its web page (e.g. temperature of air and soil in different depths, precipitation for current week, water balance for the precedent day and week) and long-term warnings for drought (10-15 days) with information about hydrological conditions in Drought monitoring Bulletin for each month.

- Do you conduct flood/drought risk assessment on national level?

Flood and drought risk assessment: Decree implementing the Decision on the Union Civil Protection Mechanism (Official Gazette of the Republic of Slovenia 62/2014) is about risk assessment for natural disasters and defines risk assessment contents and responsible agencies. Ministry of the Environment and Spatial Planning is responsible for flood and drought risk assessment on national level. Flood and drought risk assessment reports were issued in 2015. These reports had to be updated by October 2016 with outcomes from the report of the assessment of risks caused by climate change; final reports are not yet available.

Flood risk assessment has been prepared for the areas with potential significant flood risk on the national level. For other areas it is done by local communities or by private investors.

- If yes, have you designated areas for which significant risk of flooding/droughts is estimated?

Floods

Yes. There are 61 areas with potential significant flood risk identified for Slovenia.

Drought

There is a map of the risk of agricultural drought by municipalities.

- Is there a map of floods/droughts risk?

Floods

Yes. It can be seen in web GIS from the Slovenian Environment Agency (EARS 2016).

Drought

There is a map of the risk of agricultural drought by municipalities.

- Has been done an estimation of potential flood damage?

Yes. Within the preparation of expert basis for implementation Floods Directive (2007/60/EC) the task of preparation of reducing flood risk's economic plans has been carried out, which defines the assessment of the expected annual damage to APSFR and cost structure actions.

2.4. Water quality state, trends and monitoring

- Who performs monitoring of drinking water quality, which parameters are routinely observed and how frequent?

Public water companies perform monitoring of drinking water quality. Procedures associated with the extraction, storage and transport of drinking water are in accordance with quality standard SIST ISO.

Internal control of drinking water is carried out after the sampling plan, which is designed according to the principles of the HACCP. The entire system of supply is controlled in order to identify all microbiological, chemical and physical parameters, which could be a risk for human health.

Parameters and frequency of drinking water monitoring are defined in Rules on drinking water (Official Gazette of the Republic of Slovenia 19/2004, 35/2004, 26/2006, 92/2006, 25/2009 in 74/2015). Monitoring of drinking water is carried out at end-users (e.g. "on pipe" in restaurants,

kindergartens, schools), pumping wells, reservoirs, as well as random points in the distribution network after intervention works and customer complaints.

Monitoring is performed by laboratories in public water companies (only the large ones, e.g. Ljubljana water utility) and the National Laboratories of Health, Environment and Food, which have accreditation. Public Water supply is under the supervision of the Health Inspectorate of the Republic of Slovenia.

Rules on drinking water (Official Gazette of the Republic of Slovenia 19/2004, 35/2004, 26/2006, 92/2006, 25/2009 in 74/2015) determine parameters for testing. There are two types of testing: regular and periodic. Regular testing is more frequent.

Regular microbiological testing of drinking water in most of the cases includes determining the number of micro-organisms (Table 2): Escherichia coli (E. coli), coliforms and total count at 22°C and at 36°C. Where surface water is the source of drinking water or when there is impact of surface water to source of drinking water, the presence of Clostridium perfringens (with spores) has to be checked. Basic regular physical-chemical tests of drinking water include the following parameters: colour, visible impurities, odour, turbidity, pH, conductivity, total organic carbon (TOC), ammonium and nitrite.

The periodic physical-chemical investigations include a general physical and chemical parameters (smell, taste, colour, conductivity, pH, nitrate, etc.), metals and non-metals (aluminium, boron, chromium, lead, mercury, etc.), pesticides and metabolites (triazine, organophosphorus, substituted phenoxy-alkanoics, uronics, etc.), volatile aromatic hydrocarbons (benzene), volatile halogenated hydrocarbons (trihalomethane, 1,1,2-trichloroethane, etc.), polycyclic aromatic hydrocarbons (Table 3, Table 4).

Within the framework of internal conducted microbiological and physico-chemical tests are performed. The extent of testing depends on the risk assessment for a given checkpoint.

Table 2: Microbiological parameters – general requirements for drinking water

Parameter	The maximum value of the parameter (number / 100 ml)
Escherichia coli (E. coli)	0
Enterococci	0

Table 3: Chemical parameters of drinking water

Parameter	The maximum value of the parameter	Unit
Acrylamide	0.10	µg/l
Antimony	5.0	µg/l

Arsenic	10	µg/l
Cooper	2.0	mg/l
Benzene	1.0	µg/l
Benzo(a)pyrene	0.010	µg/l
Boron	1.0	mg/l
Bromate	10	µg/l
Cyanide	50	µg/l
1,2-dichloroethane	3.0	µg/l
Epichlorohydrin	0.10	µg/l
Fluoride	1.5	mg/l
Chromium	50	µg/l
Nickel	20	µg/l
Nitrate	50	mg/l
Nitrite	0.50	mg/l
Pesticides	0.10	µg/l
Pesticides - sum	0.50	µg/l
Polycyclic aromatic hydrocarbons	0.10	µg/l
Lead	10	µg/l
Selenium	10	µg/l
Tetrachlorethylene and Trichlorethylene	10	µg/l
Trihalomethanes - sum	100	µg/l
Vinyl chloride	0.50	ug/l
Mercury	1.0	µg/l

Table 4: Indicator parameters of drinking water

Parameter	The maximum value of the parameter/specification	Unit

Aluminium	200	µg/l
Ammonium	0.50	mg/l
Colour	Acceptable to consumers and no abnormal change	
Total organic carbon (TOC)	No abnormal changes	
Clostridium perfringens (including spores)	0	number/100 ml
Conductivity	2500	µS cm^{-1} at 20 °C
Chloride	250	mg/l
Coliforms	0	number/100 ml
Hydrogen ion concentration (pH)	≥6.5 and ≤9.5	units pH
Manganese	50	µg/l
Turbidity	Acceptable to consumers and no abnormal change	
Sodium	200	mg/l
Oxidising	5.0	mg O_2/l
Taste	Acceptable to consumers and no abnormal change	
Sulphate	250	mg/l
Number of colonies at 22 °C	No abnormal change	
Number of colonies at 37 °C	Less than 100	number/ml
Odour	Acceptable to consumers and no abnormal change	
Iron	200	µg/l

Minimum annual frequencies of regular and periodic testing of drinking water quality are dependent on number of inhabitants and amount of water distributed in the supply area (Table 5). If the pollution is detected the monitoring of certain parameter is more frequent.

Table 5: Minimum annual frequency of sampling and testing drinking water regarding number of habitants and amount of water distributed in the supply area

Number of inhabitants on the supply area	The amount of water distributed in the supply area m^3 / day	Number of samples for regular testing	Number of samples for periodic testing
≤500	≤100	6	Determined in the annual monitoring program
501 – 5,000	101 – 1,000	12	1
5,001 –20,000	1,001 – 4,000	24	3
20,001 – 50,000	4,001 – 10,000	36	4
50,001 – 100,000	50,001 – 20,000	72	6
> 100,000	> 20,000	120	8

- Who performs monitoring of drinking water resources (surface water, groundwater…) quality, which parameters are routinely observed and how frequent?

The same question as above. See explanation above.

- Is there systematic monitoring of quality parameter trends for drinking water and for their resources? Who performs this monitoring?

Larger water utilities monitor trends of drinking water quality parameters. Small water utilities perform only prescribed monitoring, which can be according to the Table 5 only once or twice a year.

Drinking water quality trends are monitored also by the Slovenian Environment Agency in the frame of water status monitoring according to WFD.

- Who is the user of this data?

The data is collected in the Annual Report and are public available on the public water companies websites.

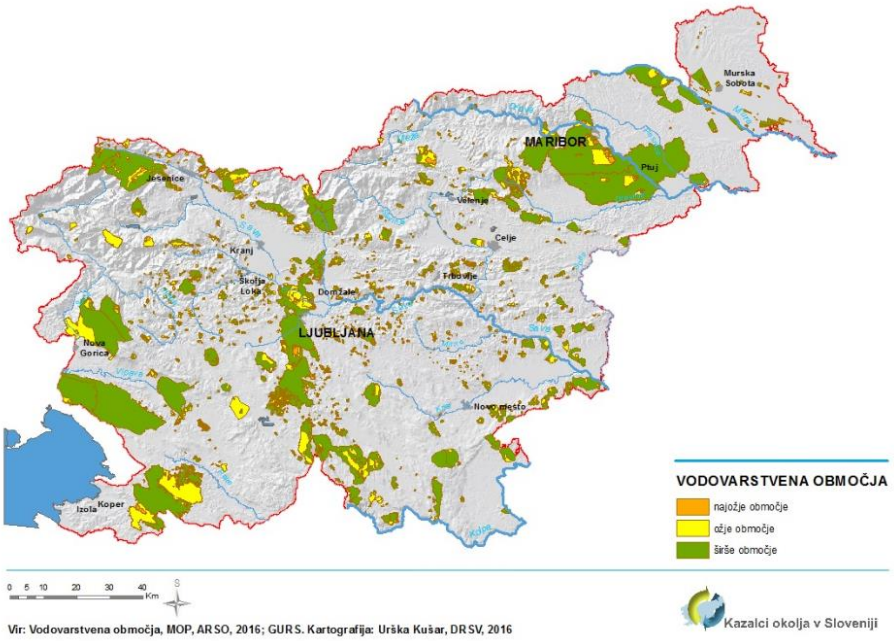
- Which is the procedure in the case of negative quality trends?

It is necessary to determine the cause of the deterioration and the remediation plan. The number of samples on the area, where the negative quality trend was detected is increased.

3. Actual land use activities

3.1. Land use map

DWPZs represents almost one fifth of the territory of Slovenia, which is around 347,000 hectares (Figure 3). The majority of areas is covered with forest (60%), 31% are agricultural areas; the other predominantly natural surfaces occupy 3% and urban areas slightly less than 6% (Figure 4). Such a ratio is very similar to the structure of land use all over Slovenia.



Vir: Vodovarstvena območja, MOP, ARSO, 2016; GURS. Kartografija: Urška Kušar, DRSV, 2016

Figure 3: Drinking water protection zones in Slovenia 2016 (ARSO, 2016a)

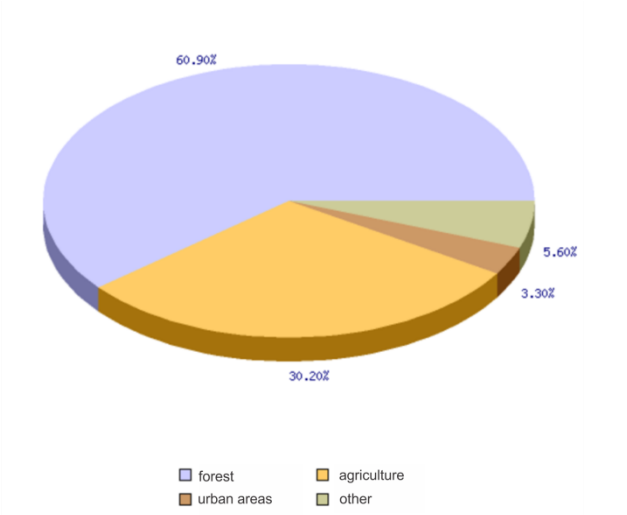


Figure 4: Land use in DWPZs in Slovenia by CLC-level1, 2016 (ARSO, 2016a)

We selected seven representative areas of drinking water protection zones (the whole recharge area) with different aquifer type (Figure 5 and Table 6). Except at Krvavec area, in all areas floods are present. Below, analyses of only these seven representative areas are presented.

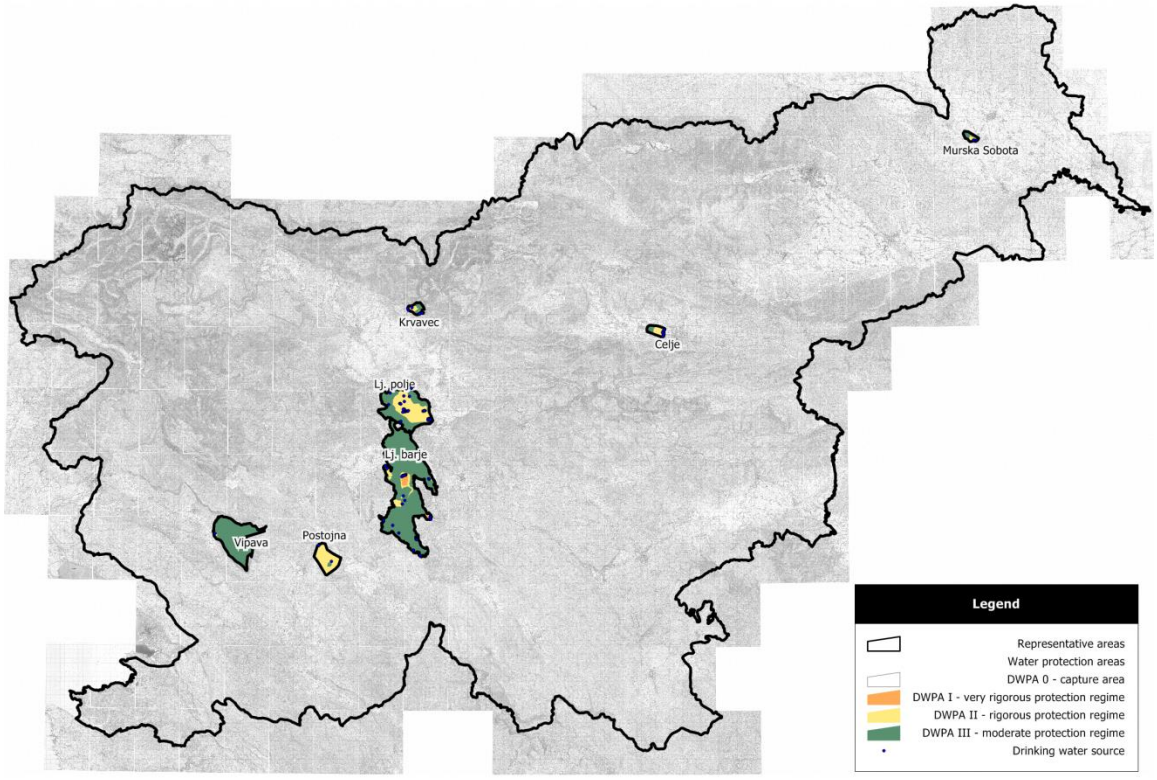


Figure 5: Selected representative areas of drinking water sources with drinking water protection zones (ARSO 2016c)

Table 6: Types of drinking water sources in seven selected representative areas

Representative area	Drinking water sources	Type of aquifer	Recharge area
Murska Sobota	Well field Krog	porous	Plain area: Mura river valley
Celje	Well field Medlog: well A, B, C, D, E, F, G	porous	Plain area: Savinja river area and surrounding hilly area
Krvavec	Ambrož pod Krvavcem, Ambrož pod Krvavcem 2, Ambrož pod Krvavcem 3, Jagošče, Krvavec, Štefanja gora-Davovec, Reka-Krvavec 2, Reka-Krvavec 3	Fractured (karst)	Mountainous area
Ljubljansko polje	Well field Hrastje (well Hrastje-1, 1a, 2, 2a, 3, 4, 5, 6, 7, 8), Well field Kleče (well Kleče-1, 2, 3, 4, 6, 7, 8a, 9, 10, 11, 12, 13, 14, 15, 16, 17), Well field Šentvid (well Šentvid-1a, 2a, 3), Well field Jarški prod (well 1, 2, 3, 4)	porous	Plain area: Sava river valley and surrounding hilly area
Postojna	Spring: Malni, Well: Rakov Škocjan RŠ-3/94	karst	Hilly/mountainous area
Vipava	Spring: Podlipa	karst	Hilly/mountainous area
Ljubljansko barje	Well field Brest (well VD-Brest 1,1a, 2, 2a, 3, 4a, 4, 5, 6, 7, 8, 9)	porous	Plain area: Ljubljanica and Iška river valley and mountainous

			valley

Land uses (CLC) in selected representative areas are depicted in

Figure 6 and listed in Table 7. Figure 7 depicts flood areas and drinking water protection zones.

Medlog well fields are in Savinja river plain area and are used for drinking water supply for the city of Celje. The most land use is agriculture (80,9 %) and the other use is artificial surfaces. In this area floods are very often and cover almost half of the area.

Recharge area of Krvavec drinking water sources (mainly springs) is mountainous area, where are mostly forests and seminatural areas (99,8 %), the rest are pastures where also ski lifts are located. There are no flooding areas.

Ljubljansko barje is a moor area and in well filed recharge area are 8,30% artificial surfaces, 39,20% agricultural areas and 52,50% forest and semi-natural areas. In this area floods can occur. The last large flood was in autumn 2010, when well field was flooded and therefore out of operation for some months.

Ljubljansko polje is alluvial plain and has four well fields, which supply drinking water to Ljubljana city, which is extending above the aquifer. In the recharge area there are 44,60% artificial surfaces, 29,60% agricultural areas and 24,20% forest and semi-natural areas; 1,50% are water courses. Flood areas are along Sava river.

Well field Krog (Murska Sobota) is very close to the Mura river and the major land uses are agriculture (44,60%) and forest and semi-natural areas (49,30%); there are 6,10% of water courses. In this area floods are very often and cover the half of the area.

Malni spring is captured for drinking water supply for Postojna municipality and the recharge area is hilly/mountainous karst area with the major land use forest and semi-natural areas (97,50%); there are also 1,40%, artificial surfaces and 1,20% agricultural areas. Floods are typical karst polje floods and can reach also the spring capture; whereas there are no floods in the recharge area.

Vipava springs In the recharge area is mountainous karst area with the major land use forest and semi-natural areas (97,00%); there are also 0,50%, artificial surfaces and 2,50% agricultural areas. River Vipava floods and can reach also the spring capture; whereas there are no floods in the recharge area.

Table 7: CLC-level 3 for each selected representative area

Representative area	CLC code	LABEL3	Surface area (km^2)	Surface area (%)
Celje	112	Discontinuous urban fabric	0,741	10,7%
	142	Sport and leisure facilities	0,585	8,4%
	211	Non-irrigated arable land	0,321	4,6%
	222	Fruit trees and berry plantations	1,546	22,3%
	231	Pastures	0,793	11,4%
	242	Complex cultivation patterns	2,96	42,6%
		Total area	6,946	
Krvavec	231	Pastures	0,009	0,1%
	311	Broad-leaved forest	2,027	33,1%
	312	Coniferous forest	0,303	4,9%
	313	Mixed forest	1,634	26,7%
	321	Natural grasslands	0,585	9,5%
	322	Moors and heathland	0,099	1,6%
	324	Transitional woodland-shrub	0,791	12,9%
	333	Sparsely vegetated areas	0,682	11,1%
		Total area	6,13	
Ljubljansko barje	112	Discontinuous urban fabric	12,655	6,9%
	121	Industrial or commercial units	0,949	0,5%
	122	Road and rail networks and associated land	0,708	0,4%
	132	Dump sites	0,802	0,4%
	142	Sport and leisure facilities	0,251	0,1%
	211	Non-irrigated arable land	5,661	3,1%
	231	Pastures	15,112	8,3%
	242	Complex cultivation patterns	42,884	23,5%
	243	Land principally occupied by agriculture, with significant areas of natural vegetation	7,778	4,3%
	311	Broad-leaved forest	15,672	8,6%
	312	Coniferous forest	28,101	15,4%
	313	Mixed forest	48,236	26,4%
	324	Transitional woodland-shrub	3,811	2,1%
		Total area	182,62	
Ljubljansko polje	111	Continuous urban fabric	0,522	0,7%
	112	Discontinuous urban fabric	22,782	30,9%
	121	Industrial or commercial units	6,643	9,0%

	122	Road and rail networks and associated land	2,122	2,9%
	131	Mineral extraction sites	0,368	0,5%
	141	Green urban areas	0,164	0,2%
	142	Sport and leisure facilities	0,291	0,4%
	211	Non-irrigated arable land	6,756	9,2%
	231	Pastures	1,134	1,5%
	242	Complex cultivation patterns	11,011	14,9%
	243	Land principally occupied by agriculture, with significant areas of natural vegetation	2,985	4,0%
	311	Broad-leaved forest	1,201	1,6%
	312	Coniferous forest	2,756	3,7%
	313	Mixed forest	13,633	18,5%
	324	Transitional woodland-shrub	0,286	0,4%
	511	Water courses	1,097	1,5%
		Total area	73,751	
Murska Sobota	211	Non-irrigated arable land	0,464	10,3%
	242	Complex cultivation patterns	1,039	23,0%
	243	Land principally occupied by agriculture, with significant areas of natural vegetation	0,513	11,3%
	311	Broad-leaved forest	2,232	49,3%
	511	Water courses	0,278	6,1%
		Total area	4,526	
Postojna	122	Road and rail networks and associated land	0,315	1,4%
	231	Pastures	0,171	0,8%
	242	Complex cultivation patterns	0,081	0,4%
	311	Broad-leaved forest	1,813	8,1%
	312	Coniferous forest	7,872	35,0%
	313	Mixed forest	12,214	54,4%
		Total area	22,466	
Vipava	112	Discontinuous urban fabric	0,302	0,5%
	242	Complex cultivation patterns	0,997	1,6%
	243	Land principally occupied by agriculture, with significant areas of natural vegetation	0,56	0,9%
	311	Broad-leaved forest	19,286	31,4%
	312	Coniferous forest	13,147	21,4%
	313	Mixed forest	21,559	35,1%
	321	Natural grasslands	3,372	5,5%
	324	Transitional woodland-shrub	2,194	3,6%
		Total area	61,417	

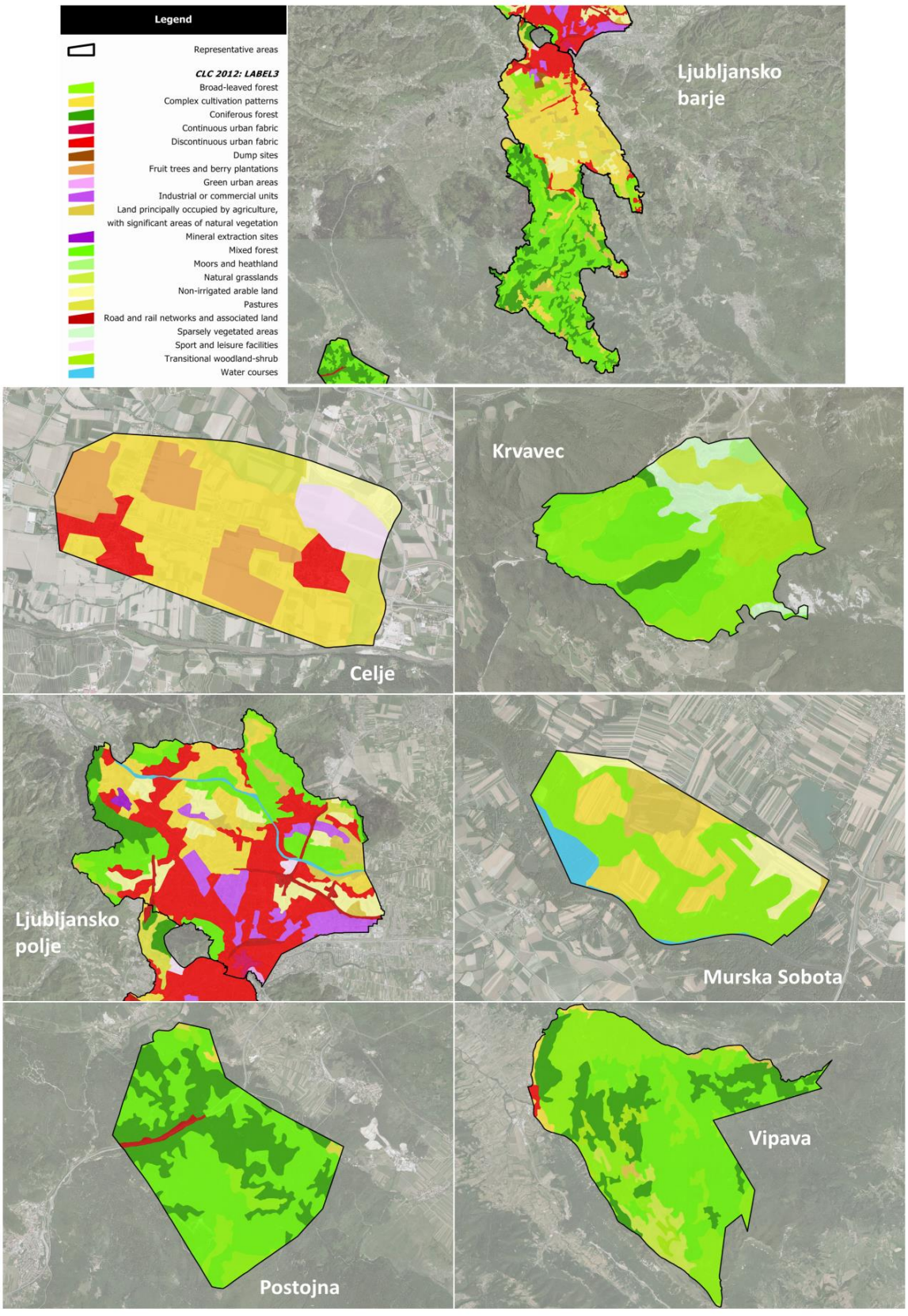

Legend
Representative areas
CLC 2012: LABEL3
Broad-leaved forest
Complex cultivation patterns
Coniferous forest
Continuous urban fabric
Discontinuous urban fabric
Dump sites
Fruit trees and berry plantations
Green urban areas
Industrial or commercial units
Land principally occupied by agriculture, with significant areas of natural vegetation
Mineral extraction sites
Mixed forest
Moors and heathland
Natural grasslands
Non-irrigated arable land
Pastures
Road and rail networks and associated land
Sparsely vegetated areas
Sport and leisure facilities
Transitional woodland-shrub
Water courses
Ljubljansko barje
Celje
Krvavec
Ljubljansko polje
Murska Sobota
Postojna
Vipava

Figure 6: Land use (CLC) in selected representative areas (ARSO 2016c)

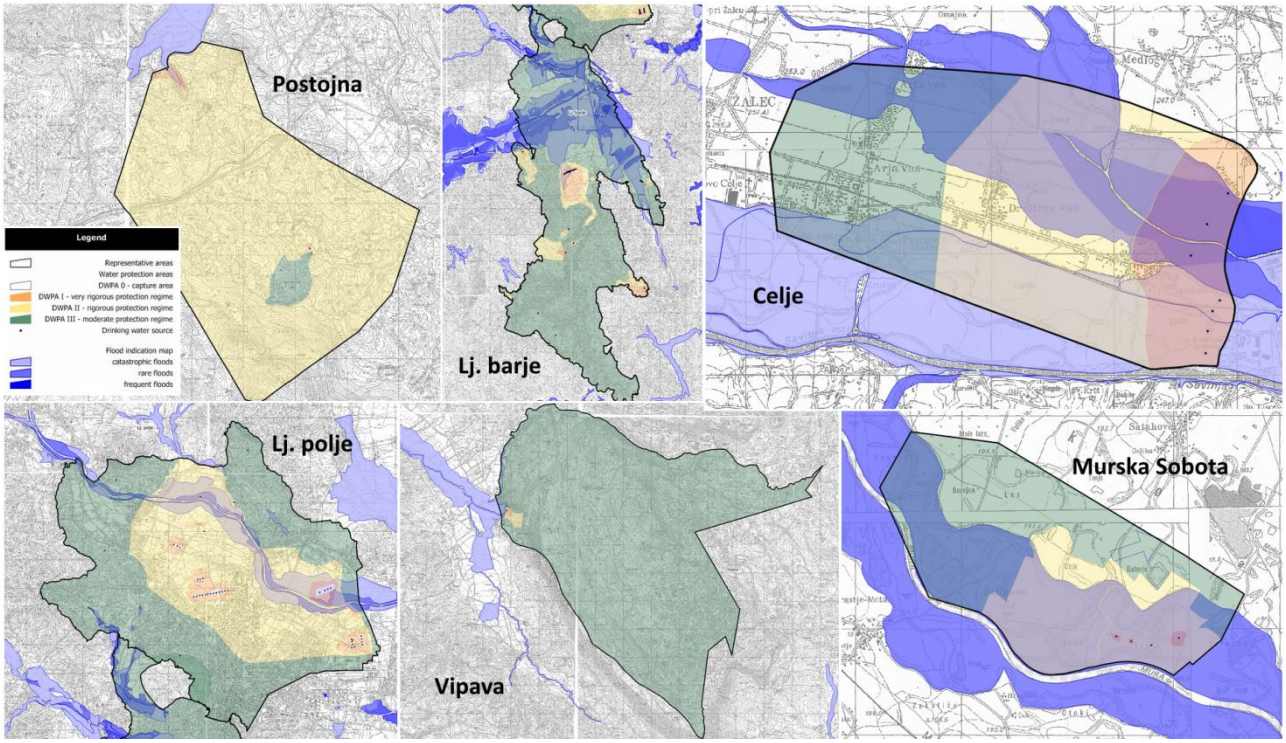


Figure 7: Drinking water protection zones and flood areas in selected reprezentative areas

3.2. Overview of the particular land use activities

3.2.1. Urban areas

Negative impact on water quality can have urban waste waters and also the use of pesticides in the sports areas, parks and cemeteries.

Urban waste water systems

In 2014, Slovenia had released 810 million m^3 of treated wastewater, or 21% more than in 2013. The amount of untreated waste water in 2014 compared to 2013 decreased by 38% (80 million m^3 of water).

In 2014, 94.5 million m^3 of rainwater was discharged in the public sewer system, surface water and soil. Their quantity in comparison with 2013 decreased by 1%. 81% of waste water was discharged into surface water.

Around 58 % of the Slovenian population has access to piped sewer systems. Only 54% of wastewater discharged from sewage systems is treated.

In recent years, the amount of waste water treated by processes of secondary or tertiary treatment increased, while the amount with primary treatment decreased. The amount of wastewater that was treated with secondary treatment processes has, since 2002, increased by 205% or 38 million m^3 (in 2002) to 78 million m^3 (in 2014). Tertiary wastewater treatment was almost nonexistent in Slovenia in 2003, while in 2014 50 % of all treated wastewater, or 78 million m^3 wastewater was treated by tertiary processes. Share of Slovenian population whose waste water was treated in urban or common waste water treatment plants of a certain treatment level in 2014 (Figure 8) is 0,5 % in primary, 33,4 % in secondary and 24,3 % in tertiary treatment (in total 58,2 % population; ARSO 2016b).

Table 8: Water balance of Slovenia

	2013	2014	2014/2013
	m3 (1.000)		index
Pumped water	895.349	980.338	109
public water supply	163.971	163.095	99
from its own reservoirs	731.378	817.243	112
Water losses in the water supply system	45.644	45.890	101
Water supplied from public water supply	118.327	117.205	99
households	78.558	78.606	100
economic activities	33.033	32.096	97
unbilled consumption	6.736	6.503	97
Wastewater	892.950	984.685	110
treated	668.351	810.134	121
untreated	128.742	80.063	62
rainwater	95.857	94.488	99

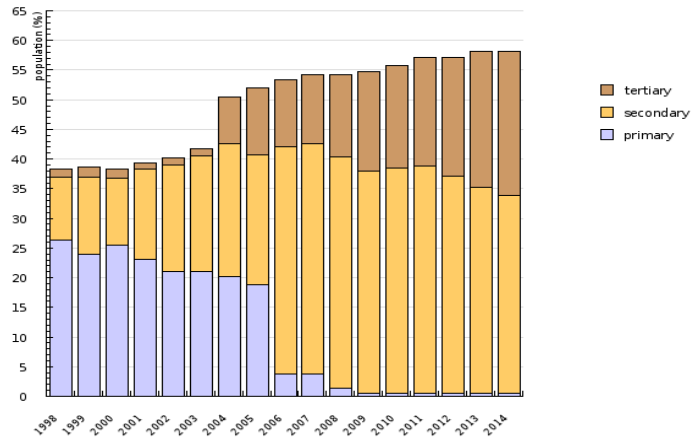


Figure 8: Share of Slovenian population whose waste water was treated in urban or common waste water treatment plants of a certain treatment level (source: ARSO, 2016b)

Sewage is generated by residential and industrial establishments and also rainwater. Table 9 shows the proportion of produced waste water in Slovenia for the year 2014.

Table 9: Wastewater pollution according to the source for Slovenia (SURS, 2016)

Year	Waste water from agriculture, forestry, fisheries	Waste water from industrial activities	Waste water from other activities	Waste water from households	Other waste water
2014	0,2%	5,8%	5,8%	37,5%	50,6%

In 2014, 800 million m^3 of water were discharged into surface waters. Most of it was discharged treated (730 million m^3). 183 million m^3 of waste water were discharged into the public sewage system: before discharge 80 million m^3 of waste water were treated. Into land a million m^3 of waste water were discharged untreated and 0,4 million m^3 of waste water were treated. Most of the rainwater (92,8 million m^3) was discharged into the public sewage system and the rest into surface waters (1,7 million m^3) and into land (0,02 million m^3; SURS, 2014).

Flooding and flood management

Flooding and flood management is managed by the Slovenian Water Agency regarding main watercourses (categry I and category II). Local communities are in charge of urban drainage. These two categories of floods are sometimes not so clearly divided in the case of urbanized watercourses.

3.2.2. Industrial areas

Around 19.000 industrial enterprises were registered in Slovenia in 2012, of which about 17.000 (90%) in manufacturing and 1.300 (almost 7%) in electricity, gas, steam and air conditioning supply. There were almost 400 enterprises in water supply, sewerage, waste management and remediation activities, which is just over 2% of all industrial enterprises in the country. The fewest enterprises (only 106 or less than 1%) were registered in mining and quarrying (SURS, 2013).

Manufacturing industry can pollute water with toxic substances and heavy metals, mining and construction with sediments and acids, and food production with organic substances. Main pollutants resulting from mechanical engineering are tri- and tetra-chloroethene.

The energy sector uses water for cooling thermal power plants and nuclear power plants. This heated water is then discharged back to the source (surface waters), so the source water temperature rises.

The systematic monitoring of waste water emissions to surface and groundwater related to industrial operation is defined in Decree on the emission of substances and heat when discharging waste water into waters and the public sewage system (Official Gazette of the Republic of Slovenia 64/2012, 64/2014, 98/2015) and Rules on initial measurements and operational monitoring of wastewater (Official Gazette of the Republic of Slovenia 94/2014, 98/2015). Industrial waste water regulations follow the ex EU IPPC directive (IPPC 1996/61/EC) and related BAT/BREF documents which are defining the treatment processes for each type of industrial facility and production processes related. This includes also Priority substances directive (2013). The relevant regulation was changed to Industrial Emissions Directive (IED 2010/75/EU), and the technologies available within sealing devices was improved.

Impact of landfills or waste waters emission on surface water quality is determined in Rules on surface water status monitoring (Official Gazette of the Republic of Slovenia 91/2013). Impact of landfills or operation of the plant on groundwater quality is determined in Rules on groundwater status monitoring (Official Gazette of the Republic of Slovenia 53/2015). In both Rules details regarding operational monitoring of groundwater are determined, such as: the scope of operational monitoring of groundwater status, determination and regulation of measuring points, parameters of the operational monitoring of groundwater, frequency and sampling time; methodology of sampling, measurement, analysis and treatment of samples; evaluation of impact on groundwater status; contents of the report on the operational monitoring of groundwater; the basis for determining the program of operational monitoring of groundwater; conditions and certification for implementing of operational monitoring groundwater status.

Groundwater bodies are polluted due to industry with chlorinated organic solvents in two areas in Slovenia; in the Savinja Basin and in the Mura Basin (ARSO, 2016d). In the Savinja basin the values were exceeded at only one measurement point. Higher pollution by chlorinated organic

solvents is found in the central part of the Mura Basin. For both areas no long term trends are specified.

3.2.3. Agricultural land

Agriculture in Slovenia represents 2.1% of the gross domestic product (GDP) of the national economy, with a downward trend in the last period. Agricultural areas are decreasing in favour of the overgrowth of agricultural areas, the building construction and transport infrastructure. Planting structure of fields is adapting to market requirements, areas with oilseeds, dry beans, vegetables and mowed fodder are increasing and areas with potatoes, hops and maize (for grain and silage) are decreasing. In Slovenia a large proportion of the areas are under special management regimes in terms of environmental protection, therefore a number of farming practices were developed and supported through agricultural-environmental program.

The farmers, who receive a subsidy, are obliged to attend lectures about plant protection products every five years and follow the plan for spreading manure, which is done on the basis of soil analysis and depends on which culture will be cultivated. Farmers are encouraged to perform organic farming without pesticides and fertilizers.

30,2 % of the DWPZs are agricultural areas (Figure 4). 46,16 % are meadows and pastures and 40,8 % cultivated land; 7,44 are permanent crops and 6,32 % overgrowth areas (Figure 9). In all DWPZ it is prohibited to fertilize without fertilization plan. In the narrowest area (I) it is prohibited to use nitrogen fertilizers, as well as liquid organic fertilizer. The only allowed fertilizers are those that are normally allowed for organic farming. In the narrow area (II) it is exceptionally allowed to fertilize in accordance with the requirements of integrated or organic farming, if the nitrogen values are not exceed and also if the results of monitoring of water quality show that the water from wells in the last five years had good chemical analysis in accordance with the regulations on the quality of groundwater. In the wider area (III) the fertilization is generally allowed, if the values of nitrogen in the DWPZ are not exceeded.

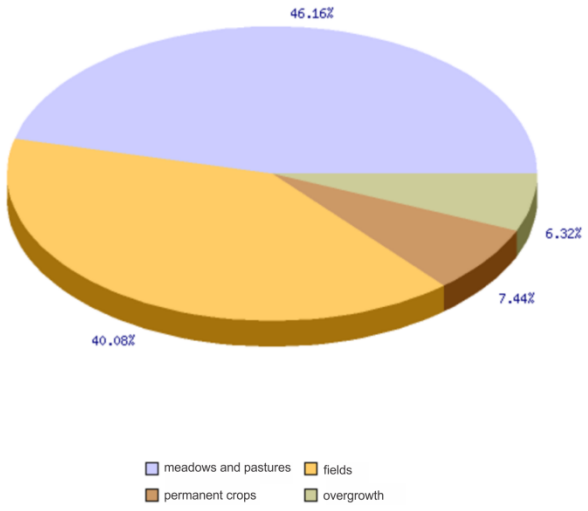


Figure 9: The use of agricultural soil on DWPZ in Slovenia, average for 2002-2011 (ARSO, 2011)

National map of spatial distribution of nitrogen and phosphorus in agricultural areas is not available in Slovenia, but the map of intensity of fertilization with nitrogen on representative agricultural areas is available (Figure 10). Net nitrogen surplus in 2014 was 10 kg per hectare and gross phosphorus surplus was 1 kg per hectare of agricultural areas (source: Statistical Office of the Republic of Slovenia).

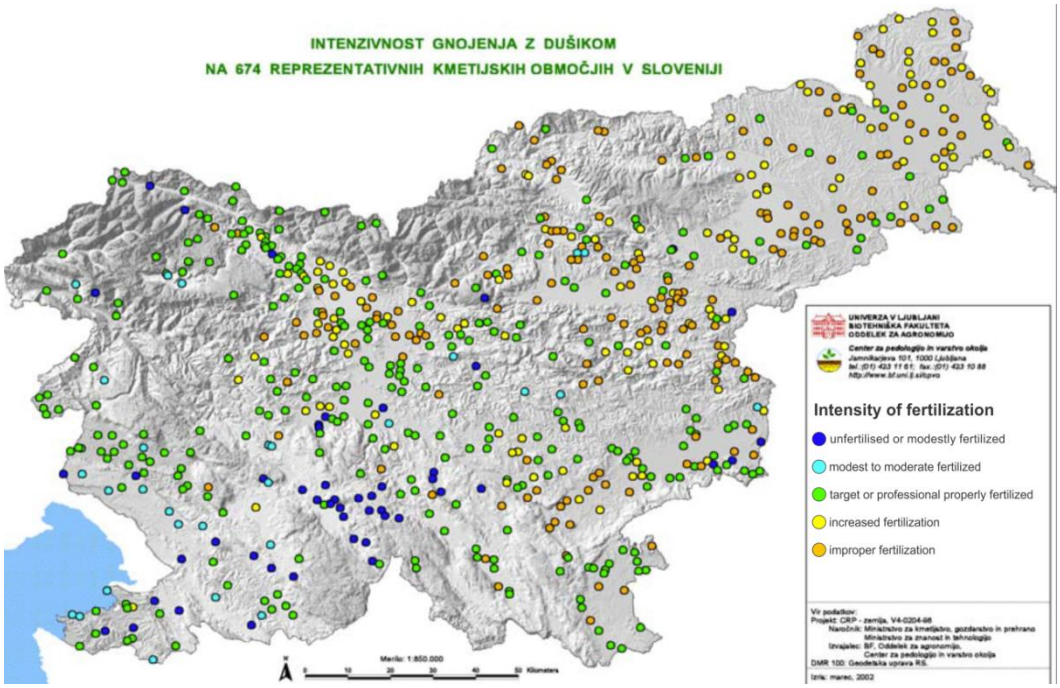


Figure 10: The intensity of fertilization with nitrogen on the 674 representative agricultural areas in Slovenia (MKGP 2006)

Groundwater is mostly polluted by nitrates, pesticides and their degradation products due to agriculture. In 2015 pesticide and fertilizer pollution is detected in several areas in Slovenia: Sava Basin and Ljubljana Marsh, Savinja Basin, Krško Basin, Sava Hills, Dolenjska karst, Drava Basin and Mura Basin. Long term chemical status (2008–2015) of all groundwater bodies in Slovenia is good, except for groundwater bodies in Savinja Basin, Drava Basin and Mura Basin. But for trends for the period 1998 to 2015 the results of monitoring of groundwater quality show statistically significant downward trends in concentrations of nitrate, atrazine, desethyl-atrazine and total sum of pesticide for Sava Basin and Ljubljana Marsh, Savinja Basin, Drava Basin and Mura Basin. In some measuring sites the values of atrazine and desethyl-atrazine does not

decrease anymore, but is around the detection limit of the analytical method. This means that parameters are no longer present in those aquifers.

In 2015 59 drinking water wells were included in monitoring. At 9 measuring points the drinking water has nitrate, atrazine, desethyl-atrazine, metolachlor and bromacil exceeded the limit values.

3.2.4. Forest

Forests in Slovenia cover 11.819,4 km^2 which represent 58,2% of the total area. Slovenia ranks fourth in the European Union in relation to the forest cover. 75% of forests are privately owned, 25% are owned by the state and municipalities. The average forest property is 2,5 ha and is divided into several separate parcels. Forests are owned by 461.000 owners and co-owners.

In the Slovenian forests deciduous trees dominate with a 54,4%, followed by coniferous tree with 45,6%. A more detailed distribution according to tree species is shown in Figure 11.

Forest with natural vegetation composition and stand structure are best for filtering pollution from neighbouring agricultural areas, roads and urban centres, leaking into surface streams and groundwater.

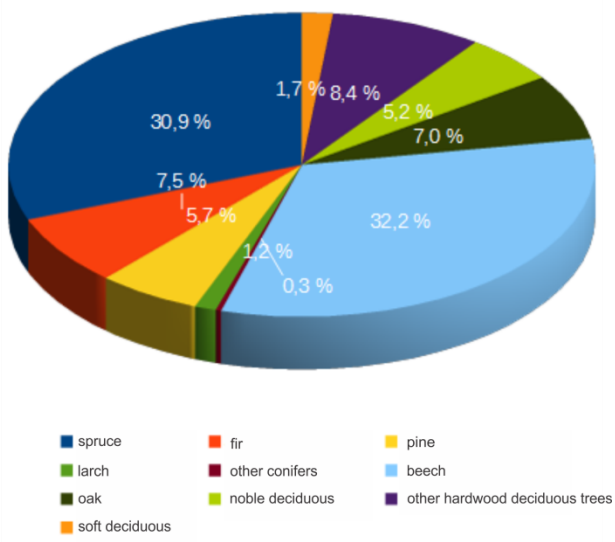


Figure 11: Percentages in growing stock by tree species (Slovenian Forest Service, 2014)

Forest management plans include also guidelines for optimization of hydrological function of forests. In this respect, three levels of hydrological function are determined (Figure 12):

- 1st level: on areas in DWPZ I and II; areas over karst caves and underground water flows; in the zone 50-500m around lakes (depending on terrain);

- 2nd level: on areas in DWPZ III; on potential water protection areas; along streams and smaller standing water in the width of one to two tree heights;
- 3rd level: all forests, since all contribute more uniform runoff.

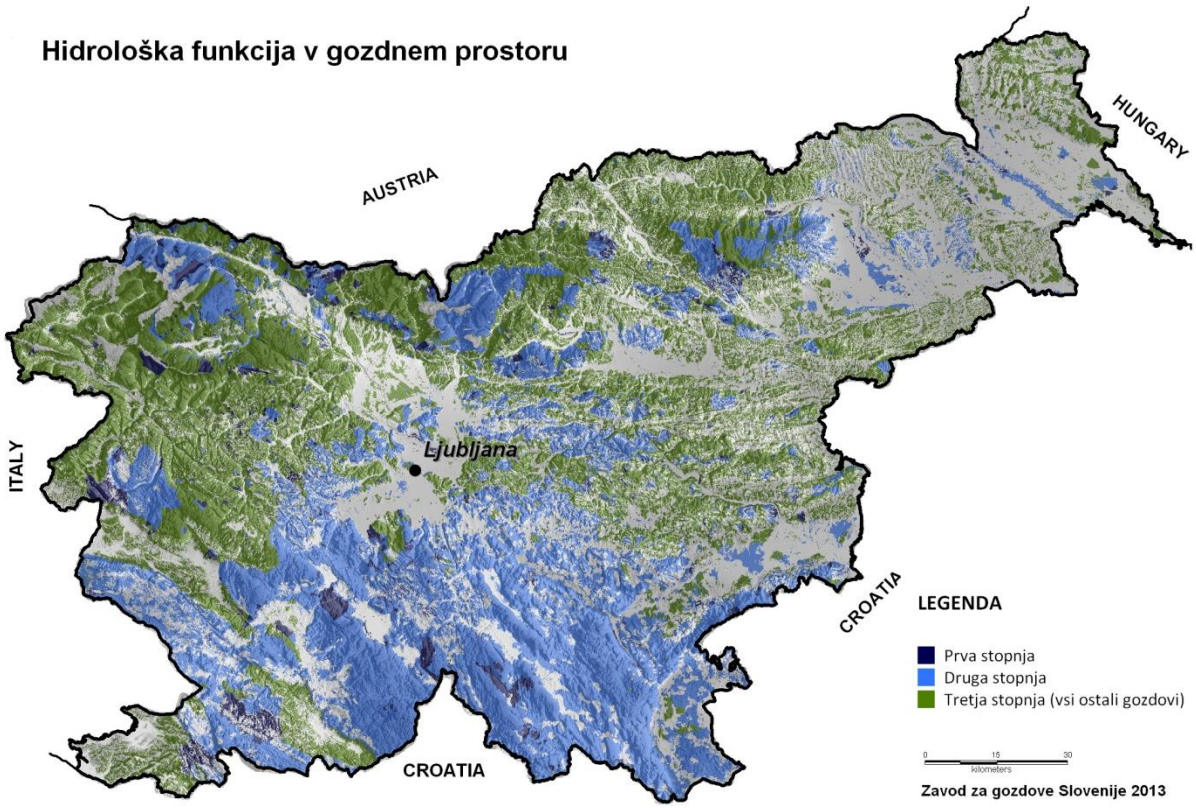


Figure 12: Hydrological function of forests (Slovenian Forest Service, 2013)

Protective forests are forests which protect from landslides, forests on steep slopes or river banks, forests, exposed to strong winds, forests in torrential areas for holding excessive runoff, forest belts, which protect forests and land from wind, water, snowfall and avalanches, forest management in agricultural and suburban landscape with emphasized function of preserving biodiversity and forests at the upper limit of forest vegetation. There are around 99.000 ha of protective forests in Slovenia. A map of protected forests in Slovenia is presented in Figure 13. Protected forests are defined in Decree on protective forests and forests with a special purpose (Official Gazette of the Republic of Slovenia 88/2005, 56/2007, 29/2009, 91/2010, 1/2013, 39/2015).

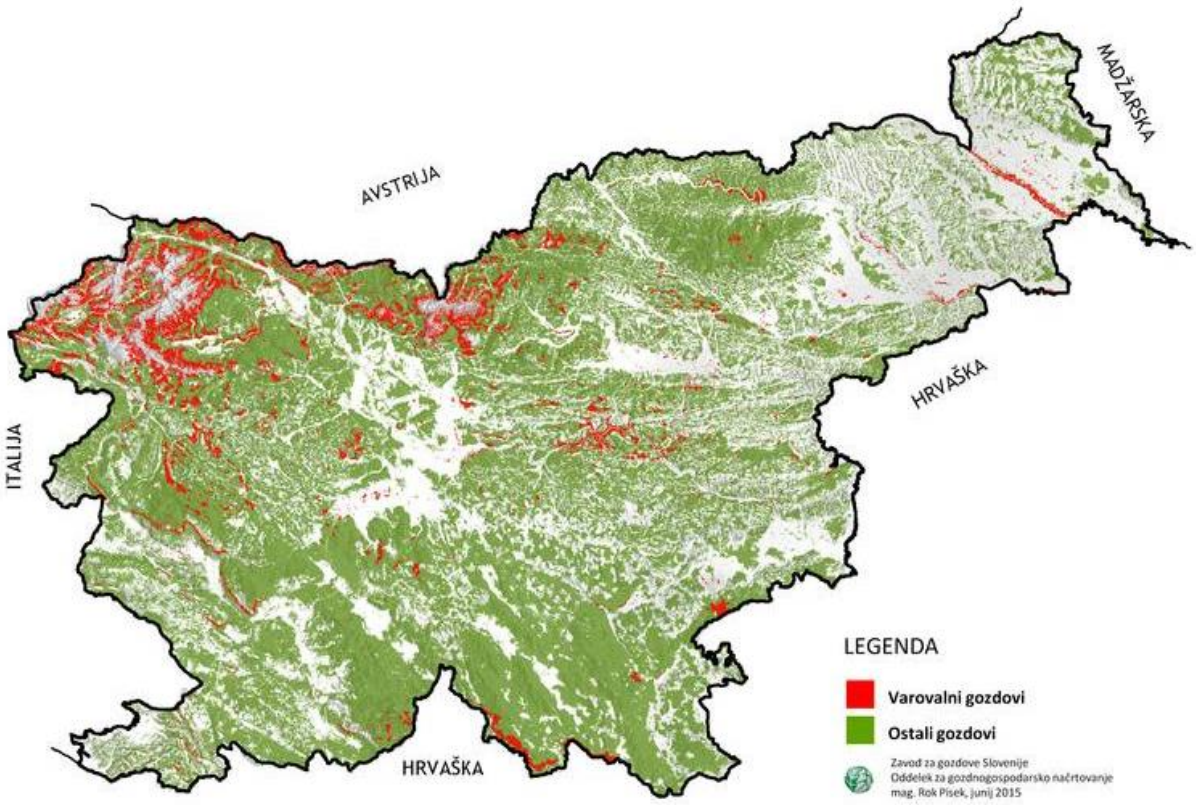


Figure 13: Map of protected forests (red colour). Green colour: other forests. (Slovenian Forest Service, 2015)

The importance of forests on the total discharge from the catchment area and the water quality increases with the proportion of the forest area. Forests can reduce the possibility of occurrence of high waters of shorter and less intense precipitation, but cannot prevent the occurrence of flooding during major precipitation over a large area. In all DWPZ (I, II and III) afforestation is allowed. In DWPZ (I and II) the clear-cutting is not allowed. Also the use of pesticides and supply of machinery and equipment with fuel in the forest is not allowed in the narrowest DWPZ (I).

3.2.5. Pastures

Livestock farming is the most important sector of the Slovenian agriculture. The livestock sector is dominated by cattle, followed by pig, sheep and goat breeding, horse breeding, poultry farming, rabbit, beekeeping and others. Grassland in Slovenia is of great importance for livestock production, it represents an important source of fodder for cattle, sheep and goats. Meadows and pastures represent the average of around 58% of the total agricultural area.

3.2.6. Transport units

Waste water from roads in managed with Decree on the emission of substances in the discharge of meteoric water from public roads (Official Gazette of the Republic of Slovenia 47/2005), which define measures to reduce emissions due to discharge of meteoric waste water from public roads, limits of emissions into water and public sewer system for meteoric waste water from public roads and evaluation and measurement of emissions. Measures are divided regarding the manner of waste water discharge: (1) point discharges of waste water, (2) diffuse discharges of waste water, (3) indirect discharges into groundwater and other measures. Point discharge is discharge of treated waste waters, which are collected in impermeable meteoric waste water. Collection and treatment of meteoric waste waters from public roads is obligatory in case of 12.000 vehicles per day and crossing porous and fractured aquifers; 6.000 vehicles per day and crossing karst aquifers; 40.000 vehicles per day and crossing geological structures with permeability less than 10^{-6} m/s. For other cases diffuse discharge of meteoric waste water from public roads is allowed.

Limits for parameters for waste water from roads have lower values for DWPZ.

In winter freezing is prevented with solvents (salt) and sands. Environmentally unfriendly solvents are allowed to use only in the minimum necessary quantities. For sanding solvents only such device should be used, that enables accurate dosing quantities. The dosing quantities of solvent should take into account the amount of solvent that it is already on the road.

Negative impact on water quality can have also the use of pesticides on railway tracks and on the roadsides.

3.2.7. Flood management

Slovenia is in general a country exposed to flood events with abundant and intensive precipitations. Already from the historical point of view, the flood and erosion control has been closely related to any human activities. Because of the mountain terrain and relatively small watersheds the floods are usually flash floods with short lead-time and limited forecasting potential. Another specific of the floods in Slovenia is related to the Karst geology, with karst geology covering for 45% of its territory. Karst geomorphology is relatively resilient to the flooding phenomena, as most of the water is percolated in the karstic fissures into cavern-type groundwater. It is also providing relatively good retention potential as the karstic groundwater systems provide significant retention capacity. Specific problems occur on the karstic polje exposed to flooding, where different urbanization patterns developed, that are now exposed to flooding.

Major flood events in the last 25 years have caused approximately 1,74 Bn EUR of flood damage in 7 major flood events.

Table 10: Major flood events in Slovenia (source: Ministry of Envrionment and Spatial Planning of RS 2015)

Event	Year	Damage (mio. EUR)
1	1990	580
2	1998	180
3	2007	200
4	2009	25
5	2010	190
6	2012	310
7	2014	255
	SUM	1.740

Current flood risk is therefore a result of several centuries of river training and settlement development, where first significant river training begun already in the Roman period (1st century AC). More systematic river training started in the 18th century (construction of large "Grubar" canal 1772-1780). Most regulation works and intensive development of the settlements were developed in the 20th century with new construction technologies applied and population growth.

Result is that almost all major rivers in Slovenia are regulated in order to ensure the conveyance of flood discharges. Along with the flood defence works the erosion control works were developed in order to control the erosion process, which is very active in Slovenia. Legal framework for the flood management is defined by the Slovenian Waters Act of 2002 which was later amended and supported with several decrees to embody the requirements defined by the EU Flood Directive (2007/60).

One of the important tools for the improved flood management is development of national catalogue of potential measures for flood prevention, protection and mitigation. The fact that all aspects of Flood Risk Management (Prevention, Protection, Preparedness, Awareness, and Recovery) were addressed in the Flood Risk Management Plan is demonstrated by the fact that the measures proposed in the catalogue of potential measures have found a clear correspondence with codes of measures proposed by the European Union.

3.3. Impact of land use activities on water quality and *quantity* floods/droughts - DPSIR approach for the present/past state - *prioritize national issues in DPSIR*

Impact on water resources quality and quantity				
URBAN AREAS				
Driving forces	Pressures	State (ECOSYSTEM SERVICES)	Impacts	Responses (MEASURES)
Areas without sewage system	Emission of microbiological pollutants and nutrients	microbiological pollution, N & P compounds, farmaceuticals, heavy metals	Deterioration of groundwater quality endocrine disrupters - impact on human health	KTM 1 Implementation of appropriate measures : construction of the sewage system
damaged sewers	leakage of wastewater	microbiological pollution, N & P compounds, farmaceuticals, heavy metals	deterioration of groundwater quality endocrine disrupters - impact on human health	KTM 1 inspection and remediation of the sewer system
Areas without waste water treatment plants	Emission of microbiological pollutants and nutrients	microbiological pollution, N & P compounds, farmaceuticals, heavy metals	deterioration of groundwater quality endocrine disrupters - impact on human health	KTM 1 Set up of waste water treatment plan for sewage system Set up of individual treatment plants for individual houses
Sealed surfaces	Lower	Higher GW	deterioration of	KTM 21

	precipitation infiltration due to disharge of meteoric waters to sewer system	temperatures Lower GW quantity	groundwater quantity and quality	Separate system for meteoric waters (inflitrationg into ground) and waste waters (dischared to WWTP)
heat pumps (water-water)	Emissions of warmer water into aquifer Discharge into sewer Not professional wells – possible direct polltion channels	Higher GW temperatures Lower GW quantity GW pollution (mainly mineral oils)	deterioration of groundwater quantity and quality	KTM 21 Strict implementation of legislation (water return, wells in compliance with standards) Banning of heat pump system without permission
hydropower plants on rivers, which have GW interactions	HPP dams	Higher GW levels (possible flooding of existing subsurface objects (e.g. oil tanks))	Higher GW levels deterioration of groundwater quality	KTM 21
cemeteries	Applitaion of pesticides to cemetery paths	GW pollution with pesticides	deterioration of groundwater quality	KTM 21 Optimized use of fertilizers (fertilization plans)
construction of big buildings or construction areas with facilities underground	Deep construction pits	higer vulnerability due to diminishing the unsaturated zone thickness GW pollution:	deterioration of groundwater quality and localy also quality	KTM 21 Measures for pollution prevention

		heavy metals, oil spill		
AGRICULTURE				
Driving forces	**Pressures**	**State**	**Impacts**	**Responses**
use of fertilisers	diffuse emissions of N and P compounds	Nitrate in GW	deterioration of groundwater quality, impact on human health	KTM 2 - optimized use of fertilizers (fertilization plans) - ecological agriculture
Manuring	diffuse emissions of N compounds and microbiological pollution	Nitrate and microorganisms in GW	deterioration of groundwater quality, impact on human health	KTM 2 - optimized use of manure (manuring plans) - ecological agriculture
INDUSTRIAL UNITS				
Driving forces	**Pressures**	**State**	**Impacts**	**Responses**
Industrial waste waters	Emissions of pollutants to surface water and GW	Different pollutants in GW (e.g. heavy metals, Cr, organic pollutants (volatile hydrocarbons))	deterioration of groundwater quality	KTM 1 and 21 - Strict implementation of legislation regarding water monitoring for determining impact of the activity or operation of the plant - better inspections
Old burdens (contaminated soil)	Emissions of heavy metals to surface water and GW	Presence of heavy metals in GW	deterioration of groundwater quality	KTM 4 Remediation of these contaminated sites
TRANSPORT UNITS				

Driving forces	Pressures	State	Impacts	Responses
Road traffic	Waste waters from roads	Presence of road pollutants in GW (heavy metals (Cd, Zn, Pb), salts (Cl, Br, ..))	deterioration of groundwater quality	KTM 21 Strict implementation of decree on the emission of substances in the discharge of meteoric water from public roads (OG RS 47/2005)
railway	Fertilizing railway gravel dams	Presence of fertilisers in GW	deterioration of groundwater quality	KTM 2 and 21 Optimized use of fertilisers
Road accidental spills	Emissions of fuel or toxic substances	Contaminated soil, possible infiltration of substances to GW (mineral oils, chemicals)	deterioration soil and groundwater quality	KTM 21 Effective action plan in case of spills, low reaction time and fast intervention
FOREST				
Driving forces	**Pressures**	**State**	**Impacts**	**Responses**
sleet (deadwood)	increesed nutrients due to less tree	increased nutrient concentrations in groundwater (nitrate)	deterioration of groundwater quality	KTM 22 fostering an adequate deadwood management after sleet events

Impact on floods and droughts				
URBAN AREAS				
Driving forces	**Pressures**	**State**	**Impact**	**Response**
Urban development in flood prone areas	Increased runoff	Decreased retention	Deterioration of retention capacity in the	KTM 23 Development of improved

			watershed	retention capacity
Urban development	Development of urban zones in flood prone areas - vulnerable structures in the flood hazard zones	Vulnerable structures and activities in the flood hazard zones	Vulnerable structures and activities in the flood hazard zones	PS-KTM27 Protection of vulnerable structures (constructive measures) - retention basins, dykes, diversion canals…
River training	Increased flow velocity	Hydraulic/hydrological peaking	Increased discharges for specific return period	KTM23 Development of retention capacities
Austerity measures	Reduction of maintenance of hydraulic structures	Increased vegetation of streams and deterioration of hydraulic structures	Reduced conveyance of watercourses	PS-KTM28 Increased financing of measures
Austerity measures	Reduction of maintenance of hydraulic structures	Decreased level of erosion control capacity	Channel levels rise and related flooding	PS-KTM28 Increased financing of measures
Austerity measures	Reduction of maintenance of hydraulic structures	Decreased level of erosion control capacity	Channel levels dropdown and related impact on groundwater level, bank erosion	PS-KTM28 Increased financing of measures
Competing activities in the field of water use	Water for electricity production more important than flood management	Flooding due to electricity production focused water management	Artificial flooding (operation of power-plants)	PS-KTM27 Development of protocols with adequate priority

Utilization of space	Poor management practice in the field of interventions that have impact on water retention and conveyance	Local impoundment, watercourses crossing with different infrastructure, heavily urbanized watercourses	Local flooding	PS-KTM27 Legal framework and its implementation regarding the watercourses in urban environment
Urbanization and related Urban drainage requirements	Urban drainage collection systems	Urban flooding due to intensive precipitation and inadequate urban drainage (stochastic development), poor legislation.	Urban flooding	KTM26 Adaptation of the DWA-A-138E type of standard on national level
Urbanization in mountain regions	Construction on erosion prone zones (erosion, deposition)	Erosion control works in the mountains not meeting the requirements regarding the erosion processes downstream	Erosion processes activated (bedload, suspended load) deposition and related flooding	KTM17 combined with PS-KTM27 Restoration of old erosion control practices and development of new practices (including erosion transport process monitoring)
Urbanization on karstic polje	Construction on flood prone zones with	Urban developments on karstic polje	Flooding	PS-KTM27 Re-allocation plans, strict implementation of rules regarding the construction on polje

Austerity measures	Poor water governance framework	Watercourses conveyance characteristics are not consistent	Flooding on some parts of the watercourses	PS-KTM 27 with PS-KTM28 Improved standards for the conveyance characteristics of watercourses
Low interinstitutional cooperation	Diverging views on water and flood management	Conflicts in management of watercourses	Flooding due to increased vegetation of watercourses	PS-KTM27 Improved interinstitutional cooperation
Austerity measures	Limited water governance	Land parcel data of limited quality - water has no defined land cadaster plots	Reduced maintenance and related flooding	PS-KTM28 Improved water governance
AGRICULTURE				
Driving forces	**Pressures**	**State**	**Impact**	**Response**
Poor supervision of hydraulic structures	Inadequate agricultural practice in the vicinity of dykes	Decreased dyke stability	Reduced flood safety	PS-KTM26 Improved supervision and response to inadequate practice
Orchads, vineyars perpendicular to flood flow direction	Increased hydraulic resistance (roughness)	Increased flood levels	Flooding	KTM12 Improved agricultural practice
Understanding of role of drainage in agriculture	Reduced maintenance of agricultural drainage systems	Clogged and inefficient Reduced retention capacity of agricultural land	Increased runoff and related flooding	KTM12 Improved practice of agricultural drainage
FORESTS				

Driving forces	Pressures	State	Impact	Response
Extreme meteorological events in forests (sleed, strong winds)	Destruction of large areas of woodland along the watercourses	Trees falling in the watercourses with clogging potential	Increased flood levels and potential for debris flow development	PS-KTM 29 Adequate forest practice and active response in the case of large scale events
Increased surfaces under forests	Impact on droughts – with increased water use by the forests	Reduced discharges in dry periods	Competitive use of water with other sectors	PS-KTM30 Target de-forestation
Forestry activities (harvesting, road construction, road drainage, towing)	Constructions in the forest areas increasing runoff and erosion process	Increased release of sediments increased drainage along the infrastructure (roads)	Erosion process in the forests and sediment deposition downstream	PS-KTM 29 Adopted standards for the road construction and harvesting in the forests for reduced erosion processes, implemented measures (i.e. check dams)
PASTURES				
Driving forces	**Pressures**	**State**	**Impact**	**Response**
Pasture	Pasture on steep hillsides causing erosion with the runoff process	Erosion due to the pasture activities	Erosion damage and deposition of the eroded material downstreams	PS-KTM 29 Good agricultural practice (reduced pasture on specific areas, especially

				cattle), development of check dams, sediment traps.
TRANSPORT				
Driving forces	**Pressures**	**State**	**Impact**	**Response**
Development of transport infrastructure	Sealed surfaces relate to transport infrastructure	Developed transport infrastructure without mitigation (retention) measures	Increasing runoff	KTM23 with PS-KTM26 and PS-KTM27 Development of retention capacity
Transport infrastructure crossing watercourse (bridges, culverts)	Reduced hydraulic conveyance	Some bridges and culverts conveyance capacity is not meeting the requirements. Also issue of clogging (debris, sediments)	Local flooding	PS-KTM31 Rebuilding the conveyance capacity of the transport – watercourse crossing
Cabled/piped transport infrastructure under bridges	Improving economy of the cabled/piped infrastructure (cheaper construction)	Cables and pipes under bridges limiting their designed hydraulic conveyance	Local flooding	PS-KTM31 Strict design standards. Supervision of bridges and culverts regarding their actual status
INDUSTRIAL AREAS				
Driving forces	**Pressures**	**State**	**Impact**	**Response**
Development of industrial areas	Sealed land (buildings, parking lots etc.) and urbanized watercourses	Increased runoff due to the sealed surfaces	Flooding	KTM23 Development of retention capacities - Green roof, urban

				agriculture, dispersed development of retention basins
Development of new industrial areas adjacent to watercourses	Usually cheaper land in flood prone areas, interesting for land developers	Construction of industrial areas in the flood hazard zones, with landfilling process	Reduced retention volumes and induced flooding downstreams	KTM23 and PS-KTM27 Protection of existing flood prone areas and development of industrial facilities elsewhere (also tartet brownfiels investments)
Existing industrial areas in flood prone zones	Investments/ measures in the protection of existing industrial facilities	Industrial facilities exposed to flooding	Inducing reduction of flood retention volumes without compensation	KTM23 Obligatory compensation of the excluded flood retention volumes in the case of flood protection measures
ENERGY PRODUCTION				
Driving forces	**Pressures**	**State**	**Impact**	**Response**
Maximizing the benefits of the hydropower production	Operational procedures of hydropower systems aimed at power production with limited focus on flood retention mechanisms	Power production focused management	Flooding	KTM23, PS-KTM 26 and PS-KTM27 Development of agreed operational protocols increasing retention potential (where feasible)
Hydropower	Reduction of the	Reduced amount	Erosion processes	KTM17

production	sediment transport (suspended and bedload) in reservoirs	of sediments in watercourses downstream, Sediment accumulation in reservoirs reducing their capacity	in watercourses down streams lacking the sediments	Adequate monitoring, Erosion control works downstream,
Hydropower production	Diversion type hydropower plants – reduction of discharges in main watercourses with vegetation buildup and reduced conveyance capacity	Vegetation buildup in the watercourses subject to diversion	Flooding due to the reduced conveyance capacity	PS-KTM26 Standards and protocols for the maintenance of hydraulic capacity of diverged watercourses
Hydropower production	Inadequate regulation procedures of HPP adding to flood discharges	Unknown operational status of regulation procedures (not fully verified)	Increased high water discharges due to limited pre-event releases from reservoires and combined discharges	PS-KTM26 Improved governance procedures and technical checking
OTHER				
Driving forces	**Pressures**	**State**	**Impact**	**Response**
Water abstraction in marsh zones	Land subsidence due to the water abstraction and drainage	Active trend of land subsidence 2 to 15 mm per year	Flooding	PS-KTM32 Control of abstraction (heat pumps) and drainage

3.3.1. DPSIR approach – Based upon the direct impact of floods on drinking water protection measures – on previous chapter it is not necessary that the issues are interconnected

Impact of floods					
Driving forces	Pressures	State	Impact	Response	Comment
River training for the purpose of floood safety	Increased flow velocity, change of the river bed level (erosion, deposition process).	Hydraulic/hydrological peaking	I1: Increased discharges for specific return period I2: Changed level and recharge capacity of groundwater	Watercourse maintenance with consideration on river to groundwater communication	River training impact on the changes of river infiltration rate with an impact on river bank filtration
Maintenance of hydraulic structures and river canals	Increased flooding due to the non maintained hydraulic structures Direct intrusion of flood water into wells, drinking water treatment facitilites	Vegetated streams	Flooded wells and othe water supply infrastructure	Maintainance of hydraulic structures and river sections accoring to defined mainenance practice	Indirect impact - well maintained hydraulic structures prevent flooding of wells, resources
Pollution sources on flood areas	Flood induced pollution	Drinking water resources (groundwater) pollution risk in the case of flood events	Polluted drinking water resources (different time span)	Identification of the flood induced pollution potential (sources) from the flood areas.	Industrual pollution (SEVESO) Impact on water resources – oil spills chemical spills – urban areas,

				Local measures for their protection, transfer of sites out of the flood prone zones.	agricultural areas, illegal dupming sites, SHOULD BE ELABORATED - SEVESO APPC ICPDR – group – material, Prohibited use of oil tanks on flood zones on DWPA Contaminated sites (flooded?), registry
Changed river hydromorpholo gy – bedload and sediment transport	Changed intergranural porosity due to floods	Colmatation of river beds and aquifers	Decreased infiltration rate	Adequate management of hydromofphol ogical processes	
Urban drainage flooding – sewerage (incl. Combined Sewer Overflows).	Pollution pressures from urban drainage in the case of flood events	Unsustainable urban drainage	Pollution of drinking water resources (reservoirs, ground water)	Development of Sustainable Urban Drainage (SUDS).	CSO activations (too soon?), flood – water quality interaction, sewage retention capacities,
Land use – agriculture	Turbidity Natural background and impact of land use	Increased turbidity in the case of intensive precipitation	Pollution of water resourcees with turbidity	Treatment of natural background (i.e. microfiltratio n) and measures addressing land use and agricultural practice	

Floating debris and waste releases (activation) during the flood events	Floating debris – transport and deposition	Floating debris and waste releases during the flood events	pollution pressures on drinking water recharge areas	Prevention of floating debris and waste release, removal of waste and debris depositions after the flood events	Potential pollution from the deposited floating debris
Slope instability and erosion process effects induced by floods (also other phenomena i.e. debri flow)	Pollution of water supply due to damage on water supply systems	Drinking water pollution induced by damaged WSS	Polluted drinking water in the supply system	Avoiding instability zones, Special geotechnical measures – slope stabilisation, technical measures fo WSS construction	
Abandoned groundwater wells and boreholes	Pollution through the Abandoned groundwater wells and boreholes	Direct pollution of groundwater resource for drinking water supply	Polluted groundwater resources	Adequate decompositio n of strucutures after their usage (old wells, boreholes..) and olf flood protection structures	

4. SWOT analysis and evaluation of gaps

STRENGTHS

- implementation of DWPZ for drinking water sources with limitations of spatial planning and activities in those areas

- education of farmers by municipality and water supply companies regarding farming and drinking water protection

- limitations of farming activities in DWPZ I with paying compensations for crop loss

- management of forests following sustainability principles: sustained preservation of forests and the sustainable use of their assets and intangible functions; use of forests to such an extent and in such a way that allows the conservation of all natural forest stands; multiple purpose management with a balanced significance of ecological, production and social functions of forests

- forest management plans: including of professional guidance on optimization of hydrological role of forests, application of the criteria for the evaluation of forest functions spatial forest management plans

- public service of river and hydraulic structure maintenance with tradition

- new legislation supporting development of flood hazard maps which impose limitations on developments on flood prone areas

- increased awareness in public due to the recent flood events

WEAKNESSES

- conflicts of interests in DWPZ areas (agricultural lobby, industry)

- insufficient inspections of good legislation implementation

- legislation on application of nitrates (EU Nitrates Directive) adopted, but poorly implemented

- for the acquisition of mineral nutrients there are no restrictions on quantities

- for the acquisition of pesticides an exam and certification is required, but the amount is not limited (farmers can buy it also for others, who do not have certificate). The consumption of pesticides is not monitored (there are no fertilization plans). Farmers have to adhere to the instructions. For use of pesticides the application diary is not obligatory. Insufficient inspection of the Inspectorate for Agriculture, Forestry, Hunting and Fishing.

- unstable governance structure with several organizational changes in last decades

- missing registry of assets of hydraulic structures

- flood hazard maps not always developed according to unified standards

- insufficient financing of the flood management domain in recent decades causing degradation of existing infrastructure

- inter-institutional cooperation –

	horizontal (among different sectors) and vertical (among different levels of governance – state, regional, local) is inefficient
▪ **OPPORTUNITIES** - eco farming with eco products with higher prices - use of ecosystem services - combined approach addressing droughts and floods with multiuse reservoirs	▪ **THREATS** - lack of investments into sewage and waste water treatment - climate change with more intensive precipitation (floods) and dry periods (drinking water shortage) in Slovenia - floods potentially causing pollution (i.e. flooding of oil tanks and warehouse with plant protection products in 2010)

5. References

ARSO 2011. Kazalci okolja v Sloveniji (Environmental indicators).- Slovenian Environment Agency Available at: http://kazalci.arso.gov.si/?data=indicator&ind_id=466&lang_id=302

ARSO 2016. Kazalci okolja v Sloveniji (Environmental indicators).- Slovenian Environment Agency Available at: http://kazalci.arso.gov.si/?data=indicator&ind_id=781&lang_id=94

ARSO 2016a. Kazalci okolja v Sloveniji (Environmental indicators).- Slovenian Environment Agency Available at: http://kazalci.arso.gov.si/?data=indicator&ind_id=790&lang_id=302

ARSO 2016b. Kazalci okolja v Sloveniji (Environmental indicators).- Slovenian Environment Agency Available at: http://kazalci.arso.gov.si/?data=indicator&ind_id=762&lang_id=94

ARSO 2016c: Environmental Atlas of Slovenia- Slovenian Environment Agency. Available at: http://gis.arso.gov.si/atlasokolja/profile.aspx?id=Atlas_Okolja_AXL@ARSO&culture=en-US

ARSO, 2016d: Slovenian Environmental Agency. Available at: http://www.arso.gov.si/vode/podzemne%20vode/publikacije%20in%20poro%C4%8Dila/Porocilo_podzemne_2015_objava_splet_13.02.2017_sken.pdf

GWP-CEE 2015: Guidelines for preparation of the Drought Management Plans - Development and implementation in the context of the EU Water Framework Directive.- Global Water partnership for Centraland Southeast europe, 47p. Available at: http://www.gwp.org/Global/GWP-CEE_Files/IDMP-CEE/Drought-Guidelines-GWPCEE.pdf

MKGP 2006. Program razvoja podeželja za Republiko Slovenijo 2004-2006.- Ministrstvo za kmetijstvo, gozdarstvo in prehrano. Available at: http://www.arsktrp.gov.si/fileadmin/arsktrp.gov.si/pageuploads/Publikacije_gradiva/PRP-program-spremembe-konsolidirano.pdf

MOP 2006. Operativni program oskrbe s pitno vodo.- Ministrstvo za okolje in proctor. Available at: http://www.mop.gov.si/fileadmin/mop.gov.si/pageuploads/zakonodaja/varstvo_okolja/operativni_programi/op_pitna_voda.pdf

Slovenian Forest Service 2014. Available at: http://www.gozd-les.com/slovenski-gozdovi/statistika-gozdov/vrstna-sestava

Slovenian Water Agency (SWA) 2016. The Water Book. Available at: http://www.dv.gov.si/en/

SURS 2013. Statistični urad RS. Available at: http://www.stat.si/StatWeb/en/mainnavigation/data/show-first-release-old?IdNovice=5890

SURS 2014. Statistični urad RS. Available at: http://www.stat.si/StatWeb/en/show-news?id=5785&idp=13&headerbar=8

SURS, 2014a. Statistični urad RS. Available at: http://www.stat.si/StatWeb/prikazi-novico?id=5541&idp=13&headerbar=11

SURS 2016. Statistični urad RS. Available at: http://pxweb.stat.si/pxweb/Dialog/viewplus.asp?ma=H007S&ti=&path=../Database/Hitre_Repozitorij/&lang=2

Žvab Rožič, P., Čenčur Curk, B. 2016: Slovenian Rules on criteria for the designation of a water protection zone.- DRINKADRIA report, Faculty of Natural Sciences and Engineering University of Ljubljana, 32p.