PROLINE-CE

WORKPACKAGE T1, ACTIVITY T1.1

D.T1.1.2 TRANSNATIONAL SYNTHESIS STATUS QUO REPORT

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TABLE OF CONTENTS

1. Introduction

Given that the main objective of PROLINE-CE project is implementation of the existing strategies and management plans in order to improve the current situation in the land-use management, water resources protection and non-structural flood mitigation, reports have been made to evaluate the present-day conditions in the partner countries on a national and regional level.

Transnational synthesis report D.T1.1.2, belonging to the Activity A.T1.1 “Peer review of land use and water management practices”, was compiled from country-specific reports (D.T1.1.1), providing a systematic and structured overview of focal points in protection of water resources, land-use management and flood mitigation. Project Partners (Austria, Croatia, Germany, Hungary, Italy, Poland and Slovenia) were asked a series of strategic planning questions, with the aim of acquiring an insight into the varied aspects of the current land use and water management programmes and policies, outlining the occurring problems and offering a basis for the improvement. Additionally, the preparation of this report was based on the knowledge and findings of earlier EU-funded projects (e.g. CC WARE, DRINKADRIA and OrienGate).

This report summarizes the main transnational strategies, action plans and other policies for the implementation of sustainable land use and water management practices in drinking water recharge areas. Although all PROLINE-CE partner countries have their specific laws and practices, all EU countries are obliged to adopt measures from common directives, mainly Water Framework Directive (2000/60/EC), Floods Directive (2007/60/EC) and Drinking Water Directive (98/83/EC).

In course of developing this report, two main analytic frameworks were utilized – SWOT analysis and DPSIR analysis. To identify and evaluate possible areas for change (weaknesses and threats) and solutions to the existing issues (opportunities and strengths) of actual land-use practices and their interdependencies with the water management, a comprehensive SWOT analytic framework was carried out. DPSIR analytic tool was used to obtain better understanding of interacting factors (drivers and pressures) that change the environment. Therefore, impacts on water resources quality, quantity and floods/droughts were evaluated according to the given land-use categories, as well as impacts of flood and drought on water quality and quantity. For the purpose of reducing or preventing significant pressures to the extent required to achieve good status of water resources, Key Type Measures (KTM) were given.

The main role of this report is, coupled with other deliverables of Work Package T1, to develop the Project Output O.T1.2 “Strategy for the improvement of policy guidelines”.

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

Thorough analysis of actual policy instruments and strategies related to water management as well as governance on all authority levels is conducted in order to provide a sort of foundation that would help the decision makers and all relevant stakeholders in future plans and strategies development processes that need to ensure adequate protection of water resources (quality and quantity) but also mitigate negative impacts of water surplus or scarcity on other land-use activities.

All of the countries within the PROLINE-CE project have state specific legislation that should be in accordance with the Water Framework Directive, Groundwater Directive and Drinking Water Directive. Different laws on both the regional (districts, counties etc.) and local level (municipalities) regulate the water supply.

2.1. Water management

Several million kilometres of flowing waters and more than a million lakes cover the European continent. Clean water is of strategic importance and the greatest treasure nowadays. The appropriate list of legislation and measures ensure the proper treatment of water resources. And it is quintessential to establish the practice of law implementation in order to protect and control water quality and quantity. A summarized view of the Project Partner government bodies and other organizations in charge of water policy control, management and implementation is given in the table below.

Table 1. Condensed data that depicts the organizations in charge of water policy control, management and implementation according to Project Partner countries

Country	Water policy control & management	Drinking water policy control & management	Legal & administrative organization of water policy	Legal & administrative organization of drinking water policy	Management & coordination of implementation of water state policy
Austria	The Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management (BMLFUW - Water department)	BMLFUW (approval of Water Management Frameworks), provincial governments (regional legislation), water cooperative societies, water associations and district authorities, state governor	BMLFUW	Austrian Federal Water Act Food Safety and Consumer Protection Act - Austrian Ministry of Health (BMG) Drinking Water Decree- BMG Austrian Food Codex - BMG Province authorities for Drinking Water Protection Areas (Water protection and water conservation areas) State and District Authorities for General Water Management Frameworks - approved by BMLFUW	BMLFUW (Water department)
Croatia	Croatian Waters	Croatian Waters	Ministry of Agriculture (Water Management Administration), Croatian Waters, National Water Council, Water Service Council and the National meteorological and hydrological service	Ministry of Agriculture (Water Management Administration), Croatian Waters	Croatian Waters
Germany	Bavarian Environmental Agency (LfU), the State Offices for Water Management (WWA)	Bavarian Environmental Agency (LfU), the State Offices for Water Management (WWA)	Bavarian State Ministry of the Environment and Consumer Protection, StMUV), district government, county offices	Municipalities that establish water supply associations	County offices and governments in cooperation with the LfU and WWA
Hungary	Ministry of Interior	Ministry of Interior	Ministry of Interior	Ministry of Interior	Ministry of Interior, Ministry of National Resources, Ministry of National Development

Country	Water policy control & management	Drinking water policy control & management	Legal & administrative organization of water policy	Legal & administrative organization of drinking water policy	Management & coordination of implementation of water state policy
Italy	Ministry of Environment, Land and Sea, District authorities	Ministry of Health, Regional authorities, competent health offices	National, regional and local administration - National and Regional Government; SNPA	National and regional administrations, competent health offices	Ministry of Environment, Land and Sea, River District authorities
Poland	Water management ministry, National Water Management Authority, Regional Water Management Board, Voivodeship Governor, local government authorities	Water management ministry, National Water Management Authority, Regional Water Management Board, Voivodeship Governor, local government authorities	Regional Water Management Boards	Regional Water Management Boards	National Water Management Authority
Slovenia	Slovenian Water Agency	Slovenian Water Agency, Ministry of Health	The Ministry of the environment and Spatial Planning	Slovenian Water Agency, Ministry of Health	Slovenian Water Agency

The **Austrian** Federal Ministry of Agriculture, Forestry, Environment and Water Management (BMLFUW - Water department) controls (in cooperation with the State governor/district authority) and manages (in cooperation with the provincial governments, water cooperative societies “Wassergenossenschaften”, water associations “Wasserverbände” and district authorities) the water policy instruments. Austria in general has no quantitative problems due to only 3% of the overall available water resources being actively used. Future problems may occur in some specific regions owing to the increase of temperatures (e.g. in the case of the near-surface groundwater body “Seewinkel” in Burgenland and deep groundwater bodies “Steirisches and Pannonisches Becken” as well as “Oststeirisches Becken” in Styria and some regions in Carinthia). Based on the 2014 statistic, Austria extracted 2.18 bn m^3/year of water for public water supply of which majority is used by the industry (69% or 1.51 bn m^3/year), followed by households (25% or 0.55 bn m^3/year) and lastly agriculture (6% or 0.13 bn m^3/year) (Umweltbundesamt, 2014) (**Fig. 1**).

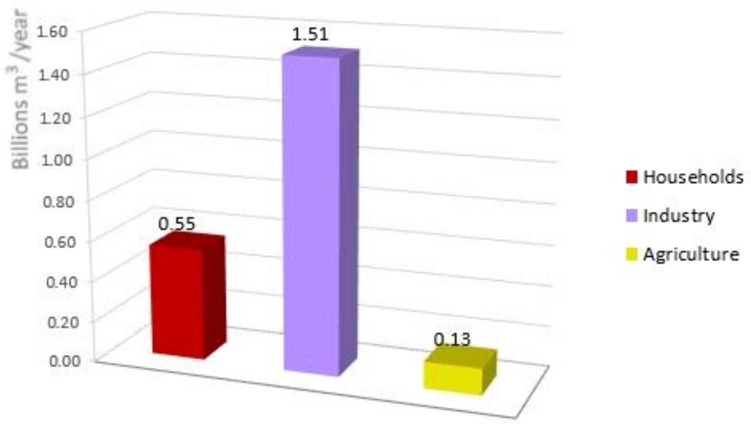


Figure 1. Water use in Austria per different sectors (industry, household, agriculture)

Water management in the Republic of **Croatia** functions under the authority of Ministry of Agriculture (Water Management Administration) which recommends and issues legal framework comprised of acts and ordinances in the field of water management. Water management is also led by Hrvatske vode (Croatian waters) founded by the Republic of Croatia as legal, executive entity which is responsible for water management, implementation and coordination of state policy in the field of water, including the development of River Basin Management Plan. Ministry of Agriculture and Croatian Waters cooperate with other administrative bodies, scientific and professional institutions on national, regional and local level (e.g. The National Water Council, The Water Services Council, National Meteorological and Hydrological Service etc.). Based on a 2012 statistics, Croatia extracted 953 million m^3 of water for various purposes (hydropower is not included). Water resources that are used for the extraction are groundwater wells (about 41%), springs (17%) and the remaining 42% are extrications of surface water. Almost half of the extracted water (460.8 million m^3/year) is used for public water supply, comprised of 49% from groundwater, around 16.4% from surface resources (rivers, accumulations and lakes) and 35% from springs. The remaining 492.5 million m^3/year of the drawn water is for technological purposes, agriculture (irrigation, livestock), for freshwater aquaculture, recreation, health and the production of electricity (**Fig. 2**) (River Basin Management Plan 2016.-2021.).

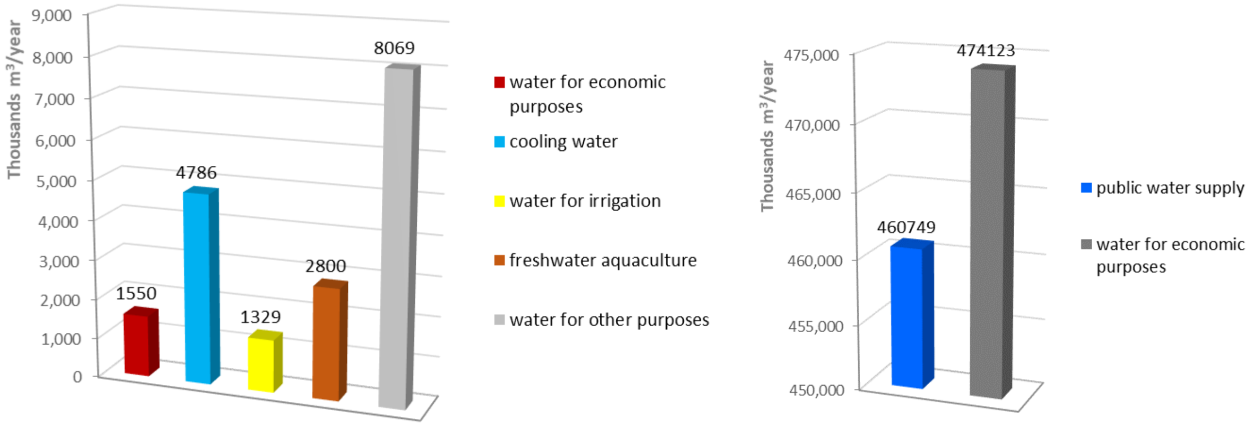


Figure 2. Water use in Croatia per different sectors (industry, household, agriculture) in 1000 m^3/year (River Basin Management Plan 2016.-2021.)

The legal and administrative organization of water policy in Bavaria (**Germany**) is divided into three parts: the highest level public water authority (Bavarian State Ministry of the Environment and Consumer Protection, StMUV), the upper public water authority (district governments) and the lower public water authority (county offices). The Bavarian Environmental Agency (LfU) gives technical support for the implementation of state policy and elaborates different drafts for the control and management of water policy. On the local level, the State Offices for Water Management (WWA) perform controls with regard to compliance with the regulations and manage water policy. The WWA further undertakes consultancy tasks for technical aspects in terms of water management to support and advice the enforcement authorities (governments and county offices) (StMUG, 2013). Statistical data on water provided for **Germany** refer to Bavaria. In 2013 a total amount of water used for public water supply was 1,039,980,000 m^3 out of which 82% was gained by extraction systems located in Bavaria and 18% from external procurement (e.g. water suppliers from neighbouring states) (**Fig. 3**). From the Bavarian extraction systems, 71% was extracted from groundwater resources, 18% from springs and 11% from surface waters (including bank filtration) (LfStat, 2015a). The non-public water supply in the same year, reached a total amount of 2,787,324,000 m^3 whereof 94% has been gained from water extraction systems located in Bavaria (LfStat, 2015b).

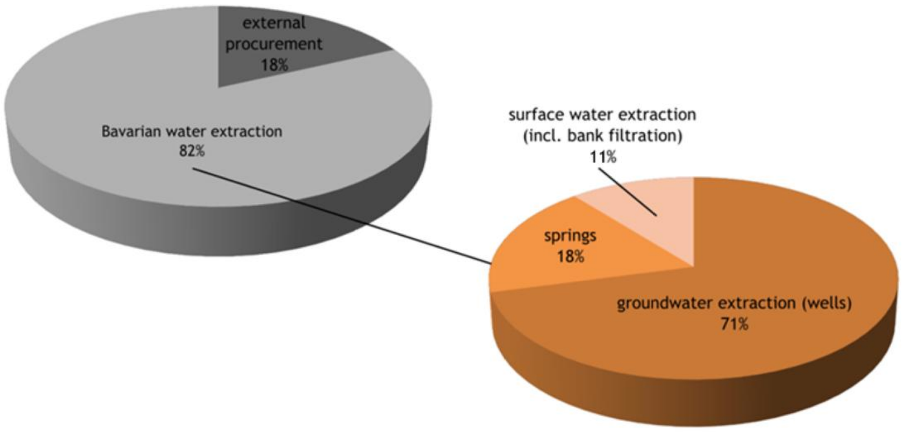


Figure 3. Public water supply and percentage distribution of relevant resources in Bavaria in 2015 (data provided by LfStat, 2015a)

70.3% of the public water supply has been supplied to end consumers, whereof 80.4% has been supplied to households and 19.6% to industrial and other customers (**Fig. 4**). 17.5% of the total water supply has been used for further distribution, while 2.4% has been consumed by the water utility itself. The remaining amounts are assigned to water losses and measuring errors (LfStat, 2015a).

Most of the water from non-public water suppliers has been used for energy supply (68%) as well as in the manufacturing sector (29%). These two activities represent the main water consumers from the non-public water supply. The third largest amount has been used in mining industry (1%). The remaining amounts are used by further economic departments, such as the construction or traffic industry (LfStat, 2015b).

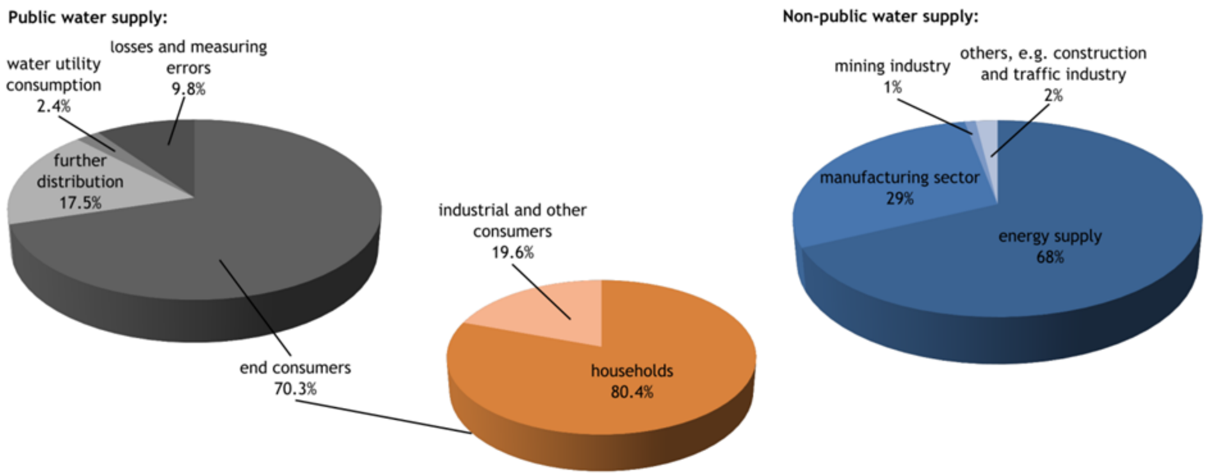


Figure 4. Distribution of public and non-public water supply in Bavaria in 2015 (data provided by LfStat, 2015a and LfStat, 2015b)

In **Hungary** Ministry of Interior is responsible for the legal and administrative organization of water policy instruments and it cooperates with Ministry of National Resources and Ministry of National Development. General Directorate of Water Management and 12 water management directorates are responsible for water management. The total amount of extracted water in 2013 was 5655 $x10^6$ m^3 or 4636 $x10^6$ m^3 (82%) from surface water sources and 1018763 $x10^3$ m^3 (18%) from groundwater sources. Approximately 95% of drinking water in Hungary is from its rich groundwater sources (including bank filtration). However, almost 2/3 of the sources are vulnerable. The geothermic gradient in Hungary is higher than average, resulting in the abundance of thermal (often 70-90°C) waters. Thermal waters are used for recreational and therapeutic purposes. The major consumer of the surface water is the energy industry (77%), in particular the atomic power industry that uses it for cooling purposes. Water demand of public use, irrigation and fish farming is also significant, followed by recreation and ecology (**Fig. 5**).

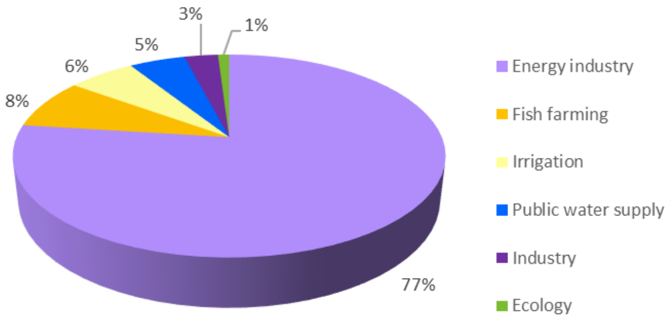


Figure 5. Distribution of surface water use among different sectors in Hungary in 2013

In total, 19 surface water resources and nearly 2,000 groundwater resources service drinking water; 5 of the 19 drinking water resources supply from rivers directly, 5 established for the purpose of drinking water supply dam reservoir, and further 7 supply from the Lake Balaton. Groundwater is used for drinking, industry, energy, mining, bath and reinjection.

In **Italy**, water policies are based on the general principle of subsidiarity, fundamental to the functioning of the European Union, as well as on the principles that all waters are public good of general interest. Regional and national policies on water are managed through a multilayer governance system, where competences are distributed among different territorial and sectoral Institutions (Alberton, 2011). It must be considered that in Italy, all European Directives both concerning water protection, water management, floods and droughts have been adopted.

Furthermore, data, statistical analysis and reports on water management are regularly published by several public and private organizations such as COVIRI, ISTAT, ANEA, UTILITALIA, IRSA, ANBI, ISPRA and the network of Permanent Observatories on water uses. Hydrological data are collected in Hydrological Yearbooks (AA.VV., La siccità in Italia; AA.VV. Un future per l'acqua in Italia).

Groundwater, surface water bodies and marine or brackish water respectively cover about 85%, 15% and 0.1% of water demand (from 3.2.1. of T1.1.1. Italy). For the time frame from 1971 to 2000, the mean annual potentially available water resource for Northern Italy was around 42.000

x10^6 m^3 and 86.000 x10^6 m^3 for Italy (from 2.1 of T1.1.1 Italy). These are theoretical values and can be considered as upper limits of available water resources. At present, data on the water supply for the Italian territory are not homogeneous.

Drinking water supply data are more detailed and complete (ISTAT, 2012), and point out to:

- 3.496 x10^6 m^3/year from springs,
- 4.528 x10^6 m^3/year from ground water wells,
- 1.427 x10^6 m^3/year from surface waters (of which 981 x10^6 m^3/year from lakes/reservoirs).

Total water abstracted for drinkable use is 9450 x10^6 m^3/year for all Italy and 4.121 x10^6 m^3/year. The use of water from public water supply is around 5.232 x10^6 m^3/year for all Italy and 2.693 x10^6 m^3/year for Northern Italy.

The water supplied per capita for domestic use is about 175 l/in./d (updated to 2011 for the 116 chief towns; ISTAT, 2012) with a remarkable decrease compared to 2008 survey (210 l/in./d; -16%); however, large variations are detectable among the urban centres with values ranging slightly over 100 l/in./d for Arezzo (Central Italy) and nearly 250 l/in./d for Catania. In this regard, a crucial role is played by pipeline leaks; indeed, the difference in percentage between water fed into the network and dispensed amount reveal losses above equal to 50% for 27 cities over 84 while only in 8 cases it does not reach 15% (average value 37%) (De Gironimo et al., 2015).

Irrigation data are less complete. Water abstractions of surface water operated by irrigation consortia are evaluated to be 20.600 x10^6 m^3/year for Northern Italy (RBMPs of Po and Eastern Alps Districts); no data is available for Italy as a whole. Similarly, no complete data is available for groundwater abstractions for irrigation uses. On the basis of ISTAT data of water used at a farm scale, an abstraction of groundwater can be estimated at ~2.200 x10^6 m^3/year in Italy and 810 x10^6 m^3/year in Northern Italy, and an abstraction of surface waters operated directly by the farmers of 2.400 x10^6 m^3/year and 1.800 x10^6 m^3/year in Northern Italy.

Industrial abstractions are at about 2.000 x10^6 m^3/year for Northern Italy (RBMPs of Po and Eastern Alps Districts). No complete data are available for Italy; about 3.000 x10^6 m^3/year can be estimated on the basis of number of employees and water consumption standards for each type of productive activity.

Hydropower uses are not included, as well as the abstractions related to internal navigation, environmental uses on canals, civic uses, etc.

Water supplied to customers (for both domestic and non-domestic use) is evaluated to be 5.250 x10^6 m^3/year for Italy and 2.600 x10^6 m^3/year for Northern Italy (ISTAT, 2012).

Water required for irrigation of the crops is estimated (ISTAT, 2014) in 11.100 x10^6 m^3/year for the entire territory of Italy, and 8.100 x10^6 m^3/year for Northern Italy.

The large part of the water supply of Northern Italy is used for irrigation (**Fig. 6**) showcasing the development of Italian agriculture and how wide spread it has become. Zootechnical uses are very low, and can be estimated be 300 x10^6 m^3/year for Italy and 200 x10^6 m^3/year for Northern

Italy on basis of livestock numbers and per capita water consumption standards for each type of livestock (from Water Balances updates in Emilia Romagna Region).

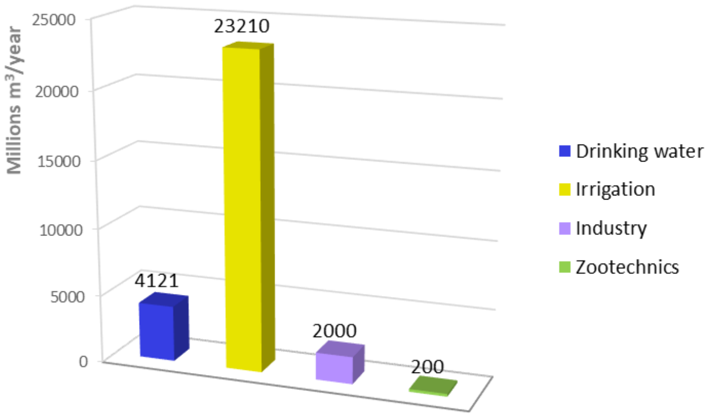


Figure 6. Water abstraction for the main types of purposes in Northern Italy (data x 10^6 m^3/year)

The inhomogeneous and fragmented data for the territory of Italy should offer room for improvement (both in water efficiency and in water distribution and use data collection) and must not be ignored. The majority of the water is used for irrigation.

In **Poland** authorities in charge of water management are Minister in charge of water management, President of the National Water Management Authority – as a central government authority, supervised by the Minister, Head of the Regional Water Management Board – as a non-combined government administration authority, who reports to the President of the National Water Management Authority, Voivodeship Governor and local government authorities. In 2014, total surface water resources in Poland amounted to 52,238,600,000 m^3 (including 6,620,400,000 m^3 flowing in from abroad, with the outflow from catchment areas in Poland at 45,618,200,000 m^3). Furthermore, the abstraction of water (groundwater and surface water) was over 10,689,800,000 m^3, of which 84.3% was the abstraction of surface water, 15.1% groundwater, and 0.6% was water from the drainage of mining operations areas and civil structures, used for manufacturing purposes. The majority of water abstracted for the needs of the population and economy was used for manufacturing purposes (71.5%). Water abstracted for the operation of water supply networks (water supplied to the population) accounted for 18.6% of the total abstraction, and irrigation in agriculture and forestry for 9.9% (**Fig. 7**). As much as 96.6% of the abstraction of water for manufacturing purposes was from surface water wells, with only approx. 2.6% of the abstraction being from groundwater, and about 0.8% from the drainage of mining operations and civil structures. Polish water supply predominantly consists of groundwater with a significant surface water input (15%). The interesting part is the 0.6% of drainage water from mining areas that is used in manufacturing of goods and represents a good practice of reusing resources in an environmentally friendly way.

At the national level, the greatest abstraction of water is found in the central and north-western regions (Mazowieckie, Wielkopolskie, Zachodniopomorskie and Świętokrzyskie Voivodeships). The greatest water demand, in relation to water abstraction, is observed in the energy sector, with abstraction for its purposes accounts for more than 91.2% of the total water abstraction for industrial purposes and 64.7% of the total water abstraction nationwide.

According to the data by Central Statistical Office of Poland, in 2014, 1,056,600,000 m^3 of water was abstracted for irrigation purposes in agriculture and forestry and for the filling up of fish ponds, with 975,800,000 m^3 being used for the filling up of fish ponds (with an area below 10 ha) alone (the total area of fish ponds was 49,600 ha).

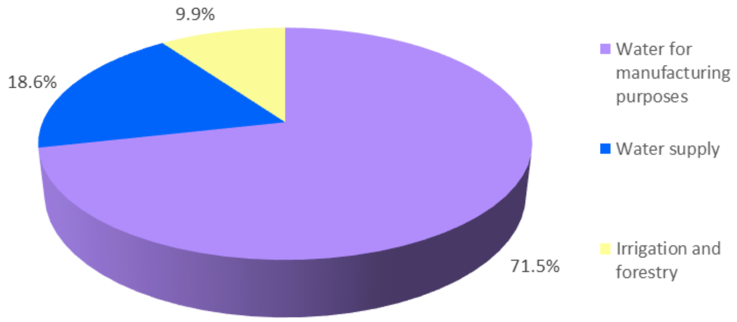


Figure 7. Water use in Poland per different sectors (Central Statistical Office of Poland, 2014)

According to the Statistical Office of the Republic of **Slovenia** (2016), the total amount of abstracted water in Slovenia in 2015 was 897.2 million m^3. 185 million m^3 or 20.6% of water were abstracted from groundwater. 712.2 million m^3 or 79.4% of water were abstracted from surface water, which includes water from watercourses and reservoirs. The amount of water used for the public water supply was 164.4 million m^3 in 2015. Households consumed 78.5 million m^3 of water from the public water supply in 2015, while on the other hand business entities consumed 33.4 million m^3 of water. 5.9 million m^3 of water were supplied but uncharged (water from hydrants, water for firefighting, water for cleaning roads, etc.) (Republic of Slovenia, Statistical Office, 2016).

The graph on **Figure 8** depicts the origin of abstracted water from the public water supply system for the year 2014. Almost all of the abstracted water belongs to the groundwater (97%), with only small parts of surface water (2%) and artificial enrichment (1%). As Slovenia is a karstic country, it is an understandable outcome.

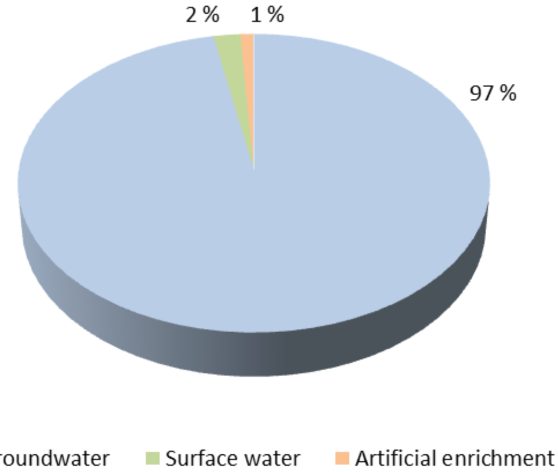


Figure 8. The percentage of abstracted water quantities in the public water supply system in 2014 (SURS, 2014a)

Overview of water supply per Project Partner countries

Water management is an individual country responsibility and should serve at its best interest. It implies control and motion of water resources in order to maximize their efficient utilization and to minimize the negative aspects such as pollution, flood and drought, just to name a few.

Austria uses only 3% of the overall available water resources which is a boon that not many countries enjoy. But the worsening climate change will in the future affect them as well. The major part of the water is being used by the industry (69%). In **Croatia**, half of the extracted water is being used for public water supply which originated mostly from groundwater resources. **Germany** extracts the majority of its public water supply from systems in Bavaria (82%) and the remaining 18% from external procurement. Bavarian extraction systems constitute mostly from groundwater resources (71%). More than two thirds (70.3%) of the total water supply is supplied to end customers for drinking and household purposes. Most of the water from the non-public water supply is being used for the energy supply (68%). Around 95% of drinking water in **Hungary** derives from its groundwater resources. The major consumer of the surface water is the energy industry (77%), in particular the atomic power industry that uses it for cooling purposes. In **Italy**, the annual available water resources are divided between the Northern Italy and the country as a whole, while the Northern part constitutes for almost the half of the country's water supply. Only theoretical values exist and the data should be statistically confirmed and unified between the North and the rest of the country. The majority of water in Italy is being used for drinking purposes, followed closely by irrigation and industry. In **Poland**, the majority of the abstracted water for technical and industrial usage comes from surface resources (84.3%). The majority of water abstracted was for the energy sector (64.7%, followed by irrigation purposes). When it comes to the abstraction of water for the operation of the water supply networks, 71.2% of water was abstracted from groundwater wells and 28.8% from surface water wells. **Slovenian**

water supply consists of predominantly groundwater resources (97%) while the rest belongs to surface water. The majority of the water extracted is used for the drinking water supply.

The following graphs offer a comparison between the amount of extracted water and water supply origin among Project Partner countries in order to illustrate the water supply status of each partner. As it can be seen on **Figure 9**, the highest amount of water was extracted in Poland with 10,690 x10^6 m^3. Poland is followed by Italy with 9458 x10^6 m^3, Hungary with 5,655 x10^6 m^3, while Croatia with 953 x10^6 m^3 and Slovenia with 164.4 x10^6 m^3 have the smallest amounts of extracted water.

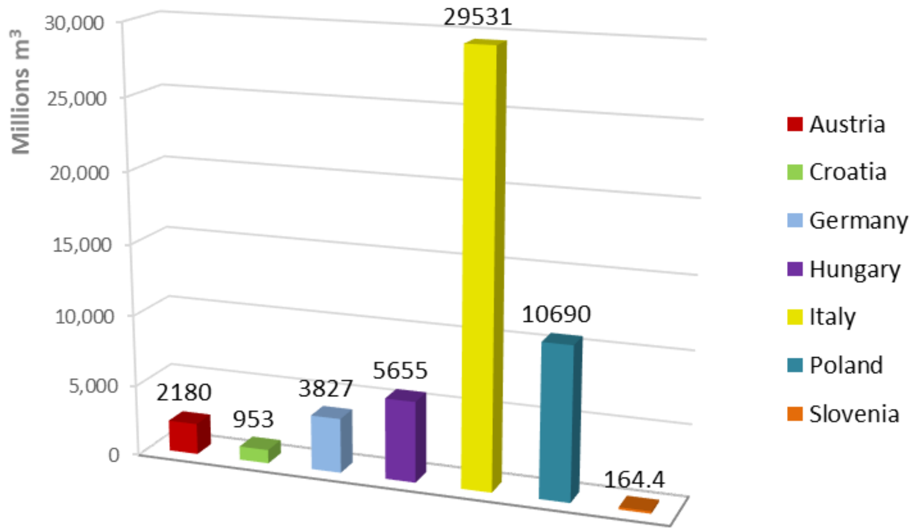


Figure 9. Extracted water per Project Partner country (*data for Italy by ISTAT (2010, 2012) relates to water abstracted for drinkable use for Norther Italy; data for Germany relate to water gained from extraction systems located in Bavaria)

Almost all Project Partner countries extract the majority of water from groundwater resources (**Fig. 10**). Only Poland along with Hungary can be singled out based on the small amounts of water extracted from groundwater resource (Poland with 15.1% of extracted groundwater; Hungary with 18% of extracted groundwater).

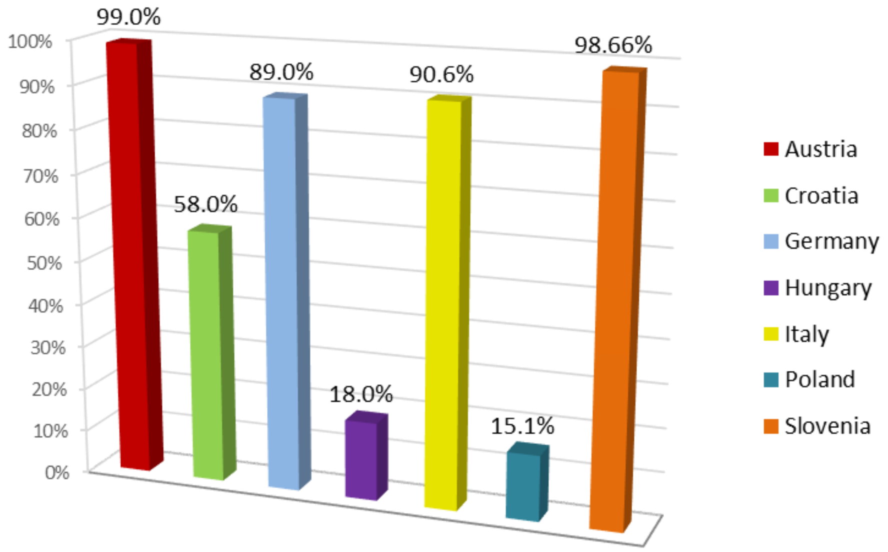


Figure 10. Water extracted from groundwater resources, per Project Partner country (*data for Austria, Croatia, Hungary, Poland and Slovenia are for the total water demand, data for Northern Italy by ISTAT (2012) relates to water abstracted for drinkable use – springs and wells)

As mentioned above, Hungary (around 82%) and Poland (around 84%) extract the majority of water for the drinking water supply from surface water resources, while Slovenia (1.34%) and Austria (1%) extract smallest amounts of surface water (**Fig. 11**).

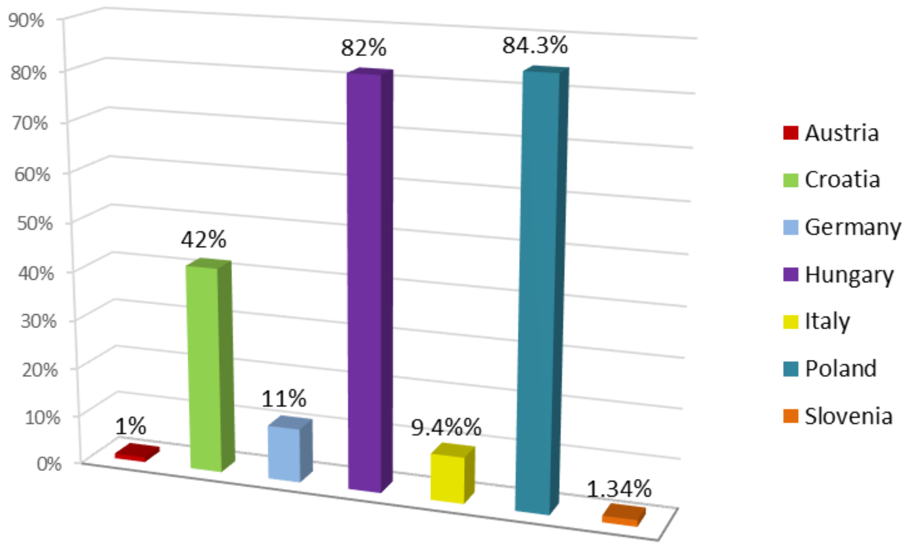


Figure 11. Drinking water from surface water resources, per Project Partner country (*data for Austria, Croatia, Hungary, Poland and Slovenia are for the total water demand; data for Germany is only water gained from extraction systems located in Bavaria; data for Northern Italy by ISTAT (2012) relates to water abstracted for drinkable use – watercourses, natural lakes, artificial basin, marine and brackish water)

According to the data provided by the Italian Project Partner, Northern Italy extracts 63.2% of water intended for drinking water supply from wells, while other 36.8% from surface waters and springs. Along with groundwater resources and surface water, Poland extracts 0.6% of water by draining mining areas.

2.2. Drinking water protection zones

2.2.1. Protection zones and restrictions

According to the Council Directive 98/83/EC of 3 November 1998 on the quality of water intended for human consumption (Drinking Water Directive), to protect human health from adverse effects of any contamination of water intended for human consumption, its wholesome and clean state must be ensured. Therefore, the establishment of drinking water protection areas where water for human consumption is abstracted, is a must. The overview of drinking water protection zones within Project Partner countries is presented in the **Table 3**.

2.2.1.1. Austria

Around 6.84% of the Austrian territory is under the DWPZ (**Fig. 12**) that are defined by the Austrian Water Act (according to the .shp data provided by Project Partner). The responsible authorities (The Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management - BMLFUW - Water department; State governor or district authority) issue a decree for Drinking Water Protection Zones (DWPZ) and are responsible for the implementation of all relevant measures. Additionally several guideline catalogues (like the "Guideline ÖVGW") are existing, but are not mandatory. The responsible authorities also regulate the land use or prohibit the construction of certain facilities within these areas and ensure the delineation within the respective spatial plans (land-use plan etc.). DWPZ are classified into two different protection zones:

- Zone 1
  - has to be protected with fences
- Zone 2
  - has to be marked by means of information boards

DWPZ one and two are defined according to the hydrogeological characteristics and are delineated parcel-specific within relevant spatial plans, while large DWPZ ("Trinkwasserschongebiete") do not have to be delineated mandatory within spatial planning instruments – depending on the respective planning authority.

The water supplier is obliged to control the relevant DWPZ and the Water Authority conducts unannounced inspections once a year. Every five years a civil engineer for land and water management makes an on-the-spot check ("technical external monitoring") – commissioned and paid by the relevant water supplier.

In case of inadequate land use or legal conflicts within DWPZ, the report is submitted to the authorities, which than issues penalties according to the Austrian Federal Water Act. Water suppliers and land owners are party in case of any legal conflicts. The position of land owners is stronger than the position of water suppliers. Due to this fact the city of Vienna has bought a huge part of the related DWPZ and hence actually is there land owner.

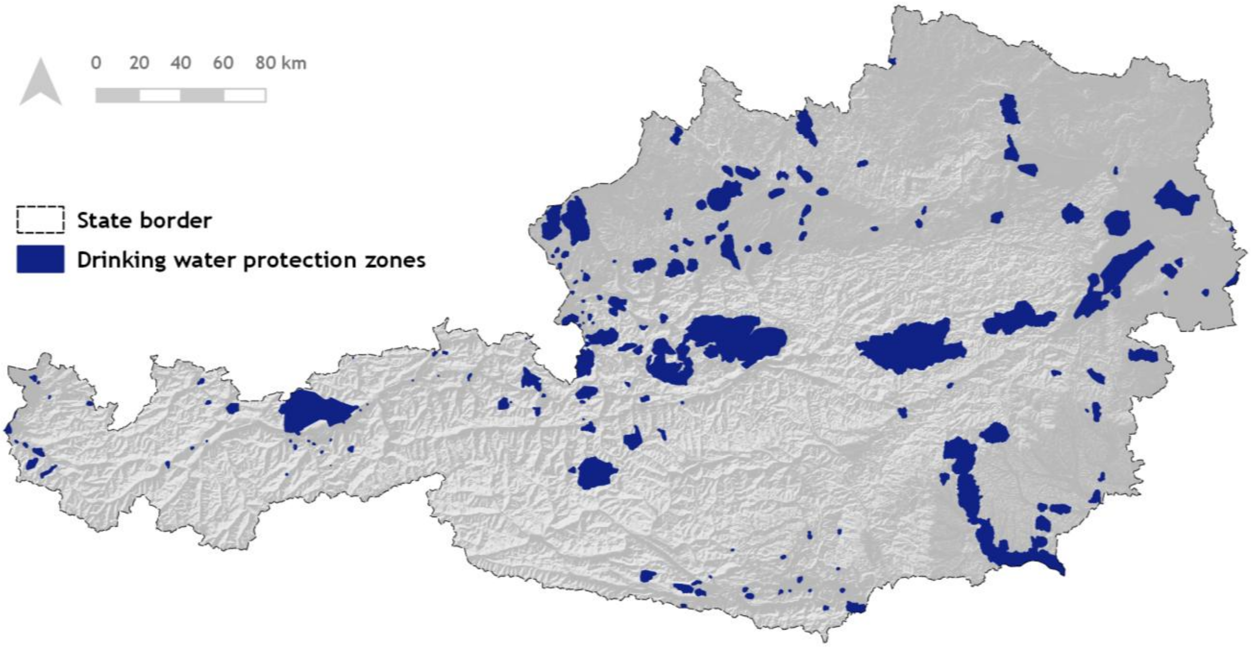


Figure 12. Drinking water protection zones in Austria

2.2.1.2. Croatia

Drinking water protection zones take up around 19.08% of Croatia's territory (Fig. 13) (according to the .shp data provided by Project Partner). Authorities responsible for water management are Ministry of Agriculture (Water Management Administration) and Croatian Waters who cooperate with regional and local government units.

Criteria for delineation of DWPZ in intergranular aquifers are groundwater travel time and discharge rate, while in aquifers with fracture and fracture-cavernous porosity criteria additionally take into account groundwater flow velocity. There are three defined water protection zones in intergranular aquifers and four in aquifers with fracture and fracture-cavernous porosity. Legislation in Croatia also allows establishing special protected areas in the sense of water protection reserves in the remote and mountainous regions where several DWPZ can be joined together. DWPZ are implemented within "Terms of use, development and protection of space" of physical planning documents on national, regional and local level. In these documents for each established zone interdictions and protection measures are given, while the borders of zones are implemented in cartographic representation of plans.

According to the Croatian regulations for DWPZ, there are a number of limitations and restrictions in the particular sanitary protection zones. In aquifers with fracture and fracture-cavernous porosity, restrictions are more rigorous then in intergranular aquifers. According to the level of limitations and restrictions DWPZ are divided into IV zones of limitations:

- IV. zone
  - wastewater discharge without previous treatment,
  - construction of production facilities for hazardous substances,
  - construction of facilities for recovery, treatment and disposal of hazardous waste,
  - construction of facilities for storage of radioactive, hazardous or oil-based fuels and materials,
  - removal of topsoil,
  - use of powder explosives,
  - exploration and exploitation wells, except for water research,
- III. Zone
  - all prohibitions from zone IV and additionally,
  - temporary or permanent waste disposal,
  - pipeline construction (hazardous fluids),
  - construction of gas stations without proper technical precautions,
  - surface of underground mining excluding geothermal and mineral waters,
- II. Zone
  - all prohibitions from zone IV. and III. zone and additionally,
  - agricultural production, except ecological (organic),
  - cattle production (maximum 20 livestock units),
  - the formation of new cemeteries and expansion of existing,
  - construction of all industrial facilities that pose threat to water environment,
  - forest clear cuts except sanitary cuts,
- I. zone
  - The first zone is intended to protect all the capturing facilities (e.g. springs, wells, drainages, etc.) and the area which directly drains toward these facilities. First zone must be fenced. In the I. zone, all activities except those related to abstraction, conditioning, and transfer of water in the supply system are prohibited

The relevant water inspection define penalties that are laid down in accordance with the applicable laws.

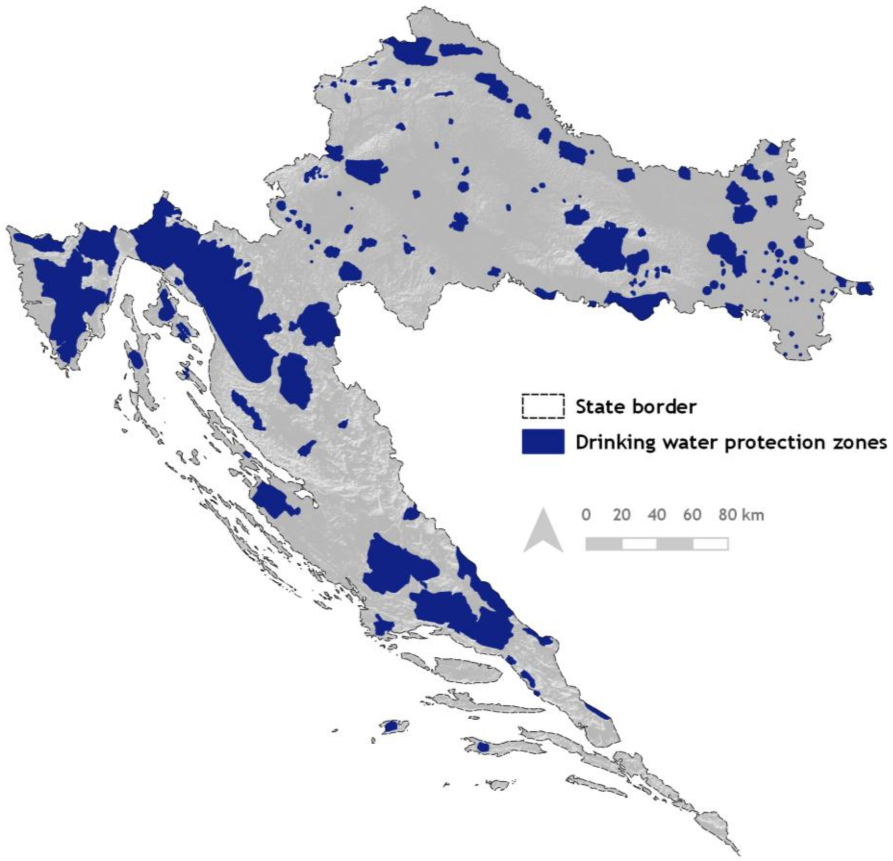


Figure 13. Drinking water protection zones in the Republic of Croatia

2.2.1.3. Germany

According to §51 in The German Federal Water Act (Wasserhaushaltsgesetz - WHG), water protection zones (**Fig. 14**) are determined as far as it is required for the general well-being. The criteria for the determination of DWPZ are:

- the protection of water bodies which are assumed to be of particular interest for currently existing or prospective public water supply;
- to quantitatively enrich the groundwater aquifer;
- to protect the water bodies from harmful rainfall runoff and discharges from agricultural land carrying soil particles, fertilizers or pesticides.

Basically, limitations and restrictions are mostly adapted to site-specific characteristics and thus may differ between water protection zones. However, general valid requirements are given by a model ordinance of the LfU (LfU, 2003). Within the model ordinance, general limitations and restrictions are made for:

- activities intruding into the subsurface (e.g. limitations for activities intruding into aquifer protective layers),
- handling of substances hazardous to water (e.g. restrictions for the construction and use of installations for the treatment or distribution of substances hazardous to water),
- wastewater treatment and disposal (e.g. interdiction to implement overflow tanks for the discharge of rain or mixed waters),
- traffic routes, spaces for specific purposes and house gardens (e.g. interdiction to implement storage facilities for construction materials),
- structural installations (e.g. interdiction to designate new building areas) and agricultural, silvicultural and horticultural land uses (e.g. interdiction to spread sewage sludge).

Data within the .shp provided by Project Partner include only DWPZ within Bavaria, and they take up around 1.01% of the total German territory. DWPZ borders are in line with the relevant spatial planning documentation and should be drawn so that they are following land plot borders (LfU, 2010a).

The responsibility to control the implementations of measures as well as their success (in terms of enhanced water quality and/or quantity) is legally transferred to the water supplier. The water supplier thus performs a self-monitoring. Furthermore, penalties may be imposed in case of negligent or intentional non-compliance with the limitations and restrictions defined for each DWPZ.

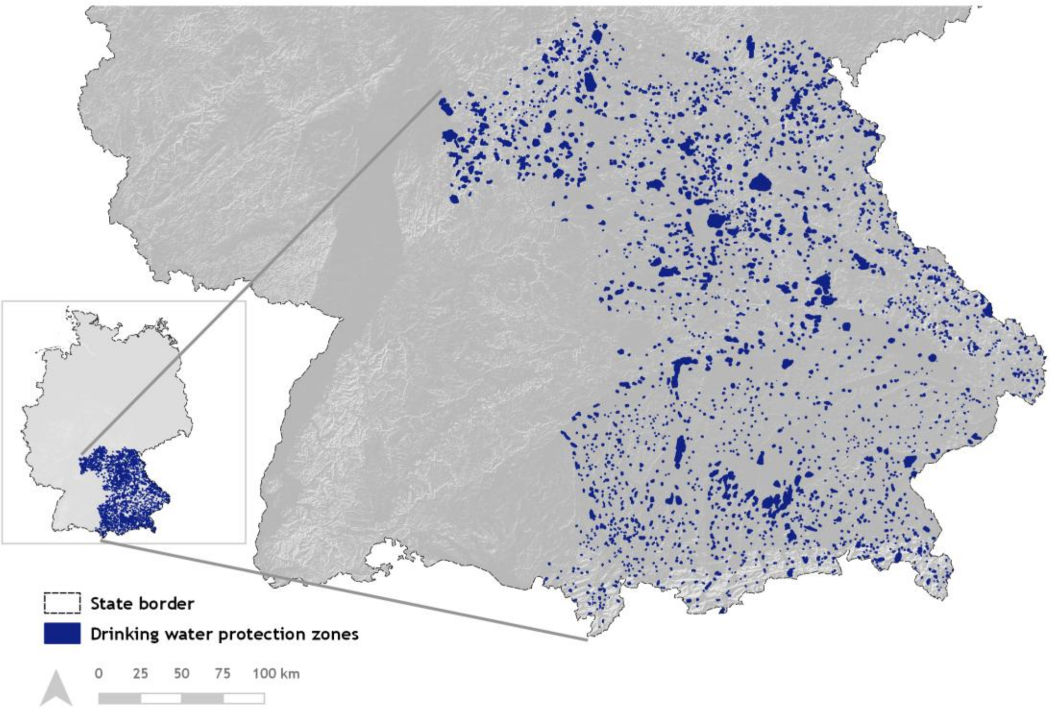


Figure 14. Drinking water protection zones in Germany (Project Partner provided data only for the Bavaria area)

2.2.1.4. Hungary

The legal and administrative organization of water policy in Hungary, is the responsibility of the Ministry of Interior. General Directorate of Water Management and 12 water management directorates are responsible for water management.

Government Regulation 123/1997 (VII.18.) on the protection of the actual and potential sources and the engineering structures of drinking water supply defines the criteria of water protection zones. The scope of this regulation extends to the sources of water serving the supply of drinking water, mineral and medicinal water development, regardless whether actually exploited, committed or designated for future use, further to the facilities which serve the treatment, storage and distribution of water for such uses, and which supply water to at least 50 persons on a daily average.

Protection includes determination, designation, establishment and maintenance of a protective block or area or zone (**Fig. 15**). Protection is realised by the implementation of part, or all of the safety measures. The boundaries of the protective zones shall be determined by observing the particular hydrological and hydrogeological conditions considering the permitted rate of abstraction or in the case of future sources of supply the full capacity of the aquifer(s). The protective measures set forth in the regulation serve the following purposes:

- The inner protective block, zone: protection of the abstraction works and the water supplies from direct pollution and damage,
- The outer protective block, zone: protection against refractory, further bacterial and other decomposable pollutants,
- The hydrology or hydrogeological block, zone: Protection against refractory pollutants by measures prescribed for the entire, or part of the catchment (recharge) area of the abstraction. The hydrogeological protective block or area is subdivided to “A”, “B” and “C” protective zones.

The delineation of the protection zones is based on the estimation of the travel time, assuming steady seepage flow.

The most stringent restrictions are in the inner zone, for example: The inner zone shall be fenced or guarded in another effective manner. The owner of the inner zone shall be the same as that of the water facilities. Regular access shall be permitted to the personnel of the operator of the water facility, who perform work there and who possess a “health book” demonstrating the regular medical checks provided for in another act of legislation. Entry shall be authorised further to superiors of the personnel and representatives of the supervisory authority, further to persons authorised specifically (e.g. for the period of performing work) by the owner of the protective area. The person authorising entry shall be responsible for preventing those staying temporarily in the protective area from causing pollution.

In the protection zones depending on in which zone, several activities are prohibited, or prohibited for new facilities and activities, or may be allowed pending on the outcome of an environmental audit or environmental impact assessment. Other activities are allowed if they operates without pollution or new facilities and activities can let pending on the outcome of an EIA, or environmental audit, or an equivalent investigation. Some activities are not restricted at all or in the hydrological or hydrogeological zones.

Spatial planning documents take into consideration all the vulnerable DWPAs and DWPZs (including those areas which are not yet designated by the authority, but are determined or estimated). DWPZs are part of the national water quality protection zone on the National Spatial Management Plan.

DWPZ take up around 7.96% of the Hungarian territory (according to the .shp data provided by the Project Partner).

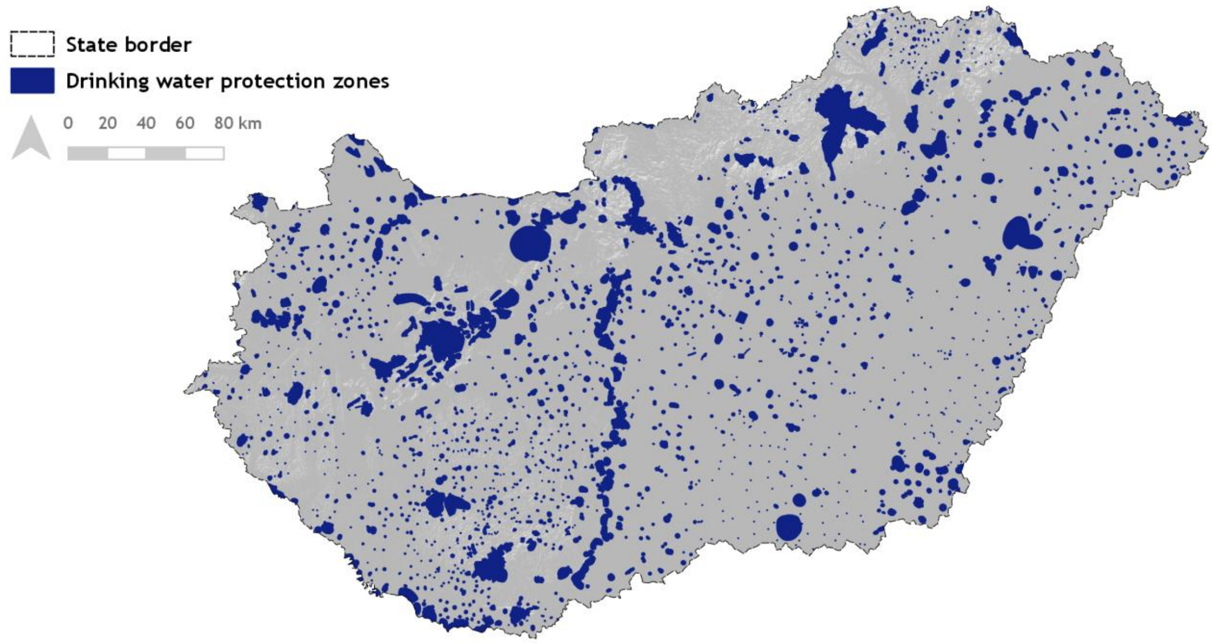


Figure 15. Drinking water protection zones in Hungary

Water Authorities of Government Offices control the compliance with the provisions, obligations and restrictions on designated and established protective blocks, protective areas and zones. Authorities also define fines and suspensions in case of non-compliance with the DWPZ requirements.

2.2.1.5. Italy

According to Italian D.Lgs. 152/06, the criteria for determining water protection zones are defined by the Regional Administrations at the proposal of the Water Services Regulation Authority; the regulation is finalized to avoid contamination of water resources for drinking water supply, from pollutants. Water Services Regulation Authority cooperates with the Environmental and Health Agency and local authorities.

The protection zones for surface and groundwater resources are designated based on the geological, hydrogeological, hydrological and hydrodynamic characteristics of springs, wells and supply points of surface drinking water. The general criteria are: geometric, hydrogeological and temporal.

Near the catchment with protected areas, land-use constraints are established, designed with the aim to ensure the appropriate quality of drinking water supply. The protection areas are designed through: “static security”, “dynamic” or “geometric” criteria.

The “static” protection consists of prohibitions, restrictions and regulations aimed at preventing deterioration in the quality of water at the catchment points, as well as measures and limiting land use for both quantitative defence and resource vulnerability.

The “geometric” protection and “dynamic” is applied in the buffer zones. The “geometric” protection is established by a circular area of 200 meter radius from the catchment point (“Water Protection plan” 2005). The “dynamic” protection is formed by the activation of a management system to monitor water quality in the catchment inflow able to check the quality parameters to allow the reporting of any resource faults.

Data within the .shp provided by Project Partner include only DWPZ within Northern Italy, and they take up around 36.33% of the total Italy’s territory (**Fig. 16**). Borders of DWPZ are part of the cartographic spatial planning documentation but are also included in regulations/restrictions of land-use activities. They do not follow the land plot borders, but the design criteria are considered no matter the ownership relationship. The list of cadastral parcels positioned on the DWPZ is not publicly available.

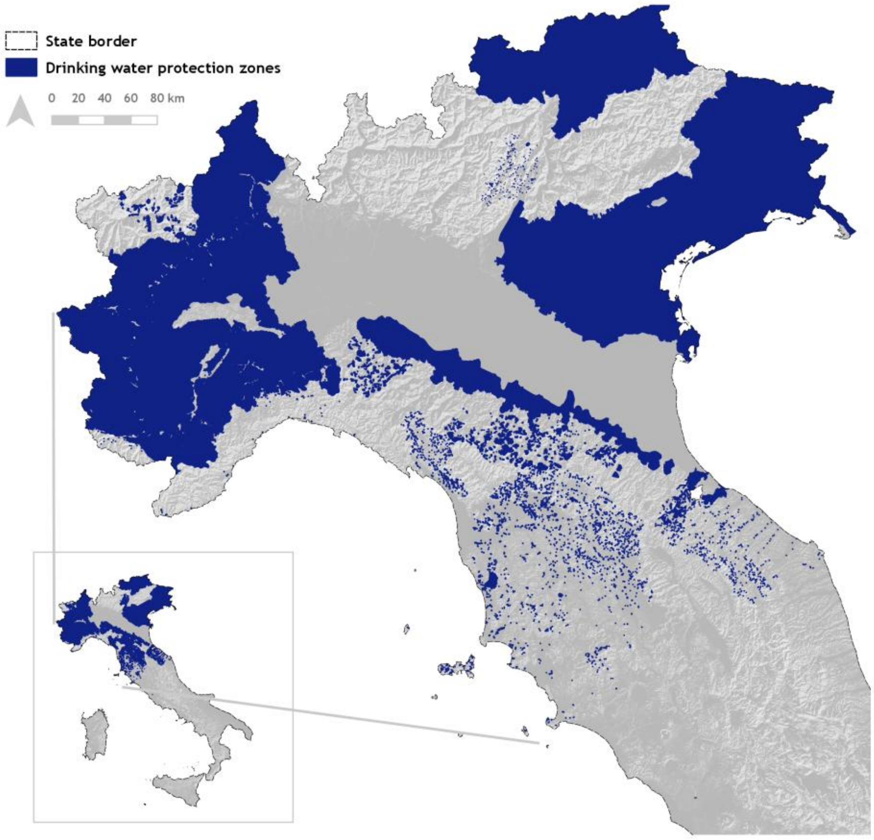


Figure 16. Drinking water protection zones in the Northern Italy

In case of inadequate land-use activities or other conflicts with the limitations and restriction defined for DWPZ, administrative fines are determined.

2.2.1.6. Poland

The authorities in charge of water management in Poland include:

- Minister in charge of water management;
- President of the National Water Management Authority – as a central government authority, supervised by the Minister in charge of water management;
- Head of the Regional Water Management Board – as a non-combined government administration authority, who reports to the President of the National Water Management Authority;
- Voivodeship Governor;
- local government authorities.

Pursuant to Art. 51 of the Water Law, in order to ensure the appropriate quality of water abstracted for the public supply of water for human consumption and supply water to industrial plants requiring high-quality water and also to protect water resources, it is possible to establish water intake protection zones and protected areas of inland water reservoirs. DWPZ are determined based on hydrogeological characteristics.

Water intake protection zones are divided into primary and secondary protection zones. In primary surface water and groundwater intake protection zones it is forbidden to use land for purposes unrelated to water intake. In such areas:

- rainwater must be discharged in a way which prevents it from penetrating into water abstraction devices;
- land should be covered with greenery;
- wastewater from sanitary equipment intended for use by persons employed to operate water abstraction devices must be discharged outside the primary protection zone;
- the presence of non-employees in the area of operation of water abstraction devices must be limited to situations in which it is absolutely necessary.

Primary protection zones must be enclosed and their borders along surface waters must be marked using permanent standing or floating signs located in visible places; the enclosures and signs must feature information boards containing information about the water intake and warning that entry by non-authorised persons is prohibited (Art. 53 (3)).

Secondary protection zones may impose a ban or restriction on works and other activities which could reduce the suitability of the abstracted water or water-intake efficiency, in particular:

- Discharging wastewater into water or onto land;
- Using wastewater for agricultural purposes;
- Storing or landfilling of radioactive waste;
- Using fertilisers and plant-protection products;
- Constructing motorways, roads and rail tracks;
- Conducting drainage and excavation works;
- Locating industrial establishments and breeding farms;
- Locating warehouses for petroleum products and other substances, and also pipelines for their transport;
- Locating landfills for municipal, hazardous, non-hazardous and non-inert, and inert waste;
- Washing motor vehicles;
- Establishing car parks, camps and bathing sites;
- Locating new water intakes;
- Locating cemeteries and burying animal carcasses.

In secondary groundwater intake-protection zones, in addition to the said bans and restrictions, the following activities might be banned or restricted:

- Extracting minerals;
- Performing building or mining drainage works.

In secondary surface water intake protection zones, in addition to the said bans and restrictions listed in points 1 to 13, the following activities might be banned or restricted:

- Locating residential and tourism-related buildings;
- Using aircraft for agricultural operations;
- Depositing silage heaps;
- Fish farming, feeding or baiting;
- Watering and grazing animals;
- Extracting stone, gravel, sand and other materials, and cutting plants growing in the water or along its banks;
- Doing water sports;
- Using ships propelled by internal-combustion engines.

Measures in protected areas of inland water reservoirs should be based on the current land-management type and specific bans, orders and restrictions on land and water use are defined in order to protect the water resources from degradation. Activities such as construction, which could result in significant environmental impact such as permanent land or water pollution are banned within these areas.

Spatial planning in Poland will place greater focus on the coexistence of various ways in which water resources are utilised and also on regulating how long water stays in the environment, with a view to reducing any risks to the quality and amount of this resource.

Owners of land located within a protection zone are eligible for compensation for any damage incurred in connection with the establishment of bans, orders or restrictions on land and water use in the zone from the owner of the water intake under the terms and conditions specified in the Water Law (Art. 61 (1)). The rules for the payment of compensation for restricting the ways of using land in connection with the establishment of inland water reservoir protection zones are specified by provisions on environmental protection (Art. 61 (2)).

Drinking water protection zones take up around 1.3% of Poland’s territory (according to the .shp data provided by Project Partner) (**Fig. 17**).

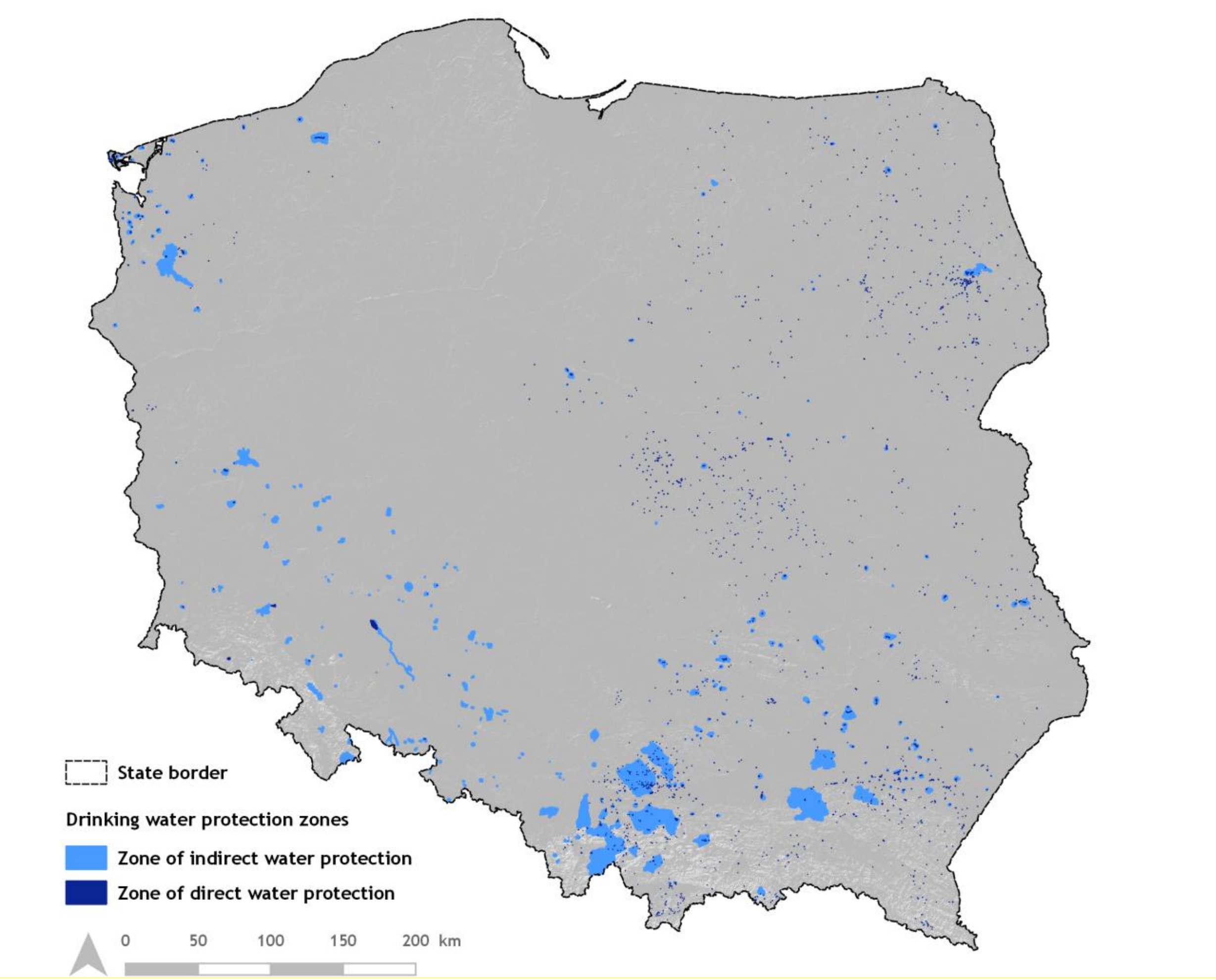


Figure 17. Drinking water protection zones in Poland

2.2.1.7. Slovenia

In Slovenia the Ministry of the Environment and Spatial Planning is responsible for the legal and administrative organization of water policy. The Slovenian Water Agency cooperates with the Ministry of Health of the Republic of Slovenia in the field of drinking water management and protection.

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:

- 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.

- 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.
- 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).
- 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 (**Fig. 18**) depends on the water source type (surface water (surface water, lake) / groundwater (aquifer type: porous, fractured and karst aquifer)). DWPZ are considered as protected areas in spatial plans and their borders are generally following cadastral parcel borders.

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. 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, while prohibitions and restrictions directly on capture are inspected by health inspectors. In case of conflict with the requirements defined for DWPZ, penalties are defined in accordance with 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 individual person.

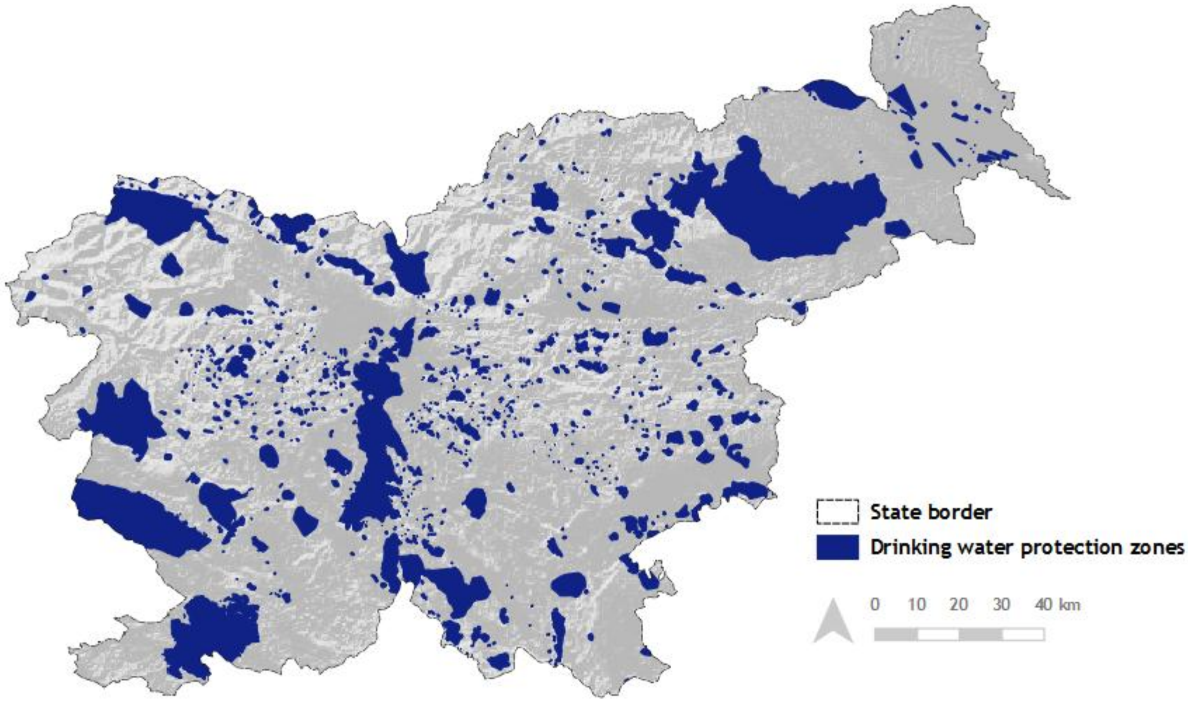


Figure 18. Drinking water protection zones in Slovenia

Table 2. Overview of drinking water protection zones in Project Partner countries

<table>
<tr><th>Country</th><th>Drinking water protection zones</th><th>Authority</th><th>Legislation</th><th>Delineation with spatial plans</th></tr>
<tr><td rowspan="2">Austria</td><td>The protection zone 1 (immediate surrounding)</td><td rowspan="2">Ministry, State governor or district authority
Water supplier is obliged to control the relevant DWPZ</td><td rowspan="2">Austrian Water Act and other subordinate acts and regulations
Official document “Wasserbuch”</td><td rowspan="2">DWPZ (zone 1+2) are delineated parcel-specific within the relevant spatial plans
Large DWPZ (“Trinkwasserschongebiete”) do not have to be delineated mandatory within spatial planning instruments</td></tr>
<tr><td>The enlarged protection zone 2</td></tr>
<tr><td rowspan="2">Croatia</td><td>3 DWPZ in intergranular aquifers:
III zone of limitations and surveillance;
II zone of strict limitations and surveillance;
I zone of strict protection and surveillance</td><td rowspan="2">Ministry of Agriculture (Water Management Administration);
Croatian Waters (legal, executive entity responsible for water management);
Regional and local government;
Water services with water permit control the drinking water</td><td rowspan="2">Croatian Water Act and other subordinate acts and regulations (Act on water intended for human consumption;
Regulation on protection measures and conditions for determination of sanitary protection zones of the drinking water source)</td><td rowspan="2">DWPZ are embedded into the physical planning documents</td></tr>
<tr><td>4 DWPZ in fracture and fracture-cavernous aquifers:
IV zone of limitations;
III zone of limitations and surveillance;
II zone of strict limitations and surveillance;
I zone of strict protection and surveillance</td></tr>
<tr><td>Germany</td><td>3 DWPZ with different levels of protective requirements for the drinking water protection</td><td>local authorities;
water suppliers</td><td>The German Federal Water Act (Wasserhaushaltsgesetz - WHG) and other subordinate acts and regulations (Drinking Water Ordinance (Trinkwasserverordnung - TrwV))</td><td>borders of DWPZ are considered for each spatial planning process</td></tr>
</table>

Country	Drinking water protection zones	Authority	Legislation	Delineation with spatial plans
Hungary	The inner protective block, zone; The outer protective block, zone	Water Authorities of Government Offices; Operator (permit holder) of the water works	Government Regulation and other subordinate acts and regulations	DWPZs are part of the national water quality protection zone on the National Spatial Management Plan
Italy	buffer zones with applied "geometric" protection (a circular area of 200 meter radius from the catchment point) buffer zones with applied "dynamic" protection (monitoring of water quality in the catchment inflow)	Water Services Regulation Authority; Regional Administrations; The Regional Environmental Agencies; Local authorities	Italian D.Lgs. "Water Protection plan"	DWPZ are considered in the planning procedures and are drawn on cartographic maps and specific regulations/restrictions of land use or activities are established
Poland	Primary and secondary protection zones for surface and groundwater intake; Protected areas of inland water reservoirs	Minister in charge of construction, local planning, spatial management and housing, in liaison with the Minister in charge of the environment, Water Management and Health	Water Law and other subordinate acts and regulations	yes
Slovenia	Outer protection area with moderate protection regime (III); Middle protection area with the rigorous (strict) protection of the water protection regime (II); Inner protection area with the most rigorous protection regime (I)	Ministry of the Environment and Spatial Planning Regional and local authorities Inspectors responsible for water	Water Law and other subordinate acts and regulations (Rules on Criteria for the Designation of a Water Protection Zone)	DWPZ are presented as protected area with their limitations regarding spatial planning.

According to the data within the .shp files of the drinking water protection zones, provided by Project Partner countries, following statements can be made (**Fig. 19**):

- smallest area of DWPZ can be found in Germany, where around 1.01% of the country's territory is under the DWPZ (this data relates only to the DWPZ in Bavaria)
- DWPZ take up also small amount of Poland's territory (around 1.3%), Austrian territory (6.84%) and Hungarian territory (7.96%)
- somewhat larger areas of country's territory take up the DWPZ in Slovenia (16.92%), Croatia (around 19.08%), while the largest amount of country's territory under the DWPZ can be found in Italy (36.33%)

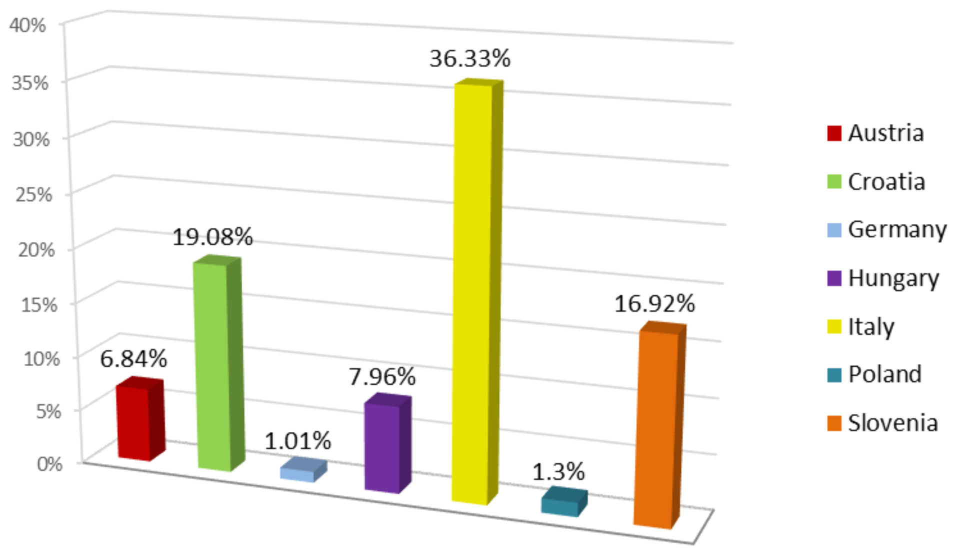


Figure 19. Drinking water protection zones within PROLINE-CE Project Partner countries (according to the .shp data)

2.2.2. Administrative aspects of DWPZ

2.2.2.1. Austria

The Austrian Water Law was designed by the BMLFUW to guarantee continuous provision of water for future water supply. Therefore this law regulates the use of water, respectively the authorisation of the use of water, the protection of water resources and protection against floods and common water management obligations.

Other legislative documents related to the drinking water policy in Austria are as follows:

- Food Safety and Consumer Protection Act (Austrian Ministry of Health (BMG));
- Drinking Water Decree (BMG);

- Austrian Food Codex (BMG);
- Drinking Water Protection Areas (Water protection and water conservation areas – province authorities; “Wasserwirtschaftliche Rahmenpläne” / General Water Management Frameworks – approved by BMLFUW) – State and District Authorities;
- Strategy concepts for drinking water supply and Drinking Water Plans in each Federal State;
- Water Supply law for municipalities;
- Water Supply Connection law for Federal States (except Tyrol – supply directly managed by the communities and water associations).

The province authorities can issue a decree for Drinking Water Protection Zones (DWPZ) and are responsible for the implementation of the relevant measures – therefore the realization differs in the different regions and in every legally decreed DWPZ. After a given permit in accordance with the Austrian Federal Water Act the respective protection zones are delineated in the “Wasserbuch” (land register including all relevant water related issues).

DWPZ are discussed with the respective land owners within the DWPZ and the relevant Water Authorities and the borders are negotiated, agreed and drawn according to the hydrogeological circumstances. Water suppliers are obliged to submit all necessary documents and to negotiate with the respective land owners (including relevant compensation). In some cases boundaries of DWPZ can be changed also after their approval due to new circumstances (new hydrological survey, land-use changes, changes of the course of streams etc.). In these cases the Water Authority asks the relevant water supplier to define the new boundaries of the respective DWPZ and the procedure for approval starts again.

2.2.2.2. Croatia

DWPZ are determined by the Decision on the water source protection and designation of sanitary protection zones that is in accordance with the Water Act (Official Gazette No. 153/09, 130/11, 56/13, 14/14) and Act on water intended for human consumption (Official Gazette No. 56/13). Some of the other legislative documents related to the drinking water policy in Croatia are as follows:

- Regulations on parameters compliance and analysis methods for water intended for human consumption (Official Gazette No. 125/13)
- Decree on water quality standard (Official Gazette No. 73/13)
- Regulations on fees for water use and protection
- River Basin Management Plan (2016.-2021.).

Obligatory measures and limitations that are conducted within DWPZ as well as the deadlines for decisions on protection and the process of making these decisions are governed by The

Ordinance on the conditions for the establishment of sanitary protection zones (Official Gazette No. 66/11 and 47/13).

The Decision on water source protection, as the key document for the protection of springs, prescribes on the basis of water research works, the size and borders of DWPZ that are negotiated and agreed by an Expert Commission. Furthermore, The Decision on water source protection, with the prior approval of the Croatian Waters, is adopted by the representative body of the local or regional government if the zone is in the area of the government unit. As far as the proposed borders are concerned, they are proposed through a study of protection zones which precedes the process of creating the Decision on the water source protection and designation of sanitary protection zones. Borders must be proposed on the basis of expert proposals set out in the conducted water research works. After preparing the study, the institution (municipality, city or county) has to request a binding opinion of the Croatian Waters. Upon receiving the request, the Croatian Waters appoint a body among their employees for evaluating the received request and adopt a decision within 30 days. In the end, the defined borders represent a cartographic review of sanitary protection zones as an essential part of the future Decision on sanitary protection zones.

The borders of the DWPZ are drawn only in accordance to the design criteria, no matter the ownership relationships. The borders always need to be proposed through water research works and after that, through a study of DWPZ submitted to Croatian Waters.

The Decision on DWPZ and its cartographic section displaying the borders are publicly available since that is a document adopted by the representative body of a local or regional self-government unit. However, given that there is no obligation to harmonize all borders with cadastral parcels, there is no list of parcels located inside the proclaimed DWPZ. The same applies to some of the second DWPZ for which water research works were conducted and which served as a basis for harmonizing borders with cadastral parcels.

According to The Ordinance on the conditions for the establishment of sanitary protection zones (Official Gazette No. 66/11 and 47/13), within 12 months from adopting the Decision on DWPZ it is necessary to draw up a Program of remediation measures within the sanitary protection zones for existing buildings and existing activities which become an integral part of the Decision on water source protection. The Program of remediation measures contains a list of all pollutants in the area of sanitary protection zones, priority remediation interventions, implementation deadlines for remedial interventions, remediation costs, institutions in charge of financing the implementation of the Program.

2.2.2.3. Germany

The legal and administrative organization of water policy in Bavaria is divided into three parts: the highest level public water authority (Bavarian State Ministry of the Environment and Consumer Protection, StMUV), the upper public water authority (district governments) and the lower public water authority (county offices). These bodies represent executive authorities. The highest level public water authority assumes the control of water management and legal supervision on the state level. The upper public water authority coordinates and bundles the administrative and technical supervision of water management to ensure a consistent administrative process implemented by the county offices (StMUG, 2013).

Following Art.83(1) of the Bavarian constitution (BayVerf), the water supply ranks among the responsibilities of the municipalities. Additionally, Art.57(2) of the Bavarian municipal code (BayGO) obligates the municipalities to establish and to maintain the drinking water supply. Following Art.31 (2) BayWG, the controlling and managing tasks of legal acts for the determination of drinking water protection are assumed by the local authorities.

In general, the WHG prescribes that water protection zones have to be designed based on state-of-the-art regulations and techniques. The water supplier engages a hydrogeological expert bureau to elaborate and assemble the required documents.

The assessment of water protection zone borders starts with the spatial delimitation of the hydrogeological catchment area and thus with an assessment of aquifer properties. This investigation also comprises an assessment of the protective function of aquifer protective layers. Following a method introduced by HÖLTING et al. (1995), a mean protective effect of these layers can be achieved if the percolation time until the water reaches the aquifer is at least equal to 3 years. The area in which the general requirements of water protection are insufficient represents the outer boundary of the water protection zone (zone III).

The spatial delimitation of zone II is based on further protective requirements for the drinking water protection. This includes the assessment and implementation of hygienic requirements, especially human-pathogenic germs which should almost completely be degraded before the water arrives at the extraction well.

Generally, a minimum radius of 10 m has to be maintained for the assignment of protection zone I. The criteria for the spatial delimitation of zone I are similar or stricter to those for the determination of zone II (LfW, 1995; LfW, 1996; LfU, 2010a).

Negotiations or objections about the borders of drinking water protection zones can be part of the legal procedure of water protection zone implementation. At this stage, borders can be negotiated and also agreed in case the objections are reasonable and target-oriented. Since the borders are a result of field investigations and desk studies, other suggestions have to ensure similar protective effects. Once the protection area has been determined borders are fixed and cannot be negotiated any more.

During the planning process, an engineering office (appointed from the water supplier) prepares an expert opinion. Already at this stage, the water supplier involves the concerned persons and parties to timely recognize conflicts in terms of possible limitations that should be eliminated. In a next step, the water supplier submits the proposal to the local authority. The local authority verifies the proposal in agreement with the WWA and the responsible Agency for Agriculture and Forestry.

All persons and parties who raised objections during the public engagement are invited to a public hearing to clarify and discuss the stated objections. The objections are accepted if the technical and legal authorities agree to the objections.

The water supplier performs self-monitoring. Moreover, the local authority and the WWA also control the surface of the DWPZ. According to Art.74 BayWG, a penalty of up to 50.000€ may be imposed in case of negligent or intentional non-compliance of the DWPZs.

2.2.2.4. Hungary

The main legislative documents related to the water management in Hungary are:

- Act LVII of 1995 on water management
- Act LIII of 1995 on protection of environment
- Act LIII of 1996 on protection of nature
- Act CCIX of 2011 on water utility supply
- other relevant Government regulations and Ministry regulations

The dimensions of the protective block, zone of a particular subsurface source of supply shall be estimated in terms of the travel time, assuming steady seepage flow, starting from the point of abstraction. The period of seepage flow between the terrain and the surface as the saturated zone shall be neglected in the computations.

The protective block, area determined by computation or an engineering guess shall be delineated as follows:

- In the case of a protective block the horizontal projection of the three dimensional blocks, the distance (in metre units) of the points closest to, and farthest from, the surface shall be specified.
- The boundaries of a protective area shall be traced relative to topographic contours, natural and/or artificial terrain features, or relative to data (lines) shown on the land register maps - on the enlargements thereof if necessary - so that these shall include the block, area determined by computation.
- The area including the protective areas of several water facilities (intake works) shall be delineated as the common protective area thereof as a possibly simple shape.

The protective block, area or zone around the source of supply, or water facility protected, or to be protected is designated in compliance with the provisions of the present order by the water authority empowered to permit the execution of the particular water use, observing the general rules of state administration and the procedure laid down in a separate act of legislation.

DWPZs are determined only by expert determination, but after the hydrogeological modelling, the borders of the DWPZs are snapped to the land plot border, so the decision of authority of the DWPAs contains the actions and measures for that snapped areas.

The list of cadastral parcels positioned on the DWPZ is available on the property documents (title-deed) of the land administration; also the decision of the water authority contains this information as like the diagnostic investigation of the DWPA.

2.2.2.5. Italy

In Italy regional and national policies on water are managed through a multilayer governance system, where competences are distributed among different territorial and sectoral Institutions (Alberton, 2011). The regulations of drinking water protection zone for surface and groundwater resources can be integrated by Regional Administrations, by local authorities during planning procedures, by Water Services Regulation Authority and by Environmental and Health Agency with monitoring. These are the only stakeholders engaged in the process.

The legal acts for determination of drinking water protection zones are controlled and managed by Water Services Regulation Authority (in Emilia-Romagna ATERSIR) and Regional Administrations. Drinking Water Protection Zones (DWPZ) are designed on basis of field investigations and desk studies. The delimitation of recharge areas and of the protected zones, of surface and groundwater waters, have been designated by the aid of geological, hydro-geological, hydrological and hydrodynamic field and desk studies, of springs, aquifers and surface waters exploited for water supply. The DWPZ, defined by cartographic delimitation, are considered in the planning procedures (PTCP and PSR) and local authorities must make provisions in relation to protection zones for the protection of water resources.

There is no procedure explicitly dedicated to the negotiation of the DWPZ borders, but the process of DWPZ drawing is agreed by stakeholders. Interdictions, limitations and measures are agreed in the planning process. Coordination is carried out by the authority competent for the preparation of the plan. Comments on DWPZ are either accepted or rejected during the planning phase, giving reasons for made decisions.

2.2.2.6. Poland

In Poland water management that follows the principle of sustainable development, and in particular, the shaping and protection of water resources, water use and water-resources management is regulated with the Water Law (Journal of Laws, No. 115, item 1229).

As stipulated in Art. 50 of the Water Law, the Ministers of the Environment, Water Management and Health in the Regulation of the Minister of the Environment of 27 November 2002 on the requirements to be met by surface water used for the public supply of water intended for human consumption (Journal of Laws No. 204, item 1728) jointly prepared the requirements for surface water used for the public supply of water intended for consumption.

The provisions of the Regulation shall not apply to:

- Spontaneous, natural and concentrated outflows of ground water to the surface,
- Infiltration water from the infiltration of meteoric and surface water into a rock mass,
- Sources feeding groundwater deposits, constituting a complex of groundwater, the extraction of which can yield economic benefits

The regulations relating to water intake protection zones are specified in Chapter 2 of the Act of 18 July 2001 – Water Law. A protection zone is established, by way of an Act of local law, by the director of the regional water-management board at the request and cost of the water-intake owner, indicating the bans, orders and restrictions and the areas covered by them.

2.2.2.7. Slovenia

The main Slovenian legislative document for water management and protection is Waters act (Official Gazette of the Republic of Slovenia 62/2002). Additionally, drinking water is governed by the Rules on drinking water (Official Gazette of the Republic of Slovenia 19/2004, 35/2004, 26/2006, 92/2006, 25/2009 in 74/2015), while DWPZ are designated in accordance to the 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).

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. DPWZ are discussed with municipalities and all involved parties. DWPZ borders are negotiated and agreed upon. Interdictions, limitations and measures are not negotiated. They are defined in the Decree on the water protection area for particular drinking water source. Coordination is involved during the process and described in the procedure.

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

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. Borders mostly follow cadastral/parcel borders, but it is not necessary (e.g. in case of large parcels). DWPZ are designed that natural criteria are considered.

There are some exceptions in cities, e.g. Ljubljana, where industrial zones already exist and inner DWPZ is divided into two subzones with different limitations. Graphical presentation of the cadastral parcels and DWPZ are available in the on-line GIS portal of the Slovenian Environment Agency.

The general public as well as some water suppliers are not well informed about the positive effects of optimal land-use management on drinking water protection. Some regional and national public authority who have been already involved in previous projects, know about these correlations, but the respective practical implementation (e.g. legislation) is very difficult.

Municipalities are well informed about the importance of safe-guarding drinking water resources for the future and will have a deeper knowledge about best land-use management practices in their relevant region. Other governmental institutions (regional/national level) are aware of necessary steps towards drinking water protection and will try to convince also other relevant sectors and interest groups to share the same goal. Involved water suppliers have enough arguments to enforce their issues. The general public know about the interdependences between drinking water protections, flood/drought mitigation and land use. Some are also aware of the vulnerability of drinking water resources.

2.3. Flood/drought management

The great hazards of today have become such dangers due to climate change that is shaping our landscapes and lives. In order to deal with these natural forces, measures and strategies must be made, legislation implemented and monitoring established.

As said in the Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007 on the assessment and management of flood risks (Floods Directive), "**floods** are natural phenomena which cannot be prevented, however some human activities (such as increasing human settlements and economic assets in floodplains and the reduction of the natural water retention by land use) and climate change contribute to an increase in the likelihood and adverse impacts of flood events".

Floods endanger lives and cause human tragedy as well as heavy economic losses. By implementing adequate measures the likelihood of flood can be reduced and their impacts limited. In addition to economic and social damage, floods can have severe environmental consequences (EC, 2016). Annual flood losses can be expected to increase fivefold by 2050 and up to 17- fold by 2080. The major share of this increase (70–90%) is estimated to be attributable to socio- economic development as the economic value of the assets in floodplains increases, and the remainder (10–30%) to climate change (EEA, 2016).

All of the countries within the PROLINE-CE project have state specific legislation that should be in accordance with the Floods Directive which requires of Member States to assess and map flood risks and hazards and to manage them by putting in place flood risk management plans that will include measures to reduce the flooding probability and its repercussions.

Regardless of the fact that in general Europe has adequate water resources, **water scarcity** is becoming more frequent and widespread water management problem in certain countries. European Commission defines water scarcity as a phenomenon that occurs where there are insufficient water resources to satisfy long-term average requirements. It refers to long-term water imbalances, combining low water availability with a level of water demand exceeding the supply capacity of the natural system. Water availability problems frequently appear in areas with low rainfall but also in areas with high population density, intensive irrigation and/or industrial activity.

It was estimated that by 2007, at least 11% of Europe's population and 17% of its territory had been affected by water scarcity, putting the cost of droughts in Europe over the past thirty years at EUR 100 billion. The Commission expects further deterioration of the water situation in Europe if temperatures keep rising as a result of climate change. Water is no longer the problem of a few regions, but now concerns all 500 million Europeans (EC, 2016).

According to the European Commission **droughts** can be considered as a temporary decrease of the average water availability due to e.g. rainfall deficiency. Droughts can occur anywhere in Europe, in both high and low rainfall areas and in any seasons.

Over the past thirty years, droughts have dramatically increased in number and intensity in the EU. The number of areas and people affected by droughts went up by almost 20% between 1976 and 2006 (EC, 2016).

2.3.1.1. Austria

Federal Water Engineering Administration ("Bundeswasserbauverwaltung") develops flood hazard maps and risk assessments as well as the provision of information for municipalities and affected people along rivers. The construction of protective measures takes place on the basis of planning processes, from river basin planning to general and detailed project planning.

According to the Austrian Forest Act, the Service for Torrent- and Avalanche Control (WLV) is responsible for the relevant hazard zone maps and the respective protective measures within the catchments of torrents.

Austrian flood mitigation measures are extensive and very well developed. In addition, they have a good example of positive flood management coupled with innovative engineering technology – the use of mobile flood walls, in particular during the documented flood in Grein in June, 2013 (**Fig. 20**). Such implementation strategy is a role-model for other countries with flooding issues.

The EU Flood Risk Directive was implemented within the Austrian Federal Water Act. Therefore the catchment-based water management comprises the assessment and the management of flood risks every six years. First of all, a temporary assessment of flood risk was conducted within all river basins leading to the provision of potential significant risk areas. For these areas flood hazard and flood risk maps (**Fig. 21**) were developed. Based on these results the Flood Risk Management Plan 2015 was published containing targets and measures for risk reduction. Settlements and important economic assets and transport assets need protection against floods occurring statistically every 100 years (HQ 100), assets of lower significance, e.g. roads, are to be protected against HQ30, areas used for agriculture and forestry are not to be specifically protected.

Also torrent related risks are shown in relevant hazard zone maps based on intensive surveys within catchment areas and evaluation of previous events. The extent of risks is shown parcel-specific through the distinction between "red" (high risk – absolute construction ban concerning new buildings) and "yellow" (medium risk – official requirements for new buildings) zones based on long-term experiences of relevant experts. Experts try to estimate possible damages in flood scenarios due to their experiences and by means of computer-assisted models.

Figure 20. Redirected flood in the city of Grein, Austria in June, 2013[1]

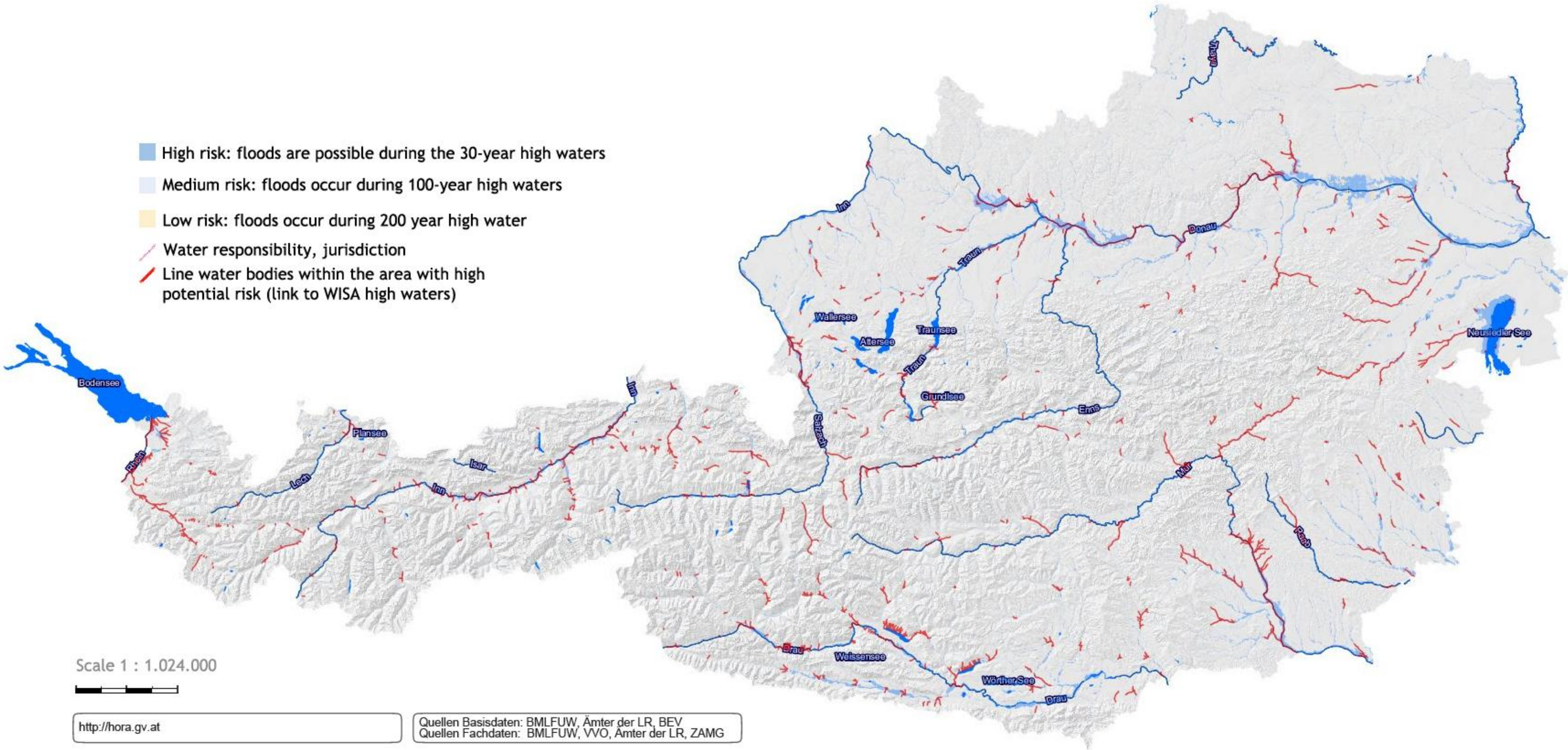


Figure 21. Flood risk map of Austria (data by Ministerium für ein Lebenswertes Österreich, HORA Natural Hazard Overview & Risk Assessment Austria)

Protection from droughts can be regarded as less relevant within the Austrian territory, as the precipitation regime mostly covers the water demand of the forest ecosystems. Within the context of climate change drought events could become more frequent. The stability and resiliency of forest ecosystems in those cases depends on the tree species composition of the forest stands, which has to be adapted in DWPZ according to the potential natural vegetation. Diverse forest ecosystems show more stability, also under drought conditions.

2.3.1.2. Croatia

The main objectives of the flood risk management in the Republic of Croatia are designated by The Water Management Strategy, Water Act and provisions of the Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007 on the assessment and management of flood risks. According to the Water Management Strategy main goal of water management is to achieve integrated and coordinated water regime with respect to international obligations. Integral water control is provided to protect people and property from flooding and other forms of harmful effects of water and to achieve economically justified levels of protection of the population, material goods and other endangered values by encouraging the preservation and improvement of the ecological status of waters and flood and droughts areas in order to create conditions for further economic development.

Competent institutions for the flood risk management and implementation of the Flood Risk Directive are the Ministry of Agriculture, as the central governmental body responsible for water management and Croatian Waters, as a legal entity with public authority for water management. Croatian Waters implement any measures to manage the risks from flooding predicted by The Water Act and the National Flood Defence Plan and in accordance with their obligations, responsibilities and financial capacities (dedicated funds raised from water fees and fees for water regulation). According to the Water Act, Hrvatske vode (Croatian Waters) are obliged to undertake a preliminary flood risk assessment (in compliance with Articles 4 and 5 of The Floods Directive); to develop flood hazard maps and flood risk maps (Article 6) and to prepare flood risk management plans (Article 7 and 8).

The establishment of the flood defence system that ensures an acceptable risk of flooding in the whole Croatian territory potentially affected by the floods is a goal that can be achieved through gradual realization and implementation of a number of activities and measures.

Flood/drought risk assessment on a national level is presented in Chapter D of River basin management plan 2016-2021. There are areas for which significant and potential risk of flooding is estimated and they are marked on the map of flood risk. Map shows three flood scenarios (**Fig. 22**):

- high probability flood scenario,
- medium probability flood scenario (return period 100 years),

- low probability flood scenario that includes accidental flood caused by destruction of embankments on bigger water courses or by destruction of dams (artificial floods).

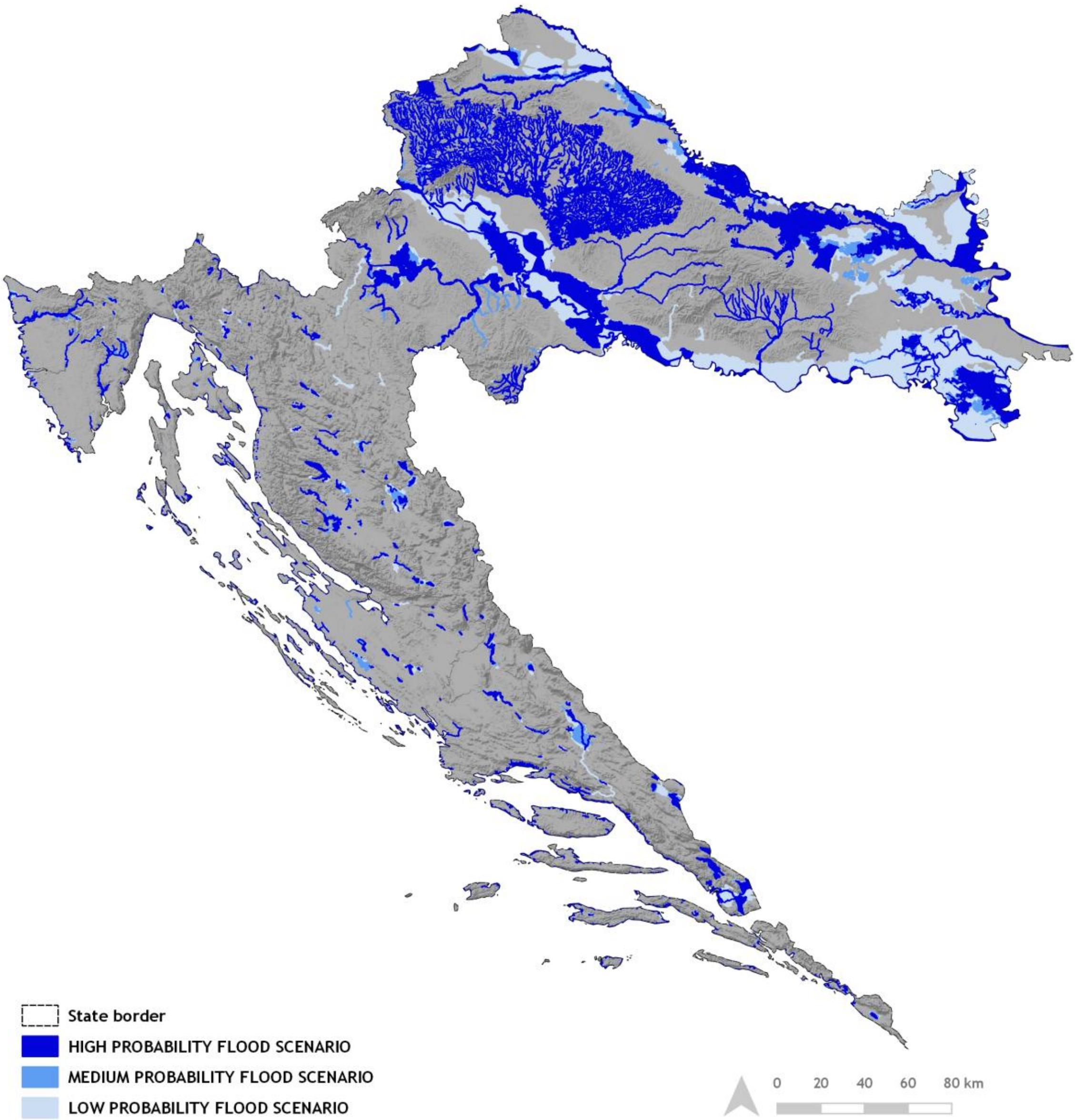


Figure 22. Flood risk map of the Republic of Croatia (data provided by Croatian Project Partner – Croatian Waters; hillshade by ArcGIS REST Services Directory)

Croatia has had major problems with floods in the past years, most notably in 2014. In light of this hazard, the country should invest more in the implementation of mitigation measures. The flood prevention system is outdated and in dire need of reconstruction. Drought is an even bigger issue than flood. Irrigation systems should be modernized and better developed in order to salvage the food-bearing parts of the country that are most hit by the extreme weather.

According to Water Management Strategy, the aim is to increase levels of functionality of flood defence systems (against flood waters of I and II order):

- to a level of around 87% by the end of 2023,
- to the level of 100% by the end of 2038.

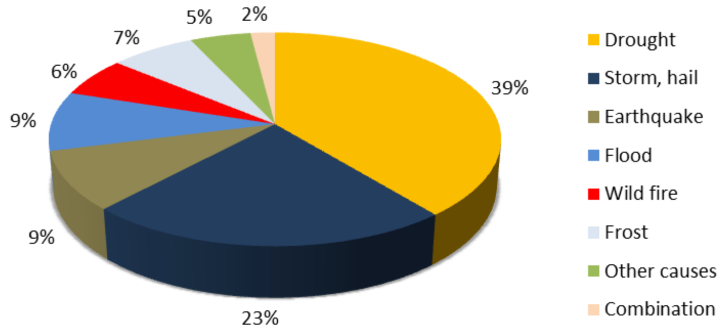


Figure 23. Types of natural hazards and their share in the total damage in Croatia, 1981-2010 (GAJIĆ-ČAPKA et al., 2010)

2.3.1.3. Germany

The requirements given by the Floods Directive are integrated in the WHG as well as in the BayWG. In Bavaria, flood management plans are developed based on three steps:

- Preliminary risk assessment based on a status analysis of the river catchments;
- Creation of flood hazard maps and flood risk maps for risky areas;
- Development of flood risk management plans.

In order to develop comprehensive flood risk management plans for Bavaria, flood management strategies are based on four priorities: prevention, protection, provision and after-care. These priorities are key elements of the Bavarian flood management programme "Aktionsprogramm 2020plus" (StMUV, 2014). Risk assessment as well as adaption strategies for floods and droughts have been elaborated within the Bavarian climate adaption strategies project (BayKLAS) (StMUG, 2009).

The prevention of flood risks includes e.g. the leaving of inundation areas and the prevention of building developments on these sites to avoid an exposure of humans and economic goods to flood risks. Moreover, a removal or a relocation of infrastructures is considered as well under this item. The following priority of flood risk management is the protection that includes any kind of structural and non-structural measures fostering the technical flood protection as well as the natural water retention in the catchment (**Fig. 24**). These may include the construction of dykes and flood control reservoirs or the implementation of water management measures in the catchment, respectively. The provision of flood risk management integrates flood forecasting, the planning of support measures for the emergency case (both in the sense of information provision) as well as improvements of behavioural precautions by sharpening the public awareness. As a result of a flood event, after-care measures have to be performed in order to recover and to check the effects of the flood event. In a first step, the impacts for individuals, societies and the environment have to be recovered. In a following step, the obtained data are used to review, to extend and also to revise fundamental aspects of flood risk management strategies (StMUV, 2014).

The map in **Figure 24.** shows the positions of flood retentions and illustrates the region's extensive river network system that is a great flood hazard if left unmanaged.

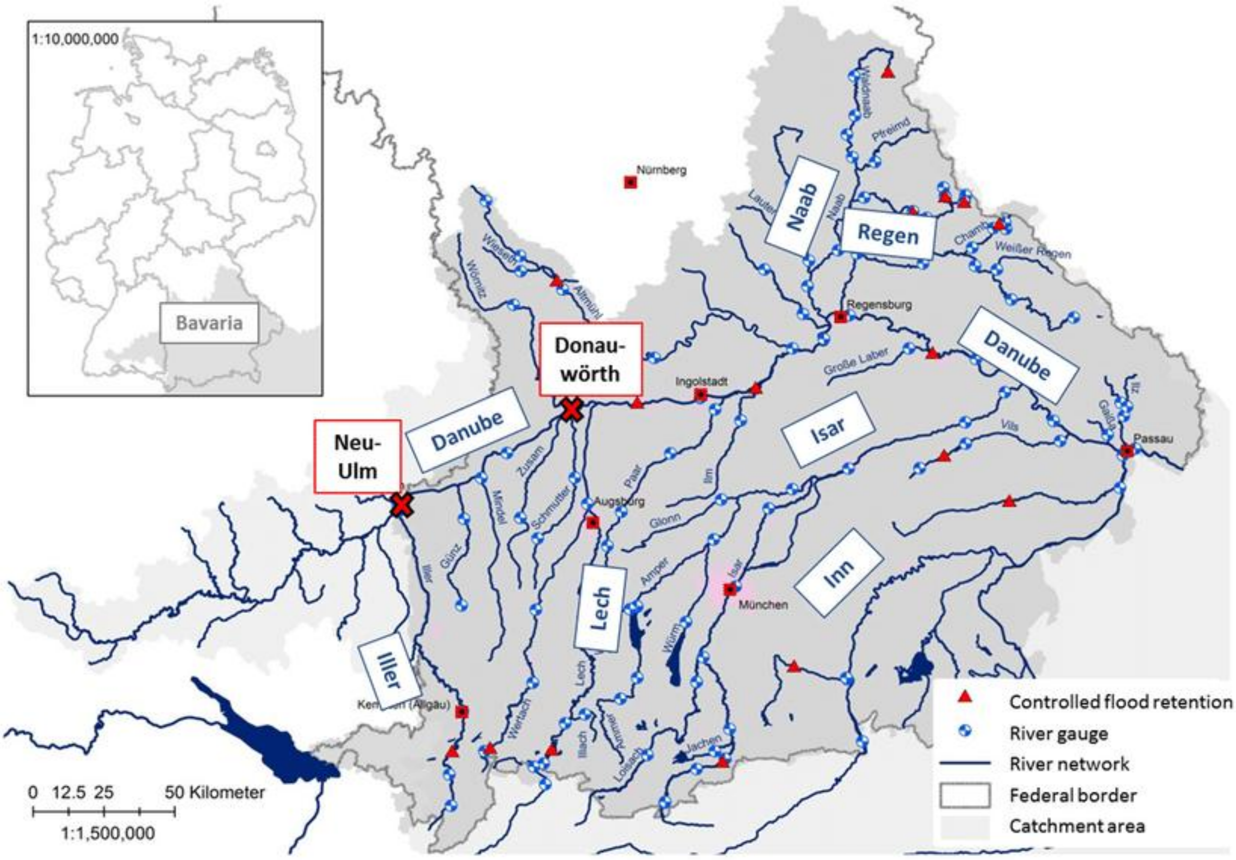


Figure 24. Catchment of the Bavarian Danube with most important tributaries. Also indicated are large flood retention reservoirs, flood retention polders and important river gauges (from Seibert et al., 2014 (modified))

Current Bavarian research projects are focusing on the subject of estimating the significant risk areas for flash floods, where inter alia the Chair of Hydrology and River Basin Management of the Technical University of Munich are involved. First results are estimated to be published in three or more years.

The LfU provides a web-GIS application designating flood-prone areas for HQ100 and flood risk areas for HQfrequent, HQ100 and HQextreme (LfU, 2016a). Moreover, the flood information service provides gauge-based information on current water levels and discharges as well as notification stages in case a certain water level threshold has been exceeded.

Germany, i.e. Bavaria is doing a lot for the implementation of the European Flood Directive. The flood events in recent years (2013 and 2016) have prompted the government to invest more in the mitigation projects. The Bavarian state has maintenance responsibility for embankments (1350 km), flood protection walls (80 km) and mobile flood protection systems (20 km) for category I and II water bodies. Between Ulm/Neu-Ulm and Vilshofen the Bavarian Danube is secured with almost uninterrupted flood protection (ICPDR, 2013).

In terms of drought management, the LfU established a low-water information service in 2008 (LfU, 2016c). This service performs a continuous monitoring of the already existing meteorological and hydrological monitoring networks. The data is used to run forecasting models and to assess possible impacts of droughts. The provided data further supports the management as well as the decision-making process in case of droughts.

2.3.1.4. Hungary

Hungary is facing serious issues due to both floods and droughts. The temporal and spatial distribution of surface water resources is very extreme. Generally there are two main periods of river flooding events: floods in early spring are caused by runoff from snowmelt, while floods in early summer are the consequences of maximum precipitation at the beginning of summer. Nearly the half of Hungary is plain area (44,500 km^2), with endorheic lowlands having a significant share. More than 20,000 km^2 are exposed to floods, of which 5,610 km^2 belong to the river basin of River Danube, and 15,641 km^2 to the river basin of River Tisza. The most recent flooding event was is Budapest in May 2017.

Flood management of Hungary has been based on the EU Floods Directive (2007/60/EC). Riverbed management plans are aimed at reduction of flood levels, keeping or repairing capacity of riverbed and ensuring the flood protection safety. Government Regulation 232/1996 (XII.26.) on protection against damages caused by water regulates the flood protection tasks and competencies including the governance of activities and responsibilities of institutions. The height of the damage protection infrastructures is based on the Minisztatial Regulation 74/2014 (XII. 23.).

There are 8 areas with potential significant flood risk identified in Hungary (Felső-Duna, Balaton, Dráva, Alsó-Duna, Közép-Duna, Felső-Tisza, Középső-Tisza, Alsó-Tisza) (**Fig. 25**).

The preliminary flood risk assessment has been done based on the already available information within the Hungarian water management. In Hungary, three flood groups are created for an examination of inundation hazards:

- Floods of river sections protected by dykes (riverine floods);
- Floods of river and stream sections not protected by dykes (flash floods);
- Inland inundations (excess water).

Flood hazard maps show the extent and expected water depths/levels of an area flooded in three scenarios (**Fig. 25**):

- a low probability scenario or extreme events (1000 years return time period),
- a medium probability scenario (with a return period of 100 years)
- and if appropriate a high probability scenario (with a return period of 33 years).

Flood risk maps were also prepared for the areas flooded under these scenarios showing potential population, cultural economic activities and the environment at potential risk from flooding, and other information for instance sources of pollution.

A good management practice example is the establishment of the NAGIS map portal by Natér which offers up-to-date data on the policy-making, strategy-building and decision-making processes related to the impact assessment of climate change and founding necessary adaptation measures in Hungary.

According to the flood risk .shp data provided by Hungarian Project Partner, around 14.9% of flood risk area has high probability flood scenario, medium flood probability scenario occupies 37.8% of the flood risk area, while low flood probability scenario take the remaining 47.3%.

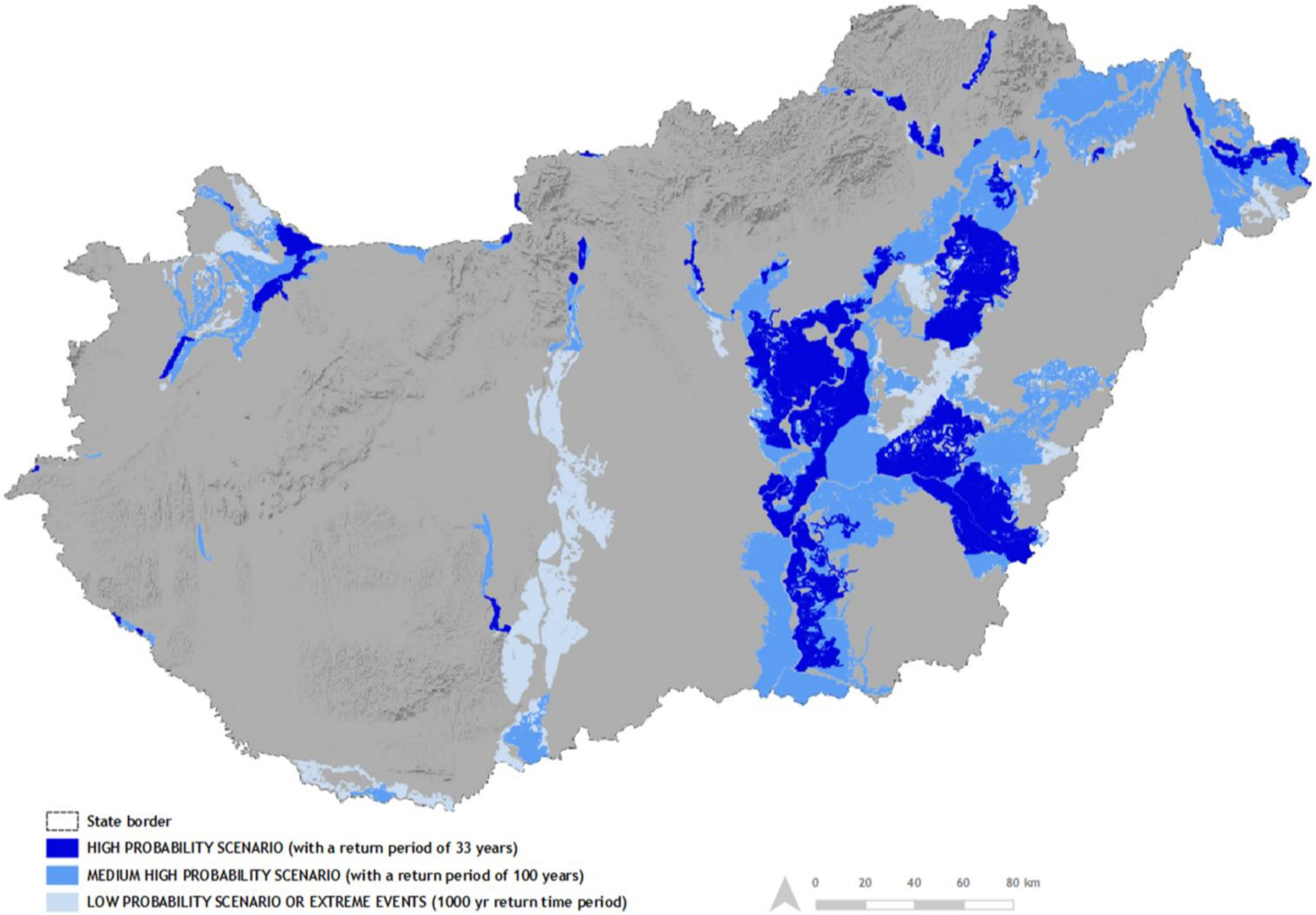


Figure 25. Flood hazard map of Hungary (data provided by Hungarian Project Partner; hillshade by ArcGIS REST Services Directory)

The drought can occur in 90% of the Hungary and can primarily affect the centre of the Great Plain, where the evapotranspiration usually exceeds the precipitation amount (climatic water scarcity). The climatic water scarcity/excess is ranging from 100 mm/year excess to 350 mm/year scarcity, with the peaks in the southern Tisza catchment. This periodically occurring phenomena – causing long-term water scarcity for the flora and the fauna, the agriculture and for the society – will be worsen by the climate change.

Drought risk assessment is based on a national methodology called "Pálfai Index" (PAI). There are no specific regulations on droughts management but according to the Act LVII of 1995 on water management there is priority order of sectors in water supply. In case of water shortage the drinking water utility supply has the priority. But the situation will only worsen in the coming years as groundwater level differences exceed the -10 meter mark (**Fig. 26**). Therefore, drought management should become a priority.

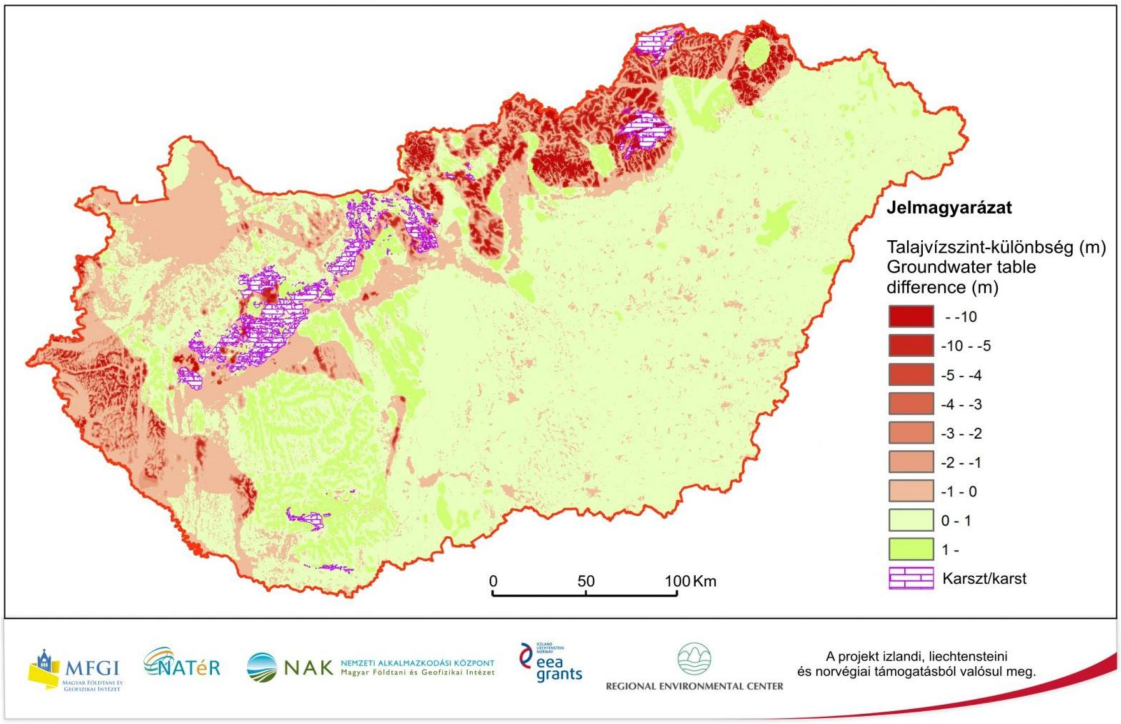


Figure 26. Groundwater table differences in the upcoming years due to drought (NAGIS, 2015)

Hungary adopted the United Nations Convention to Combat Desertification in Those Countries Experiencing Serious Drought and/or Desertification, Particularly in Africa. Our obligation is to report regularly to the UNCCD on the activities supporting the implementation of the Convention. The LDN (Land Degradation Neutrality) Target Setting Program is the UNCCD's new initiative contributing to the SDG (Sustainable Development Goal) target 15.3 which aims to "sustainably manage forests, combat desertification, halt and reverse land degradation, and halt biodiversity loss". Hungary is currently considering joining the programme.

2.3.1.5. Italy

Flood management is regulated by the Italian Laws D.lgs. 49/2010, according to the European Flood Directive 2007/60/EC and D.lgs 152/2006. These laws establish the Flood Risk Management Plan and the District Hydrogeological Regulation Plan (PAI). According to the D.P.C.M. 29/9/1998 “Atto di indirizzo e coordinamento per l'individuazione dei criteri relativi agli adempimenti di cui all'art. 1, commi 1 e 2, del D.L. 11 giugno 1998, n. 180” River basin Authorities are charged with identifying flood risk areas and dividing them into four risk classes, from low risk areas (R1) to very high risk areas (R4).

Flood alerting system is regulated by the Directive of the President of the Ministers Council on 27.02.2004 “Organization and functional management of the national and regional distributed alerting system for hydrogeological and hydraulic risk for Civil Protection” (Fondazione CIMA, 2010).

The Italian National Institute for Environmental Protection and Research, ISPRA, yearly publishes the updated maps of flood hazard, deriving from the collection of flood hazard maps supplied by every Italian River District Authority. The estimation of potential flood damage has been done at a national level, considering flood exposure, vulnerability, hazard maps and the number and location of exposed people as well. According to the ISPRA DissestoidrogeologicoinItalia: pericolositàe indicatori dirischio Rapporto 2015, ISPRA created mosaics of flood hazard areas for three different scenarios: “elevata P3” (frequent floods with the return period between 20 and 50 years), “media P2” (rare floods with the return period of 100 to 200 years) and “bassa P1” (low probability of floods or extreme event scenarios) (**Fig. 27**). As it can be seen from **Figure 27**, Italy has high probability of floods and should focus their efforts in protection and update of existing facilities, measures and buildings.

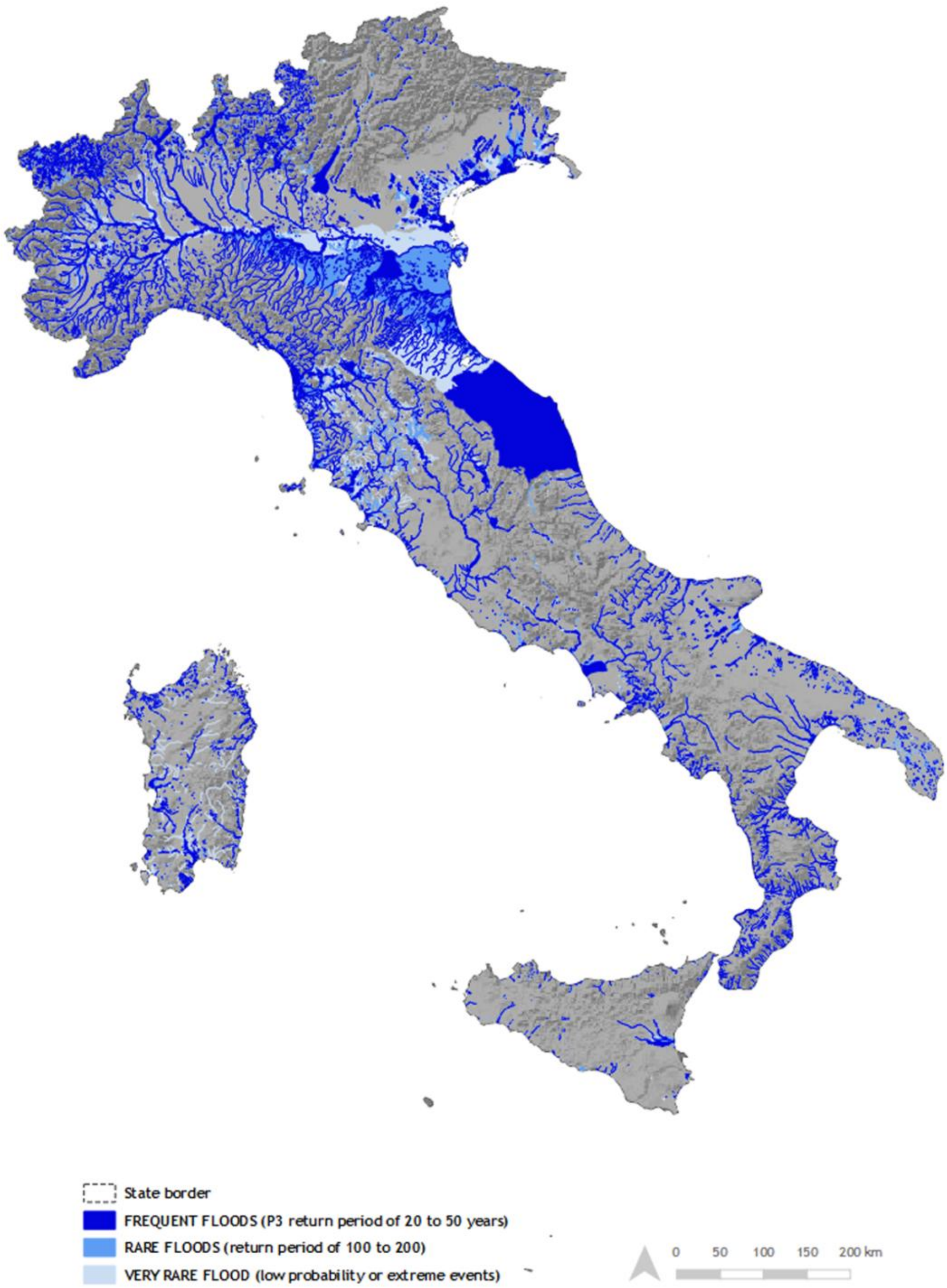


Figure 27. Flood hazard map of Italy (data provided by Italian Project Partner and created by ISPRA; hillshade by ArcGIS REST Services Directory)

Drought management is regulated by the Italian law D.Lgs. 152/2006, according to the European WFD 2000/60/EC. This law establishes the District Management Plan, containing the Water Balance Plan to manage drought and water scarcity. Also the Regional Water Protection Plans, introduced by the same Law, are instruments for water resources management and protection during drought events (Fondazione CIMA, 2011). The permanent national network of

"Observatories on water uses" established on 13 July 2016 assess temporary water scarcity and shortage events. This network considers three scenarios, low, medium and high, for temporary water scarcity.

No drought risk assessment is done at a national level, because the Law R.D 1775/1933 requires the nomination of an emergency commissioner in case of drought/water scarcity events. There are no designated areas exposed to significant drought risk at national level. Many River District Authorities have developed drought risk assessment within the Water Balance Plan, as part of the River Basin Plan. ISPRA has published a report about desertification prone areas in Italy and another about guidelines for locating aridity and desertification prone areas.

Italy has had major flood and drought problems for the past few years. The lack of a drought risk assessment should be remedied as soon as possible. The division of flood risk maps between the river district authorities is a good involvement strategy and a best practice example of management. Italy's decentralization in these matters is commendable.

2.3.1.6. Poland

In line with the Floods Directive and the Law on Water Management of 18 July 2001 (Journal of Laws of 2015, item 469, as amended), by 22 December 2011, the President of the National Water Management Authority had prepared and published the Preliminary Flood Risk Assessment (WORP), the first of the required planning documents. Flood risk areas were identified for two types of floods, namely river floods and coastal floods. In total, 253 rivers, with a total length of 14,481 km, were identified for flood risk areas. This preliminary flood risk assessment was conducted under the project "IT system for the protection of the country against extraordinary threats" (ISOK), by the Institute of Meteorology and Water Management – National Research Institute, Flood and Drought Modelling Centres in Gdynia, Poznań, Kraków and Wrocław (centres are the part of the Institute of Meteorology and Water Management), in consultation with the National Water Management Authority. The ISOK project also produced coastal flood risk maps and flood hazard maps. The assessment of coastal flood risk is the responsibility of the Minister in charge of maritime economy.

In line with the Floods Directive and the Law on Water Management, the preparation of flood hazard maps (MZP) and flood risk maps (MRP) for the areas at risk of floods identified during the preliminary flood risk assessment, was necessary by 22 December 2013. The deadline was met and the flood and hazard maps and flood risk maps, provided by the map contractor, were published online in the form of PDF files. Flood hazard maps and flood risk maps were prepared in scale 1:10 000, in digital form, and include spatial data and cartographic visualisations as well as information about potential flood losses. Flood hazard maps show areas where the likelihood of flood is low (Q0.2% – once every 500 years), moderate (Q1% – once every 100 years) and high (Q10% – once every 10 years), and areas at risk of flooding as a result of destruction of, or damage to, a flood bank or a storm dyke. The flood hazard areas presented on the maps were identified through hydraulic mathematical modelling. The modelling was based on a highaccuracy (10-15 cm) digital elevation model, obtained using airborne laser scanning between 2011 and 2013.

The amendment of the Law on Water Management of 16 December 2015 changed the regulations concerning the inclusion of water hazard maps and water risk maps in zoning plans. In line with Article 88f.5 of the Law on Water Management, the area borders presented on the maps can be included in national zoning plans, voivodeship zoning plans, local zoning plans and decisions on the location of public investments, and zoning approvals.

In line with national and European law, in 2014 and 2015, the President of the National Water Management Authority worked on the preparation of flood risk management plans (PZRP). Planning documents that had been developed prior to plan preparation included a preliminary flood risk assessment and flood hazard maps and flood risk maps (**Fig. 28**).

Flood risk management plans for river catchment areas and water regions were prepared with the support from the European Regional Development Fund under the Technical Assistance Operational Programme 2007-2013. The draft flood risk management plans were subject to social consultations and whenever justified, the conclusions and follow-up recommendations were used to complement or review the draft PZRP.

The legislative procedure for the approval of flood risk management plans for river catchment areas and water regions has not been completed yet.

Figure 28. Flood risk map of Poland (data provided by the Polish Project Partner and by the Hydroportal of the National Water Management Authority)

The Law on Water Management, which governs drought control, entrusts this task to government and local-government authorities. Efforts of KZGW and RZGW in this area have focused on the development of drought mitigation plans in river catchment areas and in water regions, which, in addition to water management plans for river catchment areas, the national water environment programme, flood risk management plans, terms of use for water regions, and terms of use for catchment area water, prepared on an ad-hoc basis, constitute an essential planning documentation for water management.

2.3.1.7. Slovenia

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,
- 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,
- 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 establishment 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.

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 a 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. There are 61 areas with potential significant flood risk identified for Slovenia (**Fig. 29**).

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. A map of the floods risk can be seen in web GIS from the Slovenian Environment Agency (EARS, 2016). According to the flood risk .shp data provided by Slovenian Project Partners, around 6.9% of flood risk area is taken up by frequent floods; rare floods occupy 28.5% of the flood risk area, while very rare floods take the remaining 64.7%.

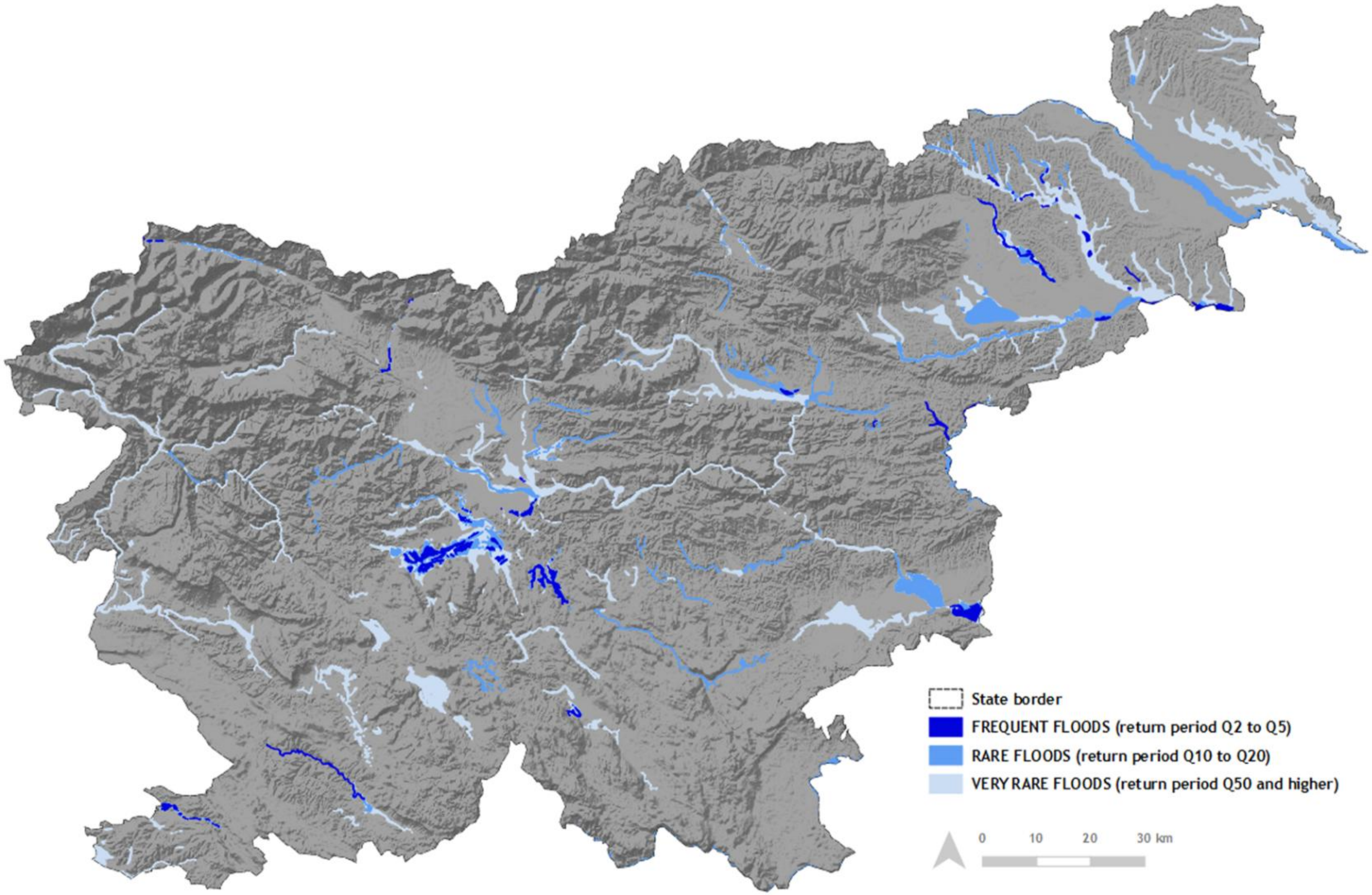


Figure 29. Flood risk map of Slovenia (floods data provided by Slovenian Project Partner; hillshade by ArcGIS REST Services Directory)

Drought is not implemented directly 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 a natural disaster.

Slovenian Environment Agency is very active in drought management, because it was leading the Drought Management Centre for South-eastern 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. There is a map of the risk of agricultural drought by municipalities.

All the Project Partner countries have had problems with floods and/or drought for the past decades, but due to global climate change, the effects of these naturally occurring processes have been more severe throughout the years. The need to restructure and update the existing protection measures has arisen.

Austria has set itself apart by implementing innovative engineering technology with the use of mobile flood walls. **Germany** boasts itself with its flood mitigation buildings – embankments (1350 km long), flood protection walls (80 km) and mobile flood protection systems (20 km). **Hungary** is known for its strict legislation which is a very positive aspect especially in the flood/drought management sector. Another good example is the NAGIS map portal created by Natér which shows graphically everything related to impact assessment of climate change on the territory of Hungary. The division of flood risk maps between the river district authorities is a good involvement strategy of **Italy** and a best practice example of management. Decentralizing the issue, responsibility is branched out and many more are involved and aware of the danger floods represent to the nation as a whole. And **Slovenia** has defined Water Protection Areas in order to protect key aquifers and they cover almost a quarter of the country.

Croatia on the contrary has had issues with mitigation measures implementation for years. The flood prevention and irrigation systems are antiquated and should be modernized in order to increase their effectiveness. **Hungary** is especially vulnerable to the rapid change in climate and the frequent droughts and floods due to its small elevation difference, which should prompt the government to act more determinedly. **Italy**'s absence of a drought risk assessment and unification of the Northern Italy data with the country as a whole should be rectified in the following period.

2.4. Water quality state, trends and monitoring

As stated in Water Framework Directive water is a heritage that must be protected, defended and treated as such. The quality and quantity of water is essential for the survival of human beings, a basic prerequisite for life. Degradation of its quality or inadequate, unsustainable management of its quantity can lead to a serious social impediments and economic costs.

Member States of European Union are bound to achieve at least good water status and protect aquatic ecosystems, terrestrial ecosystems and wetlands, by means of appropriate measures that should be implemented within national, regional and local legislation, plans and programmes.

According to the Water Framework Directive and Drinking Water Directive, Member States shall ensure the establishment of appropriate programmes, by competent authorities, for the regular monitoring of water status in order to establish a coherent and comprehensive overview of surface water and groundwater status within each river basin district, especially water intended for human consumption.

For surface water monitoring programmes shall cover:

- the volume and level or rate of flow to the extent relevant for ecological and chemical status and ecological potential,
- the ecological and chemical status and ecological potential.

For groundwater monitoring programmes shall cover monitoring of the chemical and quantitative status.

Furthermore, monitoring of water intended for human consumption is dived into check monitoring and audit monitoring. Check monitoring is regularly conducted in order to provide data on the organoleptic and microbiological quality of the water supplied for human consumption as well as information on the effectiveness of drinking-water treatment. The objective of audit monitoring is to provide the data necessary to determine whether or not all of the Directive's parametric values are being complied with.

Factors that are crucial for the prevention of water resources contamination and consequently human health risk and degradation of ecosystem dependent on water, are long-term planning as well as in due course actions.

2.4.1.1. Austria

Systematic monitoring of surface and groundwater quality and quantity is mandatory due to the Water Framework Directive, Water Rights Act (WRG Wasserrechtsgesetz) and the Ordinance on the Monitoring of the Quality of Water Bodies (GZÜV Gewässerzustandsüberwachungsverordnung).

According to the BMLFUW (2017) surface waters (rivers and lakes) are nowadays surveyed and assessed in their entirety. The assessments include impacts of material pollution and hydromorphological interventions that change the function of waters as habitats. The water quality is defined via their chemical and ecological status. In the case of water sections which have been artificially created or water sections which have been substantially modified due to utilisations, the term ecological potential is applied. Chemical and quantitative status are monitored in groundwater.

In Austria drinking water protected areas are only relevant for groundwater abstraction points for drinking water supply, and are monitored according to the Drinking Water Directive. There are three types of groundwater monitoring programmes: surveillance monitoring, operational monitoring and investigative monitoring. The amount of parameters to be observed depends on the quality status of the respective groundwater body and the regional circumstances. Groundwater bodies at risk or groundwater bodies which are not of good status are monitored up to 4 times a year ("operational monitoring"). In case of "surveillance monitoring" (groundwater bodies in good status) at least 2 measurements per year are to be carried out at the monitoring points. The "pesticide-group 1" comprising Triazine with parameters like Atrazine and its decomposition product Desethylatrazin has to be observed regularly.

In addition to the national monitoring system, the drinking water suppliers conduct self-monitoring in protected areas (**Fig. 30**). For example the city of Vienna carries out continuous on-line measurements of turbidity values and SAC (Spectral Absorption Coefficient) at each spring. If the values of the source water exceed the defined threshold values, the water of the respective spring is discharged to the stream instead of being transported via the water main to Vienna. Also in Waidhofen/Ybbs SAC data are online available for the karstic springs. Other water quality parameters are measured quarterly.

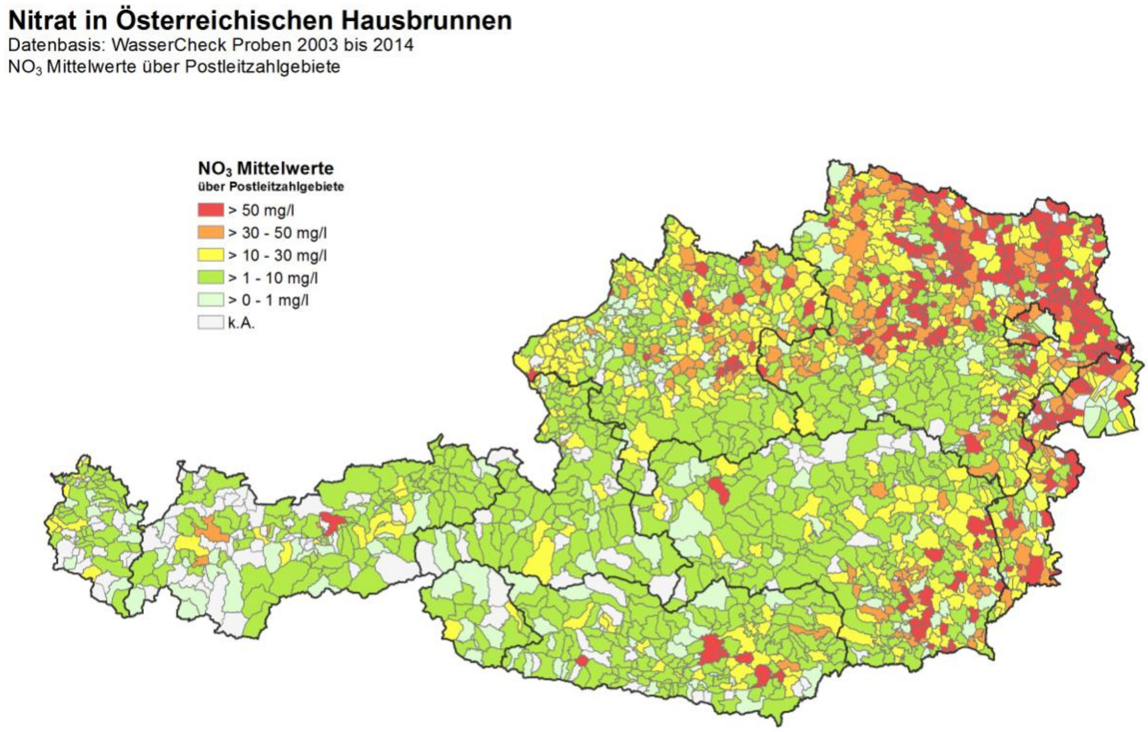


Figure 30. Nitrate levels measured in wells in Austria during the period from 2003 to 2014 (Austrian Institute of Technology / Aqua Quality Austria, 2015[2])

Emissions into surface water are registered in the “emission register” due to the Emission Register Directive (EMREG-OW, 2009). But as surface water is not relevant for drinking water purpose in Austria, these problems are not really relevant.

In case of negative quality trends, water suppliers:

- intend to identify the reason for the negative trend,
- search for the spatial dimension of the Driver and
- intend to eliminate the cause for the negative quality trend.

In some cases water protection tours are carried out yearly in order to check the status of potential contaminants for the source waters. People who are working or living within the DWPZ are informed in the course of those tours about the relevance of water protection measures.

Austrian drinking water is of the best quality in the EU, according to the inhabitants of the country. The monitoring is strict. And since the drinking water is being derived mainly from groundwater, pesticides and other chemicals are diligently observed and their usage is restricted. Vienna City practice of self-monitoring should be conducted in other cities as well.

2.4.1.2. Croatia

Systematic monitoring of quality standards for surface water and groundwater is done on a national level. Monitoring of water quality for public water supply (drinking water) is supervised by the Croatian Institute for Public Health who publishes annual reports on drinking water, while Croatian Waters perform monitoring of water quality and quantity.

According to Croatian regulations on the parameters of assessment and methods of analysis of water for human consumption (OG 125/13) there are two types of monitoring, audit and regular monitoring. Audit monitoring includes a large number of microbiological, chemical and indicator parameters to be carried out in order to determine the status of all parameters and their compliance with the requirements of water for human consumption. The purpose of regular monitoring is to obtain basic data on sensory, physical, chemical and microbiological parameters of water for human consumption. Mandatory parameters tests in regular monitoring are the following physicochemical and chemical parameters: aluminium, ammonia, colour, conductivity, hydrogen ion concentration (pH value), odour, turbidity, nitrite, taste, iron, chloride, nitrate, $KMnO_4$ consumption, residues of disinfectants (sip, chlorite, chlorate, ozone...), temperature, and microbiological parameters: Escherichia coli, total coliforms, enterococci, the number of colonies at 22ºC and 37ºC, *Clostridium perfringens* (including spores), *Pseudomonas aeruginosa*.

Those parameters which have not reached the limit during the period of two years, and that the risk assessment determines that there is a little chance of finding discrepancies, further sampling can be excluded in the annual monitoring. Analyses of the quality of water intended for human consumption are carried out minimum 4 times a year, depending on water extraction amount. With an increase of extraction, monitoring frequency is increased.

Croatian Water determine the frequency of sampling and monitoring sites for physicochemical analysis of water and are doing annual reports, and reports of trends. Water analysis are made in Water Management Laboratory of Croatian Waters and other Croatian certified laboratories authorized by the Ministry responsible for water management which are related to environmental monitoring and chemical status of surface water and groundwater.

Water resources are initially monitored, depending on the aquifer type, every 3 (unconfined aquifers) or 6 (confined aquifers) months. If it is established that the chemical status of the observed water resources is good, monitoring is carried out less frequently, at an interval of 6 months to 6 years, depending on the aquifer transmissivity and type. Following specific pollutants are monitored: nitrates, the active substances in pesticides, arsenic, cadmium, lead, mercury, ammonia, chlorides, sulphates, orthophosphates, trichloroethene and tetrachloroethene sum, conductivity.

User of quality standards of drinking water are Ministry of Health and Ministry responsible for water management. Users of quality and quantity status data are mainly Croatian waters. This data is public. Ministry of Health and Croatian waters establish the measures in case of a negative quality trend.

As it is visible from the image below (**Fig. 31**), the nitrate concentrations of groundwater are most concerning in the northern part of the country due to intense agriculture. The results of surface water monitoring are more uniform with higher concentrations in the northernmost region.

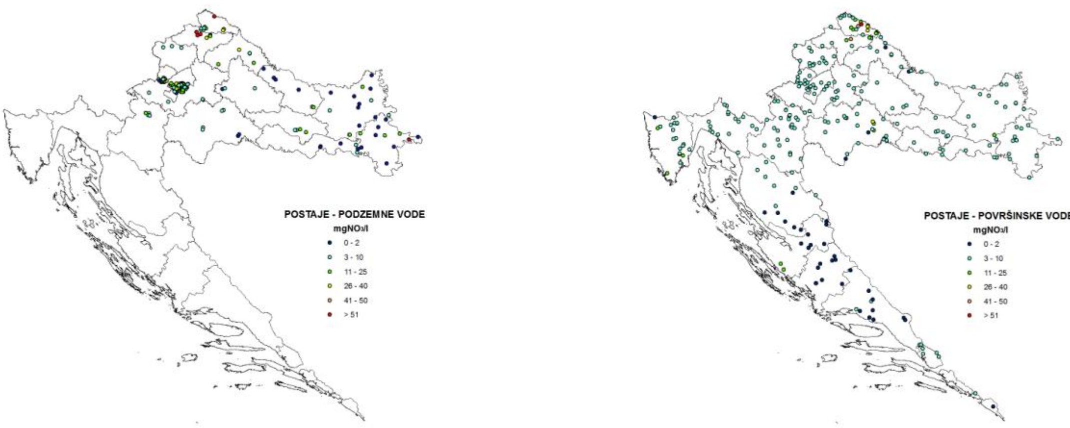


Figure 31. Nitrate concentration in groundwater (left image) and surface water (right image) in mg NO_3/l by the Faculty of Agriculture (2012)

Croatia is abundant in good quality water, yet bad agricultural practices endanger its status. Inadequate handling and application of pesticides and fertilizers and non-conservational cultivation of arable land, along with insufficient informing and education of farmers on sustainable agricultural land use were main factors that have marked the agricultural land management in the last decades. Even though Croatian Advisory Service conducts workshops and educations for farmers on the sustainable use of pesticides and fertilizers and gives

advices on the adequate soil cultivation methods, many farmers are not likely to accept advices and new practices that are different from the traditional ones. The monitoring should be more frequent and repercussions for violation of protective measures should be stricter. Decentralization of monitoring responsibility could offer a more up-to-date approach and raise awareness in the local community, as it did in Austria.

2.4.1.3. Germany

Some of the following data, concerning German Project Partner, was provided on Germany-country level, while other on Bavaria level. The drinking water as well as the raw water is monitored systematically. In Germany the Health department are State Offices for Water Management legally appointed to monitor the drinking water quality. Either the Health department performs the analysis by itself, or the health department appoints the water supplier or an accredited laboratory to perform the drinking water quality analysis. The water supplier has to inform the health department about the results of each analysis.

The Drinking water ordinance separates a routine analysis from a comprehensive analysis. The time interval of both analyses varies depending on the mean amount of water supplied a day (in m^3). E.g. the water quality of a water utility supplying between 10 m^3 and 1000 m^3 a day has to be controlled four times a year for the routine analysis and once a year for the comprehensive analysis. The differentiation between routine analysis and comprehensive analysis is not made if water utilities supply more than 100,000 m^3 on average a day. In this case the water quality has to be controlled ten times a year. Once the mean water supply increases of 25,000 m^3 one control per year has to be added and so on. In general, the greater the supply the more control has to be performed per year.

According to the Drinking water ordinance, different microbiological, chemical and indicator parameters have to be controlled with regard to the threshold excess such as ammonium, various bacteria (*Escherichia coli*, enterococci), odour, taste, turbidity, electrical conductivity, pH etc.

The Eigenüberwachungsverordnung (EÜV) regulates that the water supplier is obligated to perform a monitoring of the drinking water resources and the raw water in the DWPZ. Moreover, the water suppliers have to control the development in the catchment and the DWPZ. In this context, the water supplier has to inspect the compliance with the restrictions and requirements in zone II at least every three months while an inspection of the fence and the labelling of zone I has to be done once a year. The BayWG obligates land owners to give access to their territories to the authorities in order to perform these controls.

The EÜV regulates the frequency and the parameters of the water quality monitoring. The monitoring is separated in a short monitoring and a complete monitoring. While a short monitoring has to be performed once a year, the frequency of a complete monitoring depends on the annual water supply of the facility. In case the annual water supply does not exceed a total amount of 10,000 m^3 a year, the complete monitoring has to be done once conspicuous changes in the raw water quality have been noticed. In contrast, a facility supplying more than 10,000 m³ a year has to perform the complete monitoring every five years as well as in the following year of a short monitoring if conspicuous changes have been noticed, respectively. A short monitoring does not have to be performed in a year the complete monitoring is done.

Depending on the usage of different substances in the catchment area (based on information from users), an analysis of raw water quality has to be conducted in a 5-year cycle with regard to these substances. If no details are provided, the analysis has to be performed with regard to the following pesticides (if not excludable): atrazine, desethylatrazine, desisopropylatrazine, simazine, terbuthylazine, desethylterbuthylazine, bentazone, dichlorprop, diuron, isoproturon, metazachlor.

Due to intensive fertilization done by the German farmers, the nitrate levels are in ¼ of all drinking water resources visibly higher than it is recommended (**Fig. 32**). They pose a risk to human health in many places where the groundwater is near the surface. For example, in the Wasserwerk Großenkneten, in the middle of Lower Saxony: 16 measuring points registered an average of 93 milligrams of nitrate per litre. This is nearly twice the limit, which is at 50. Although nitrate is not a deadly poison, it can hinder the transport of oxygen in infants. Or it may be converted into nitrosamines in the human stomach, under certain circumstances, which may cause cancer. The limit value is established in order to protect humans and the environment (WasserBLIcK/BfG 2010).

Figure 32. Groundwater burdened by nitrates (blue – good status, red – bad status) in 2010 (WasserBLIcK/BfG 2010)

The State Offices for Water Management and The Bavarian Environmental Agency are users of monitoring data. Moreover, the data can be provided to research institutes for research purposes.

According to the Drinking water ordinance, the water supplier is obligated to inform the Health department and to take countermeasures in case of negative water quality trends in the raw water as well as in the drinking water. The authorities, as the legally appointed water supplier, are thus obligated to take countermeasures as well. Moreover, if harmful substances that are not included in the TrwV are detected in the raw and drinking water, both the water supplier and the authorities are obligated to counteract.

Germany had strong industry in the past that polluted every aspect of the environment. For the past years, the country is turning to renewable energy sources and is one of the leading green nations in Europe. The monitoring is extensive and thorough, the legislation is being strictly implemented and a positive progress is being steadily made.

2.4.1.4. Hungary

The water supplier and the public health department regularly monitor surface and groundwater water resources (the untreated water, the drinking water and the recharge areas - the wells monitoring located on drinking water protection areas). The test data registered by the water suppliers is annually reported to the competent regional water authority.

The monitoring of drinking water quality is regulated in Government Regulation 201/2001 (X.25.) on drinking water quality and controlling. After the sampling plan, which is approved annually by the competent authority, the monitoring of drinking water is carried out. The water supplier performs analysis in his accredited laboratory, or in the health departments' laboratory, or in another accredited laboratory to perform the drinking water quality analysis.

If the water supply is more than 10 m^3/day annual averages, or it supplies more than 50 capital settlements, operator's safety management system has to record it in the drinking water safety plan. The competent public health authority approves the decision of the water safety plan.

Water supply systems that provide the needed water to higher number of settlements must perform control testing for one sample at least once a year. The sampling frequency and observed parameters are specified in the above mentioned government regulation. The legislation separates a control analysis from a detailed analysis.

In 25% of all of the samples the following control parameters are examined: hardness, sulphate, chloride, and nitrate, total organic carbon (TOC), Enterococci.

Every two years, in 5% of the samples, the microscopic biological parameters are at least twice examined.

In statutory cases in 25% reduced frequency the following parameters are examined: arsenic, boron, fluoride, Trihalomethanes – sum (total) (in case of chlorinated water), bromate (ozone water treatment).

Value of chemical, biological and radioactive substances in drinking water, as well as physical characteristics, that pose a risk to human health must be examined and if necessary corrective measures must be taken.

Competent water directorates conduct the monitoring of potential drinking water resources. The water permit of operation and the decision about the designation of drinking water protection zones includes the procedure of drinking water resources monitoring.

According to the regulation a first base state analysis must be performed (Regular base chemical analysis and Additional chemical analysis), and then it is repeated at least every 6 years. The regular base state analysis must be performed annually. Control analysis must be performed daily minimum one in case of river water abstraction, from the Lake Balaton two in every week and from the reservoirs one analysis per week. For unprotected groundwater resources an analysis should be made at least once every 6 months after the regular base analysis. In the case of water treatment (excluding degassing and disinfection) and drinking water works with capacity higher than 5000 m^3/day at the network entry points one analysis per month is required. In the period between control analyses, bacteriological tests must be performed.

The procedure of surface drinking water resources monitoring is specified in KvVM Ministry Regulation 6/2002 (XI.5.) on the required quality of surface freshwater intended for drinking water purposes and to support fish life and their monitoring.

The monitoring data is being used by the authorities, water management directorates, operators, consumers, environmental and water public enterprises, universities and research institutes.

If the operator was notified, or the authority perceives an extraordinary event about the quality of drinking water, any of the test results exceed the limit and parametric values set out in the legislation, and in case of a pollution risk, the competent public health department will investigate the cause of the overrun and the required water quality improvement measures will be ordered.

As much as 579 surface water bodies are at risk from organic and/or nutrient hazardous substances. Approximately 70% of artificial lakes are at risk from organic and nutrient loads (ICPDR, 2006). The image below (**Fig. 33**) depicts nitrate concentrations in Hungary which correspond to intense agricultural zones. The majority of the localities of tested groundwater and well water are under 5 mg/l with sporadic high contamination punctual sources.

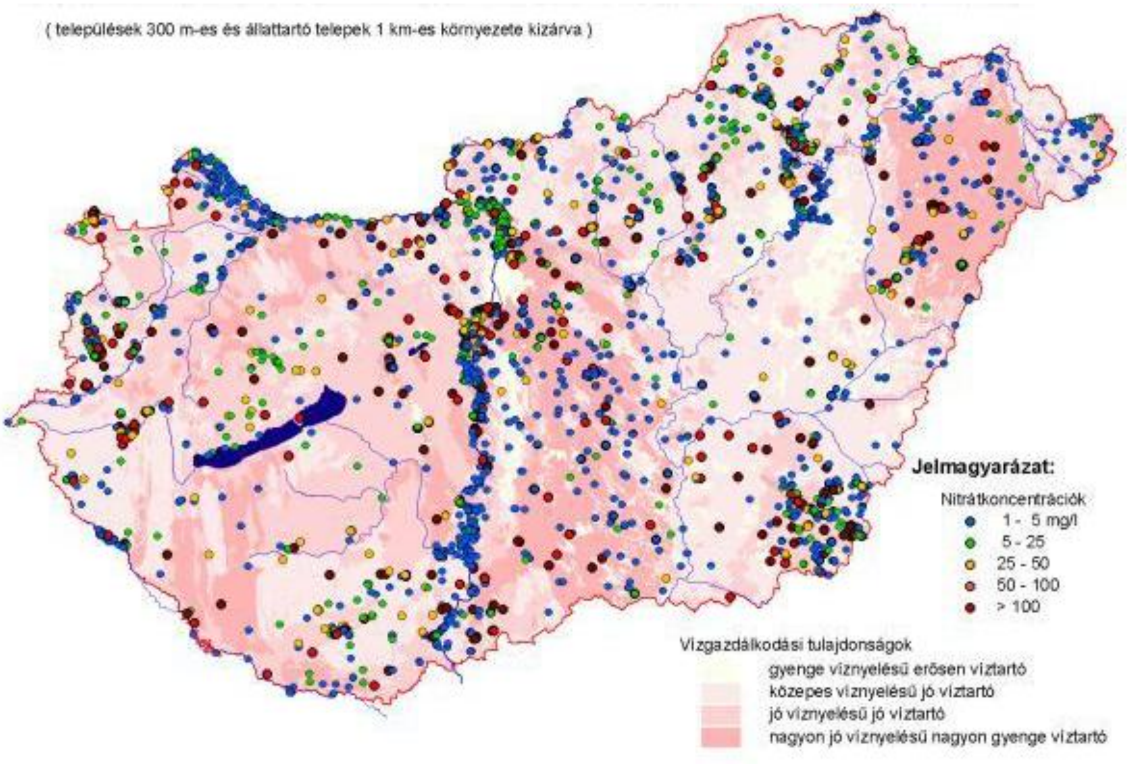


Figure 33. Nitrate concentration in groundwater and partitioned wells in Hungary (2004)[4]

Hungary is at an unfavourable geographical location where the plains contribute to excessive flooding and drought periods. The growing agriculture does not bode well for the water bodies. Regulations on pesticide control should be stricter and penalties higher in order to motivate and educate people in the interdependence of agriculture and water quality. The monitoring analyses are frequent, but they haven't contributed to the depletion of harmful substances from the surface waters. With better management and legislation implementation, the effects of drought can be substantially minimized and flood can be stopped with good management practices.

2.4.1.5. Italy

According to D.Lgs. 31/2001 monitoring of drinking water quality is carried out by water service provider (told "internal monitoring") and by public health service ("external monitoring"), ASL (Local Sanitary Authorities) and/or environmental Agencies for laboratory analysis (**Fig. 34**).

The analytical screening includes: pathogenic microorganisms (Escherichia coli, total coliforms, enterococci and so on), chemical substances (cyanides, chlorides, chlorites) and pollutants (heavy metals, chlorinated organic solvents, PHA and other organic micro-pollutants). There are two types of analytical screening: one with complete set of parameters (low frequency) and one (routine) regard a sub set of 16 substances (high frequency). Public (External) monitoring frequency is related to the amount of water supplied: minimum routine monitoring frequency is four samples per year and minimum complete monitoring frequency is one sample per year, while for very large water supplying could be necessary about 130 routine samples per year and 15 complete check samples per year.

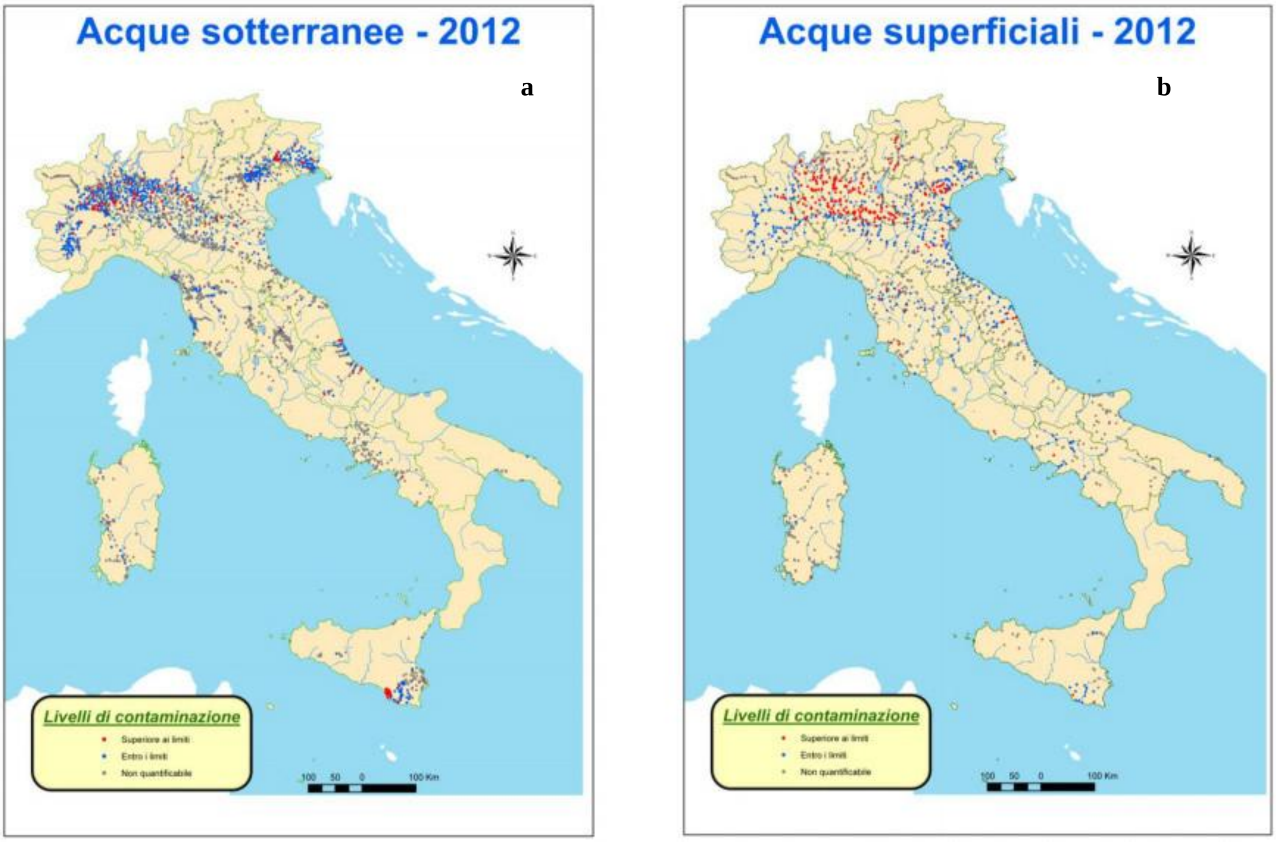


Figure 34. Contamination in groundwater (a) and surface water (b) in 2012 (red being the highest)[5]

According to the D.Lgs. 31/2001 and D.Lgs 152/06 monitoring of drinking water resources is conducted both by water service provider ("internal monitoring") and public health service ("external monitoring).

Critical issues on drinking water quality trends are analysed in the process of periodical updating of the Water Protection Plan (regional excerpt of the RBMP).

Public health service is the main user of the monitoring data for checking the compliance with legal standards of the water service; drinking water surface resource monitoring data and groundwater-monitoring data are analysed by Region Emilia-Romagna and ARPAE in the process of periodical updating of the Water Protection Plan (regional excerpt of the RBMP).

Critical issues emerging from negative quality trends are examined, with the help of pressure analysis, to detect the main cause of the risks, and the appropriate measures are settled and included in the Program of measures in next RMBP / "Water Protection plan" updates. Critical issues due to sudden phenomena are faced with emergency measures.

Italian surface water is heavily contaminated due to poor agricultural practices and the drainage of pesticides and other chemicals into the water network. The usage of untreated sewage sludge causes elevated nitrate concentrations and further pollution. It is of utmost importance to demand stern implementation of restriction and protection laws in order to impact the water quality. Better measure application for flood and drought mitigation is also advised.

2.4.1.6. Poland

Water used for the public water supply must comply with the water quality requirements provided in the Regulation of the Minister of the Environment of 27 November 2002 on the requirements to be met by surface water used for the public supply of water intended for human consumption (Journal of Laws No. 204, item 1728), hereinafter “the Regulation on water for public supply” and in the Regulation of the Minister of Health of 13 November 2015 on the quality of water intended for human consumption (Journal of Laws, item 1989), hereinafter “the Regulation on water for consumption”. The monitoring system for this kind of water has a dual structure.

A separate assessment procedure is conducted by the State Sanitary Inspection according to the criteria specified in the Regulation on water for consumption and the Inspectorate for Environmental Protection (GIOŚ and WIOŚ, at the State and voivodeship levels, respectively) in accordance with the rules of the Regulation on water for public supply.

The monitoring of bodies of groundwater intended for consumption is conducted as part of the monitoring of protected areas which is a component of the State Environmental Monitoring. In regard to groundwater, the measurement points used for this type of monitoring constitute an element in this type of water research and observation network. Pursuant to the Article 155a (5) of the Act – Water Law, the Polish Hydrogeological Survey conducts studies of and assesses groundwater in terms of its physicochemical and quantitative characteristics, while the general groundwater status is assessed by the GIOŚ. In practice, monitoring studies are conducted by the Polish Geological Institute – National Research Institute (a department of the Polish Hydrogeological Survey) at the request of the Chief Inspectorate for Environmental Protection (GIOŚ).

Studies and assessment of surface water quality are conducted, similarly to groundwater, within the framework of State Environmental Monitoring. The monitoring of water used for public supply is conducted by the WIOŚ and includes selected physicochemical, chemical, biological and microbiological parameters. The scope and frequency of tests are defined in the Regulation of the Minister of the Environment. The analysis embraces 66 indicators, including colour, temperature, sulphates, phosphates, pesticides, ammonia and total coliforms.

The minimum measurement frequency (per year) depends on a number of supplied persons and the type of surface water body. It ranges from 1 to 12 times per year, although in most cases it is 4 to 8 times per year.

The assessment of the status of water used for public supply of drinking water is carried out in accordance with the Regulation of the Minister of Environment of 21 July 2016 on the classification status of surface water and environmental quality standards for priority substances (Journal of Laws, item 1187).

The nitrate levels in Polish water are depicted in the image below (**Fig. 35**). It is visible how the results vary between spring (left image) and autumn (right image) which is proportional to the fertilizer usage in agriculture. Due to the increase in precipitation during spring time, the nitrates are easily leached into the soil and watercourses.

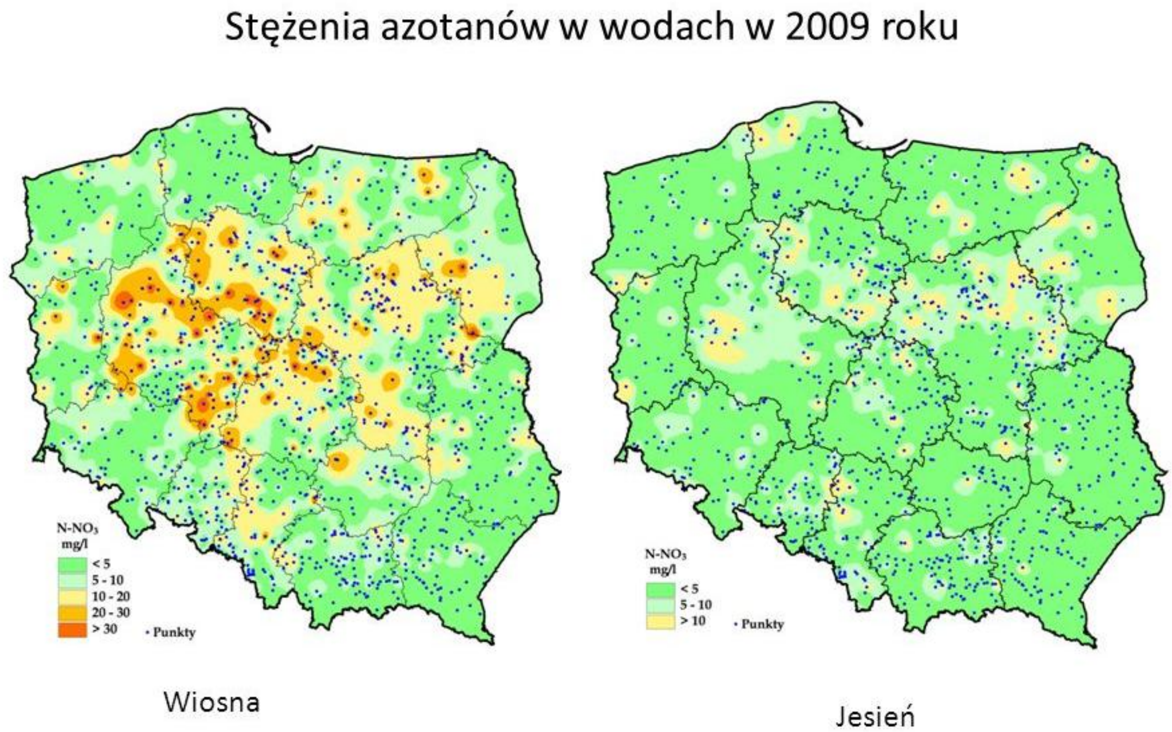


Figure 35. Nitrate concentrations in water in Poland, 2009 (Conference for advisers Radom, June 2012)[6]

Periodic water quality assessments issued every 6 and 12 months contain information regarding compliance in the supervised area with the requirements specified in Annexes 1-4 to the Regulation in the period for which the assessment is prepared. They are also useful to the responsible head of the commune (or the mayor) as a source of information necessary for taking measures aimed at supplying water of acceptable quality to consumers.

In every case of exceeded parameters, the State Sanitary Inspection bodies take individual action and issue a decision to conditionally approve the water for consumption (for a specific period of time). The decision is made on the basis of health criteria taking into account an estimation of the risk caused by the values of the said parameters' being exceeded. It should be noted, however, that a certificate of the conditional suitability of water for consumption or a temporary special authorisation are issued on a case-by-case basis after considering the health-risk level. Water which poses a significant risk to consumers is not approved for consumption.

Every case of exceeding the parameters specified in the Regulation requires performing an assessment of the threats and an estimation of the risk of potential events which pose a threat to consumer health and an assessment of the suitability of water for consumption. Water-quality assessment is conducted separately for every water supply system.

Pursuant to Art. 3 of the Act of 7 June 2001 on collective water supply and sewage collection, water supply is included in communes' own responsibilities and is implemented by water-supply companies, which are responsible for ensuring the appropriate sanitary condition. Furthermore, it should be noted that activities to improve the status of water, including those of water bodies intended for the public supply of water for human consumption are included in the national water-environment programme and its updates, specifying the entities responsible for their implementation.

Basic information on water-status assessment is publicly accessible on the GIOŚ website, including in the form of annual reports on the condition of the natural environment in individual voivodeships. Information obtained from the monitoring conducted by the State Sanitary Inspection is available, i.e., in the form of monthly reports for voivodeships on exceeded parameter values published on the official Polish government site. Information from the said sources is used mainly by the water-administration authorities, other State-administration bodies and bodies conducting environmental-impact assessments and expert studies of investment compliance with the Water Framework Directive.

Poland is one of the most air polluted countries of the EU. Excessive legislation without implementation serves no purpose. Protection laws should be followed through. The publically available monitoring data which includes the monthly reports are freely given via Internet to all interested parties.

2.4.1.7. Slovenia

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

A nitrate concentration level monitoring was conducted in 2014 and the results are displayed in the below image (**Fig. 36**). The overall concentrations are mostly under 10 mg/l with only the easternmost region showing concerning levels of over 50 mg/l.

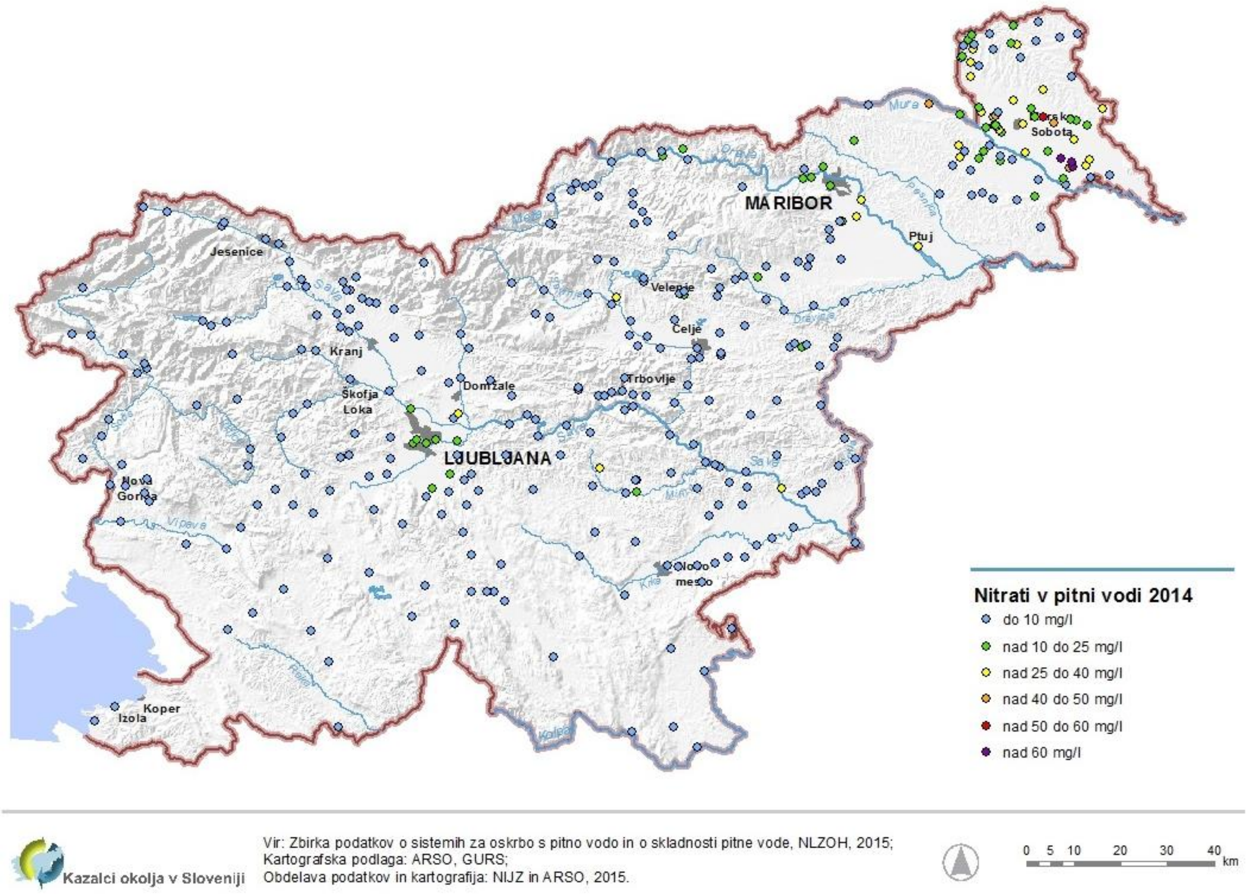


Figure 36. Nitrate concentrations in drinking water of Slovenia in 2014 (ARSO, 2015)[7]

Rules on drinking water (Official Gazette of the Republic of Slovenia 19/2004, 35/2004, 26/2006, 92/2006, 25/2009 and 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: *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. According to the data from the Danube water program, the drinking water quality improved significantly in Slovenia during 2004-2013 for both microbiological and chemical parameters. In 2009, a public registry of water supply systems (called IJSVO) and a cadastre of public water supply infrastructure were developed. These tools are now in use and have improved the analytical information on the overall status of water supply in Slovenia. It is now possible to access information on water supply from the agglomeration level to the level of individual building and supply pipe. Improvements regarding data quality and validation are still necessary, but this is a pivotal tool in the overall management of the water supply sector.

The periodic physicochemical 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.

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

Larger water utilities monitor trends of drinking water quality parameters. Small water utilities perform only prescribed monitoring, which can be 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. The data is collected in the Annual Report and are publicly available on the public water companies' websites.

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 then increased.

Slovenia has made great improvements regarding their water quality in the past years. The good management practices have contributed to the betterment of groundwater and surface water. The online tools that have been developed are an excellent example of an interactive platform that benefits the public users. The government even went as far as to amend its constitution to make access to drinkable water a fundamental right for all citizens and stop it being commercialised in 2016, which made Slovenia the first European Union country to include the right for water in its constitution.

Overview of water quality state, trends and monitoring

Water quality and quantity are major responsibilities of each and every country. Water is steadily becoming a potent strategic resource and the benefits of investing in its protection are manifold. Monitoring its state and minimizing the effects of contaminants should be at the forefront of every water management plan.

According to the country residents, **Austria** has the best quality of water in the EU. Its status was achieved through strict systematic monitoring and stern pesticide limitation. An example of good practice is Vienna City's self-monitoring of water that should be a universal policy for each city. **Germany** has had a positive development in regards to its sustainable and ecological growth, owing it to meticulous monitoring and strict legislation implementation. The country is a good example of an industrialized state turning green and self-sufficient. **Slovenia** has managed to improve its water quality drastically over the last few years thanks to good management practices. The government even made access to drinkable water a fundamental right for all citizens and thus ineligible for commercialization, which made Slovenia in 2016 the first country of the European Union to include the right to water in its constitution.

Bad agricultural practices and sparse annual monitoring jeopardise the water quality in **Croatia**. Decentralisation of water observation could benefit the country in raising awareness in the local communities and sharing the responsibility among smaller units. As the majority of the waters in Croatia are in good qualitative and quantitative state, this fact often results in neglect and infrequent monitoring, especially of groundwater, which is considered a bad practice in the long run due to high susceptibility to contamination. **Hungary** has had similar problems in regards to agricultural impact on groundwater quality. Pesticide regulation and penalties for their poor utilization should be stricter as it impacts everyone. The same applies for **Italy** whose agricultural boom is in direct connection with its rapid water quality deterioration. The use of untreated sewage sludge is poorly monitored and in opposition with the EU Nitrate Directive. **Poland** has the necessary legislation if not copious amount of it, yet are lacking in the implementation part.

In general, the countries should implement stricter repercussions for bad management practices and upgrade their monitoring to be more up-to-date with the water status. The results should have media coverage in order to promote responsible water management.

3. Actual land-use activities

3.1. Overview of the particular land-use activities

3.1.1. Land-use map

Changes of the land management practices and consequently land cover can be considered as the pivotal factors that impact and modify the hydrological and hydrogeological systems. If not observed and handled in the right way, intricate relationship between some of the land-use activities and water quality and quantity, can lead to adverse repercussions.

Hence, the role of land-use practices in achieving water resources sustainability should be cautiously evaluated in order to mitigate current and prevent future major issues like water contamination, floods and droughts.

According to the Water Framework Directive Member States shall collect and maintain information on the type and magnitude of the significant anthropogenic pressures to which the surface water bodies in each river basin district and groundwater bodies are liable to be subject. Estimation of land-use patterns, including identification of the main urban, industrial and agricultural areas and, where relevant, fisheries and forests need to be collected. Land-use data need to be collected in the catchment or catchments from which the groundwater body receives its recharge, including pollutant inputs and anthropogenic alterations to the recharge characteristics such as rainwater and run-off diversion through land sealing, artificial recharge, damming or drainage.

Land-use data (based on Corine Land Cover 2012) was provided by the Project Partner countries who also gave the overview of the current land-use practices. GIS tools were used to obtain the land-use categories within drinking water protection zones in each country and to calculate their area and percentage of presence. To compare the individual land-use activities between the countries, correlation graphs and charts were constructed.

3.1.1.1. Urban areas

Current management practices in urban environment for each Project Partner country can be seen in the text bellow.

3.1.1.1.1. Austria

The sewage disposal and treatment are carried out by means of 1,842 local purification plants and are mainly provided by municipalities or outsourced enterprises and associations. The connection rate to the sewer system in Austria is 94.9% (2011). According to the Eurostat total amount of generated urban wastewater was 1.093 million cubic meters in 2012. Only three sewage treatment plants (> 2000 inhabitants) discharge their wastewater into groundwater on the basis of water permissions, but they do not cause any degradation of groundwater quality status. Due to national requirements all municipal sewage plants have to be equipped with carbon-extraction. Moreover, most of the plants have a further wastewater treatment stage (phosphor-/nitrogen-extraction). The cleaning power achieves 80% of N and 90% of P. Nevertheless, measures that will further reduce ammonium, zinc, AOX and copper emissions are foreseen in the future.

Concerning waste management Austria takes a leading role in Europe. The recycling rates (66% - 96%) are higher than the EU requirements. According to the Eurostat, the amount of waste produced by households in 2014 was 4,170,023 tonnes, while 56.9% of the municipal waste was recycled in 2015. Innovative technologies and solutions, e.g. in the field of emissions reduction during waste incineration or waste use in industries, enable Austrian manufacturing companies to use know-how transfer to foreign countries.

Unfortunately due to 126 contaminated sites ("Altlasten") punctual pollutions of groundwater are expected or already existing (NGP 2015). These sites are systematically registered and analysed since 1990.

3.1.1.1.2. Croatia

According to the documentation of Croatian waters, 245 public sewage system are recorded, 118 in the water area of the Danube River and 127 in the Adriatic Sea catchment area. Only 46% of the total population is connected to the sewage system. Around 35% of the total population is connected to the 110 active wastewater treatment utilities of different degree of purification. At the water area of Danube River basin second level of treatment dominates, and the Adriatic Sea catchment area with submarine outlet treatment. The second level of wastewater treatment means treatment of urban wastewater by a process generally involving biological treatment with a secondary deposition and/or other procedures. Submarine discharge is water construction for discharge of wastewater into the sea at a certain distance from the coastline, normally not less than 500 m and to a depth greater than 20 m. 54% of the population is without public sewage system (56% of the water area of the Danube River and 52% in the Adriatic Sea catchment area).

Current waste management in Croatia is characterised by the lack of accurate information about the quantity of waste produced, who produces what type of waste and in what quantities, how it is further treated and disposed; then by inadequate treatment of waste, by the lack of adequate facilities within waste management system (treatment, disposal); by difficulties in finding appropriate location for disposal sites (difficulties in obtaining approvals by local communities and permits by relevant authorities). Croatian Environment Agency established the Environment Atlas an online portal with the geospatial information on all waste management facilities: landfills (active and closed), waste management centres, recycling facilities, composting stations and contaminated locations (speleological objects with illegally disposed waste and so-called black spots – locations contaminated with hazardous waste). The regulatory framework is relatively good in Croatia, and in spite of problems, there is a growing activity and interest in waste management (Dragičević et al., 2006). Organised collection of municipal waste covers an average of 92.8% of the population of Croatia. According to the EUROSTAT, the amount of waste produced by households in 2014 was 1162112.0 tonnes, while 18.0% of the municipal waste was recycled in 2015.

The disposal of waste is prohibited within DWPZ. Any temporary or permanent waste disposal is prohibited as well as construction of building/structures for waste management. Discharge of wastewater within DWPZ is regulated according to the relevant legislation: for aquifers with intergranular porosity discharge of untreated wastewater is prohibited within III zone, while treated and untreated wastewater discharge is prohibited within II and I zone; in aquifers with fracture and fracture-cavernous porosity discharge of untreated wastewater is prohibited within IV and III zone, while treated and untreated wastewater discharge is prohibited within II and I zone.

3.1.1.1.4. Germany

The public sewage system covers a channel length of about 100,000 km in Bavaria. 96% of the Bavarian population is connected to the public sewage system. According to the Eurostat 97% of Germany population was connected to the public sewage system in 2013. Private sewers are estimated to be at least twice as long as the public sewage system. It can be assumed that 80% of the private sewage system is damaged which may harmfully affect the environment (LfU, 2013a).

57% of the public sewage system is combined sewers while 43% are separated sewers. In general, wastewater treatment is organized in a decentralized manner; if ecological and economical aspects do not permit a connection to the public sewage system, smaller wastewater treatment plants can be installed for settlement structures with a population equivalent (p.e.) of < 2000 (following Art. 3 of the Council directive concerning urban wastewater treatment, the minimum requirement for these plants is similar to municipal wastewater treatment plants of size class 1).

In Bavaria, nearly 2700 urban water treatment plants are installed with a population equivalent of 26.9 million. During the last decades, a tendency towards a closure of small wastewater treatment plants can be observed due to a need of rehabilitation. The concerned settlements are thus more and more connected to large-scale treatment plants (LfU, 2010b).

According to the EUROSTAT, total amount of waste generated by households in 2014 in Germany was 36,887,634.0 tonnes, while the estimated amount of recycled municipal waste in 2015 was 66.10%. The districts and cities without districts are responsible for the public waste management in Bavaria. This task can also be further delegated to municipalities located in each district if a regular waste management can be ensured. In water protection zones, the deposition of waste is prohibited in all zones to avoid a diffuse contamination (LfU, 2003).

Bavarian flood management strategies are working towards a decentralized flood protection e.g. decentralized rainwater drainage and natural water retention. In Bavaria, some adaption strategies for low water management have already been implemented, e.g. low water elevation through the transition system Danube River - Main River (WWA-Ansbach, 2014).

3.1.1.1.5. Hungary

The rate of settlements connecting to utility sewage system is continuously increasing, and was 60.2% in 2014 (there is no data available for 2015 yet). The same rate for dwellings is 77.0%. Between 2000 and 2013, the number of settlements connected to the sewage system increased from 854 to 1860. Along with this, the number of dwellings connected to the sewage system increased by more than 1.2 million to 3.3 million resulting in 75% coverage (source: Hungarian Central Statistical Office).

Municipal wastewater plays an important role in the pollution of surface waters. Individual desiccation-type sewage disposal in residential areas with no sewage system put a heavy load on groundwater. Due to developments of collation and sewage treatment pressure on groundwater decreased while on surface waters increased in the last decade.

One of the highest priority point sources (due to the volume of emission) is communal sewage, mainly as a source of nutrient and organic matter load, but may also contribute to hazardous chemical contamination (e.g. metals, salts, antibiotics and other pharmaceuticals, household chemicals and personal care products). Nutrient emission from communal sewage treatment is monitored and reported (BOD, COD, total N, total P, salt and particulate matter) by treatment plant. Urban precipitation runoff is an additional, though not well characterized contamination source in Hungary. In addition in combined sewage systems, heavy precipitation may also lead to sewage overflow, increasing the release of contaminants significantly.

According to the Eurostat, total amount of waste generated by households in 2014 in Hungary was 2,951,303.0 tonnes, while 32.20% of municipal waste was recycled in 2015. In Hungary, household waste is mixed, separately collected as well as bulky waste generated in households including waste generated in homes, residential properties and premises used for the purpose of recreation and leisure. The proportion of recycled and composted municipal waste has risen since 2005. Comparing the distribution of the three forms of treatment, it is apparent that landfill, which is the least environment friendly form of waste treatment, is the most common process of treatment in Hungary, mainly because it is cheaper than incineration or recycling. The ratio of hazardous wastes (3.4%) to all generated wastes was near the EU average (source: Hungarian Central Statistical Office).

3.1.1.1.6. Italy

In Italy, 28% of population (about seventeen million people) live in eighty five centres exceeding 40,000 inhabitants: specifically, 32 have less 150,000 in. and six exceed 500,000; moreover, Rome (2,872,021) and Milan (1,337,155) are mentioned separately as major cities.

About wastewater, in terms of population equivalent (p.e.- expressed as 54 grams of BOD over 24 hours), four cities have values close to or greater than two millions (in order, Rome, Turin, Milan and Naples) while in other nine cases 500,000 in. are passed. Although 91/271/CEE (Art.3) limits the use of individual systems to conditions where “no environmental benefit” or “excessive cost” are recognizable, in 33 over 85 cities their use is over 2% and in 10 cases exceeds 10% (22% for Venice, 36% for Pordenone and 50% for Catania). On the other side, in about 30 cities all wastewater is channelled into sewers. Around 94% of the Italy's population was connected to urban wastewater collecting and treatment systems (sewage systems) in 2009 according to the last available data on Eurostat.

Up to 2012 (ISTAT, 2012), over 18,000 wastewater treatment plants were in function in Italy; the largest part is located in North-West Italy (35%).

According to the Eurostat, the amount of waste produced by households in 2014 in Italy was 29660116.0 tonnes, while 43.5% of the municipal waste was recycled in 2015.

3.1.1.1.7. Poland

Pursuant to section 3 of the Regulation of the Minister of the Environment of 22 July 2014 on the method for designating the area and boundaries of agglomerations (Journal of Laws 2014 item 995), certain areas, i.e. agglomerations, were identified (set) in which the population or economic activity are congested to such an extent that municipal wastewater can be collected and transported to wastewater treatment plants or to the final point of discharge of the wastewater.

The agglomerations were divided into three groups depending on the size, determined on the basis of a criterion regarding quality standards for reclaimed water discharged to the receivers. The number of agglomerations is shown in individual size groups and the population equivalent of agglomeration characterising the biodegradable load. Where the population equivalent (PE) means the organic biodegradable load's having a five-day biochemical oxygen demand (BOD5) of 60 g of oxygen per day.

The analysis showed that there are 683 wastewater treatment plants in the agglomerations, whose effluents meet the requirements laid down in the Regulation of the Minister of the Environment of 29 November 2002 on the conditions to be met for the discharge of wastewater to water or the ground and on the substances of particular hazard to the water environment (Journal of Laws, No. 212, item 1799), and Directive 91/271/EEC regarding the quality of wastewater.

377 wastewater treatment plants constitute a permanent solution, providing a full or partial service for an agglomeration by 2015. On the other hand, 306 wastewater treatment plants provide the service of the existing sewage systems, but to ensure the service by 2015 and a wider scope of provided sewage services connected with the expansion of network systems, the plants will require extension, or it will be necessary to build new wastewater treatment plants.

Hence, the number of agglomerations in the 2015 update amounted to 1 502 (38 million PE), where 1643 wastewater treatment plants were located. According to the adopted methodology, these agglomerations were divided into four priorities on the basis of the significance of investment and the urgency for providing financial resources.

The investment plans presented by agglomerations show that 119 new wastewater treatment plants are due to be built and 985 other investments within the plant area are planned within the framework of the fourth update.

According to the Eurostat, the amount of waste produced by households in 2014 in Poland was 8,240,413.0 tonnes, while the estimated amount of recycled municipal waste in 2015 was 42.5%.

3.1.1.1.8. Slovenia

Negative impact on water quality can have urban wastewaters and also the use of pesticides in the sports areas, parks and cemeteries. In 2014, Slovenia had released 810 million m^3 of treated wastewater, or 21% more than in 2013. The amount of untreated wastewater 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, when compared with 2013 it is a decrease of 1%.

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 wastewater 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 non-existent 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 wastewater was treated in urban or common wastewater treatment plants of a certain treatment level in 2014 is 0.5% in primary, 33.4% in secondary and 24.3% in tertiary treatment (in total 58.2% population; ARSO 2016a). Sewage is generated by residential and industrial establishments and also rainwater.

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 wastewater were discharged into the public sewage system: before discharge 80 million m^3 of wastewater were treated. Into land a million m^3 of wastewater were discharged untreated and 0.4 million m^3 of wastewater 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).

According to the Eurostat, the amount of waste produced by households in 2014 in Slovenia was 562,375 tonnes, while the estimated amount of municipal waste recycled in 2015 was 54.1%.

Overview of urban land use by Project Partner countries

Bad management practices along with gaps in the national legislation related to the urban land use can cause numerous potential negative issues that might affect water quality and availability. Thus densely populated or constructed urban areas with high amount of impervious surfaces can result in increased surface runoff, increased water usage, inadequate sewage and waste disposal. Furthermore, poor spatial planning in the development of rural or urban areas in flood prone areas can lead to serious flood risks.

According to the Eurostat data, in majority of Project Partner countries more than a half of the population is connected to the sewage systems (**Fig. 37**). One half of the Project Partner countries have the connectivity around 95% which is commendable, while the other half has around 70% of population connected to sewage systems. Only Croatia stands out with just 46% (data from Croatia River Basin Management Plan 2016-2021) of population connected to the sewage systems.

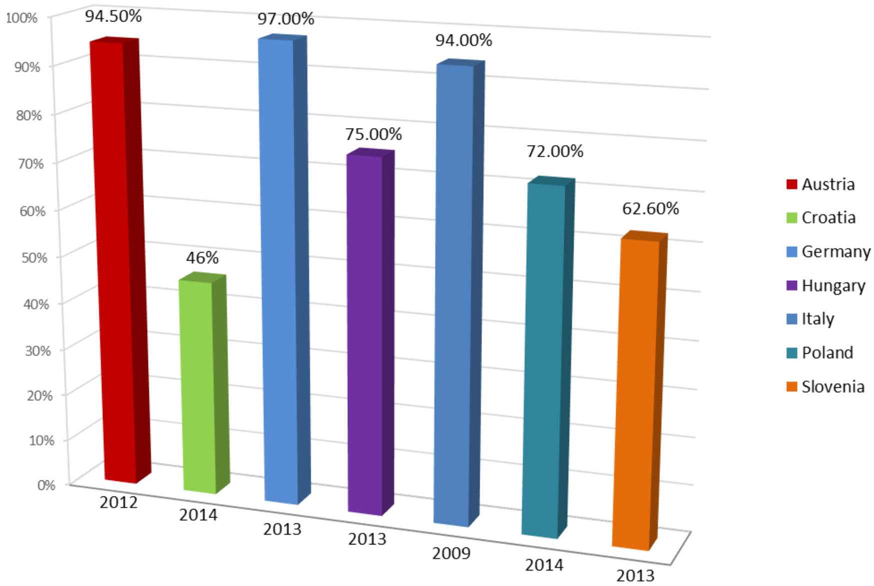


Figure 37. Connectivity of population to sewage system in Project Partner countries (data by Eurostat; some of the data is estimated; X axis shows the year of the acquired data)

According to the data provided by Project Partner countries, Italy has the largest number of treatment facilities (18,000), while Croatia has the smallest number of treatment facilities (110) (**Table 3.**).

Table 3. Number of wastewater treatment facilities per Project Partner country

County	Number of wastewater treatment facilities
Italy	18000
Germany	2700
Austria	1842
Poland	1643
Slovenia	683
Croatia	110
Hungary	No data

Germany has the largest amount of generated urban wastewater (10,078.6 millions of cubic meters), while in Croatia the amount of produced wastewater is 393.5 millions of cubic meters (according to the Eurostat data for the year 2013). 1,093.0 millions of cubic meters of wastewater was produced in Austria according to the latest Eurostat data from 2012 (**Fig. 38**) (Eurostat). Data for Slovenia was provided by Project Partner and relates to the year 2014. There was no data for Italy.

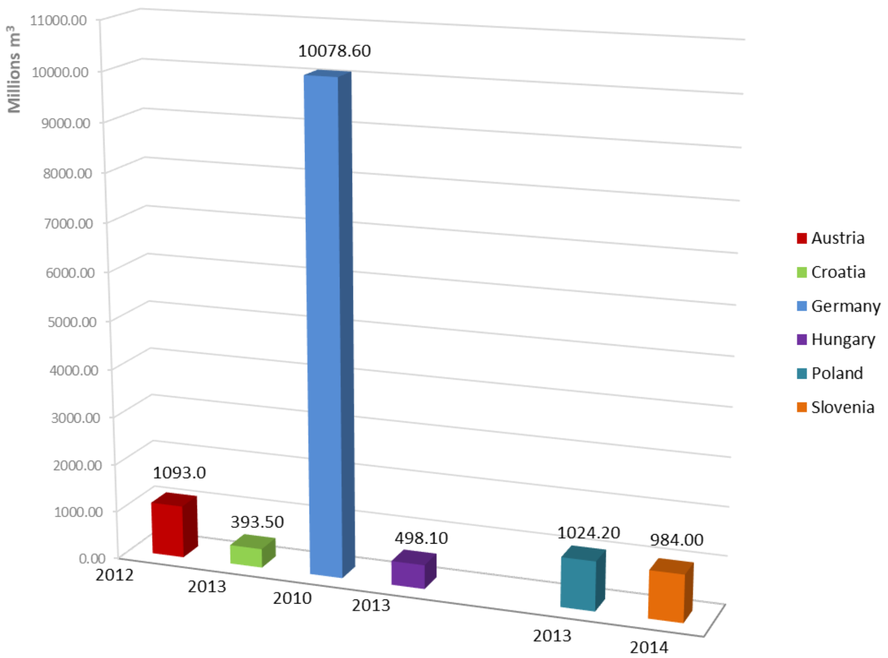


Figure 38. Generated urban wastewater in Project Partner countries (X axis shows the year of the acquired data and Y axis is in millions)

Low connectivity of the population to the sewage systems are often repercussions of inadequate or unsustainable spatial (urban and rural) development, insufficient funding and exhaustive legislation procedures. Individual properties or whole settlement without the proper sewage systems and waste water treatment facilities, as well as those having these systems that are unmaintained or devastated, pose a serious environmental problem especially from the aspect of water resources protection. Some of the poorly developed settlements that due to their dispersed spatial structure and distance from the urban or rural fabric with adequate sewage network, have cesspits which are in most cases permeable and prone to leak. Germany stated that almost 80% of the private sewage systems are damaged which may harmfully affect the environment. Although the sewage network development in Croatia is not on the satisfactory level, significant efforts (planned measures) are being taken according to the River Basin Management Plan. In Hungary number of settlements connected to utility sewage system and wastewater treatment facilities is continuously increasing which has decreased pressure on groundwater while on surface waters increased in the last decade. Also Slovenia stated that the amount of treated wastewater increased, but it is still only around 54%. Remarkable is the fact that in Austria only three sewage treatment plants discharge their wastewater into groundwater on the basis of water permissions, but they do not cause any degradation of groundwater quality status.

According to the Eurostat data for year 2014, the biggest amount of waste was produced in Germany (36.89 millions of tonnes), while the smallest amount was produced in Slovenia (0.56 millions of tonnes) (**Fig. 39**). Less than a half of Project Partner countries recycle around 55% of produced municipal waste. Croatia stands out as a country that recycles the least (only 18% of municipal waste) (**Fig. 40**).

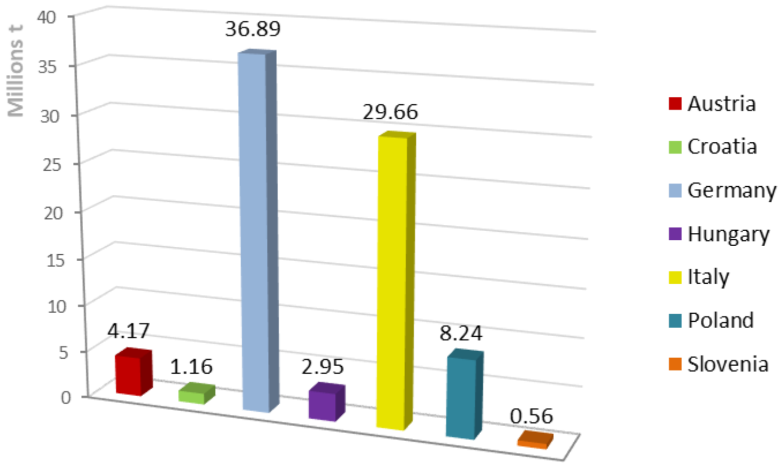


Figure 39. Produced total household waste by Project Partner countries in 2014 (data by Eurostat)

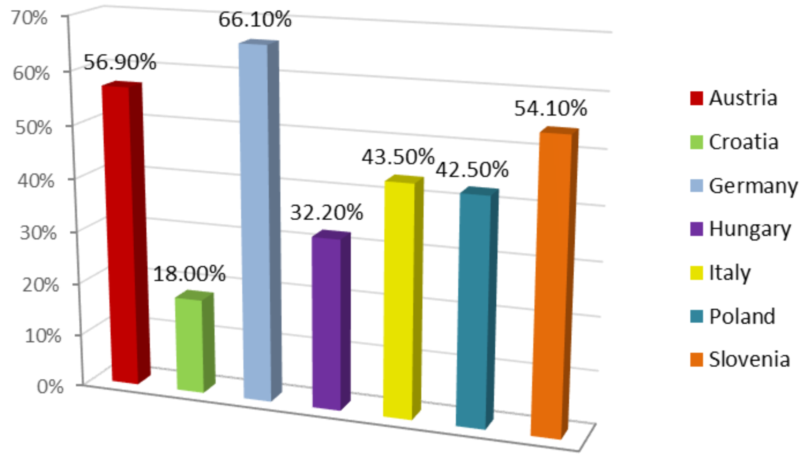


Figure 40. Recycled municipal waste in Project Partner countries in 2015 (data by Eurostat, some of the values were estimated)

Austria stated that they have a leading role in Europe concerning waste management, while in Croatia and Hungary the activities and interest in waste management are growing and the proportions of recycled or composted waste are in increase.

According to the CLC data provided by Project Partners, the amount of land used as an urban area in drinking water protection zones varies between the smallest amount in Croatia with 2.81% and largest amout of 13.54% in Hungary (**Fig. 41**). These urban areas often encompass continuous and discontinuous urban fabric and areas that are constructed more than 80%. Other urban areas that can be found within DWPZ are green urban areas and sport and leisure facilities.

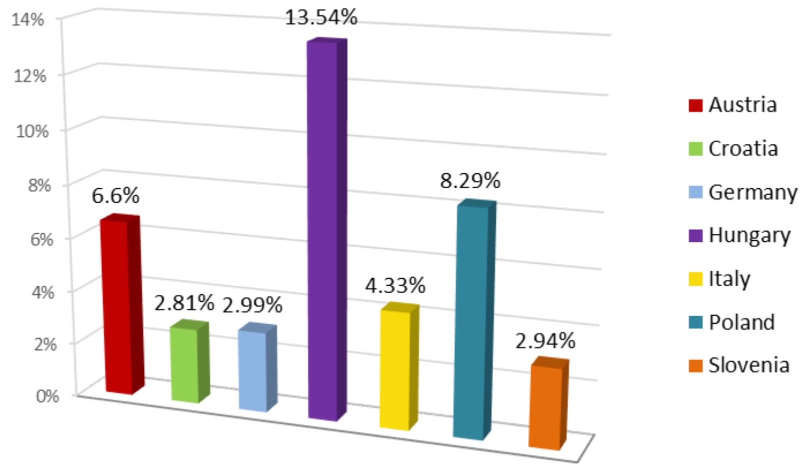


Figure 41. Urban areas in drinking water protection zones (Corine Land Cover 2012 data and DWPZ provided by Project Partners)

Given the average amount of urban land use in DWPZ of Project Partner countries is around low 5%, it is a praiseworthy fact concerning the aspect of water resources protection.

3.1.1.2. Industrial areas

Current management practices of industrial land for each Project Partner country can be seen in the text below.

Austria

Due to the contribution to GDP (2015, Statistik Austria) following industrial branches are important for Austria:

Metal production and processing, engineering, production of data processing and electrical equipment, food and beverage production, production of furniture and other goods, chemical and pharmaceutical products, paper production.

Regarding water consumption and wastewater emission especially following industrial branches are relevant: paper production, chemical industry, production of glass and metal.

Taking into account the trends observed concerning water abstraction and the expected production increase, the industrial water demand will probably decrease between 5% and 15% till 2015. Therefore also the wastewater amount is expected to decrease till 2015 (NGP 2015).

Croatia

Until the recession, industrial production in the Republic of Croatia covered a significant place in the overall production, especially manufacturing and petrochemical industries and ship building. Some companies were abolished in transition process and some were destroyed during war. The above mentioned, mainly refers to the companies that manufacture textiles, leather, metal and wood products. The production in construction and energy sectors was also significant. Some industry still continues to generate positive results and participate in foreign trade. According to the total income, the leading industries are production of food, beverages and tobacco products followed by the chemical and petroleum industries. In exports, the most common industry is manufacture of refined petroleum products, motor vehicles, chemical products, food products, electrical equipment, machinery, fabricated metal products, pharmaceutical products.

In Croatia, about 50% of industrial wastewater was purified on pre-treatment plants. Such water is released into the public sewage system where it is further purified at the wastewater treatment plant. 20% of industrial wastewater after the previous purification is directly released into natural recipients, while the remaining 30% of waste industrial water is released in natural receivers without any treatment.

Germany

Manufacturing industries contribute most to the industrial sector in Bavaria. From an economic point of view, the manufacturing industries contribute 27.4% to the gross value-added in Bavaria.

In terms of sales and number of employees, mechanical engineering productions and car and car parts production represent the strongest industries in Bavaria. As a product of their operations, different pollutants have to be removed from the waste water before it can be discharged into a water body or the public sewage system (StMWi, 2014).

Basically, pollutants resulting from mechanical engineering are heavy metals (e.g. copper, lead or zinc), washing and cleaning agents (e.g. phosphonates, absorbable organic halogen compounds [AOX], polycarboxylates, ethylenediaminetetraacetic acid [EDTA]), oils and lipids or acids and lyes from pickling. Many of these substances, in particular agents of washing and cleaning products, are persistent and thus require special treatment procedures. Moreover, oils and lipids have to be removed before the wastewater can be recycled as process water.

An important source of contamination in the automotive industry results from painting processes. The use of solvent-based paints can pose a risk for the environment and thus sets requirements for industrial water treatment. In this context it is worth to note that the use of solvent-free powder paints is on the rise and was primarily used in the series production of BMW (Gruden, 2008).

The treatment of wastewater from industrial facilities has to be adapted to the specific requirements of each industrial sector since different branches emit different pollutants. The WHG regulates that private wastewater treatment plants have to correspond to state-of-the-art techniques. The AbwV gives further requirements to reduce the discharge of pollutants from industrial sites.

Hungary

Industrial sewage from industrial or commercial activities is directly impacting the receiving water, or if the facility is located within a municipality, its sewage is generally combined with communal sewage after pre-treatment or storage if necessary. The emissions from industrial and communal sewage in the latter case cannot be separated at the emission point but are estimated based on the scope of the industrial activity. Operations qualifying as significant sources of pollution are listed in the European Pollution Release and Transport Register (E-PRTR) and report yearly on their emission.

Industry using hazardous substances (registered in Seveso) does not necessarily have continuous emission, but it is a risk of pollution in case of industrial accidents, and should be therefore considered. All industrial or commercial activity (import, manufacturing, storage, transport, distribution or retailing) related to hazardous substances is to be reported to national authorities.

Other potential point sources include previously contaminated sites and active or recultivated waste dumping sites. Mining is considered as a diffuse source of heavy metals. Industrial or other accidents may also heavily impact water quality.

Italy

Six sectors cover around 74% of employees: manufacture of basic metals and fabricated metal products (17%), textiles and similar (13%), machinery and equipment (12%), food and beverage (11%), rubber and plastic products (10%), other manufacturing including repair and installation of machinery and equipment (11%). Concerning water resources, slightly over 5 billion m^3 of water have been used in 2012 (the only year for which investigations are currently available) (Istat - Eurostat Grant agreement 2013).

Three sectors exert a high water demand (about 33%): manufacture of chemicals and chemical products (681 million of m^3), rubber and plastic products (645 million) and manufacture of basic metals (552 million). An effective way to investigate environmental pressure is given by Water Use Intensity (WUI) Indicator representing, for sector, the ratio between consumed water and sold production on yearly scale. According ISTAT analysis (2016) for 2012, higher WUI values are returned for textiles sector (25.1 l/€); moreover, for six sectors values ranging between 17 and 19 litres are estimated. In this regard, less water demanding sectors (4 or less l/€) include food production, leather and related products and pharmaceutical preparations.

Concerning wastewaters, ISTAT (2012) displays how 19.5% of waters undergoing treatment derive from industrial facilities (respectively, 21%, 25% and 13% for North, Central and South Italy). The significant decrease with respect the previous 2008 survey is primarily due to increase in greater pollution load from domestic use and the economic crisis leading to the closing of many activities.

The available most recent data for the Pollutant Release and Transfer Register are for 2014. Considering, for Italy, again only "Manufacturing activities", 1652 facilities have provided data regarding air and water pollutant releases; regarding the most dangerous substances, it can be note that 427 t of heavy metals are declared released in water bodies (about 172 t for Zn, 93 t for Cr and 63 for Ni). Concerning inorganic substances, are detectable high amount of chlorides (2590410 t with 14310 t accidentally released) while nitrogen and phosphorus releases respectively amount to 28866.3 t (44.6 t accidentally released) and 2896.2 t (4.89 t) and 219 kg for pesticides.

In Italy the direct input of chemicals releases by industrial activities in the surface water bodies is still high with potential extremely negative consequences, according to the comparison performed by NGO environmental organization. Available data (source E-PRTR) display how, also after treatments, remarkable amounts of pollutants are released in water bodies.

Poland

In the area of the Vistula river basin (the largest river basin area in Poland - covering 59% of the area of Poland), industrial pollutants influencing surface water bodies are i.a. pollution from crude oil processing, organic and inorganic chemical plants, paper mills, the textile industry, the iron and steel industry, food production, shipyards, etc. 1057 industrial wastewater discharge points were identified in the Vistula river basin area.

In the area of the Oder river basin (the second largest river basin area in Poland - covering 38% of the area of Poland), industrial pollutants influencing groundwater bodies are i.a. organic and inorganic chemical plants, paper mills, the textile industry, the iron and steel industry, food production and shipyards. 513 industrial wastewater discharge points were identified in the Oder river basin area.

The main causal agents of the point sources of pollution of groundwater located in the Vistula river basin area are: industrial waste disposal sites and industry (industrial wastewater discharge), including the oil refining industry and gas and dust emissions.

The intensive exploitation of groundwater constitutes another threat to the quantitative status of groundwater bodies in the Vistula river basin area.

The monitoring of surface and groundwater bodies is carried out within the National Environment Monitoring (NEM).

The aim of research within NEM is to provide knowledge on the condition of water, which is necessary to initiate measures aimed at improving the condition of water and protecting it from pollution (measures included in the update to the National Water and Environmental Programme).

Slovenia

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).

The systematic monitoring of wastewater emissions to surface and groundwater related to industrial operation is defined in Decree on the emission of substances and heat when discharging wastewater 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).

Impact of landfills or wastewaters 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.

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, 2016b). 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.

Overview of industrial land use per Project Partner country

Industry is one of the key driving forces for the development and prosperity of today's economy and society. From the aspect of environmental protection it represents potentially negative pressures and impacts. Bad management practices along with gaps in national legislation related to the industrial land use can cause numerous adverse issues that can affect water resources. Inadequate treatment and discharge of wastewater produced during industrial processes and industrial waste disposal can cause groundwater pollution as well as surface water pollution.

According to the Eurostat (**Fig. 42**), Germany stands out as a country with the largest amount of waste (61,083,247.0 tonnes) produced during manufacturing processes, while Croatia produced around 484,906.0 tonnes of waste. Italy (26,645,071.0 tonnes) and Poland (31,431,202.0 tonnes) have somewhat similar amounts of produced waste. Austria produced around 5,395,577.0 tonnes while Hungary produced 2,699,460.0 tonnes in the year 2014.

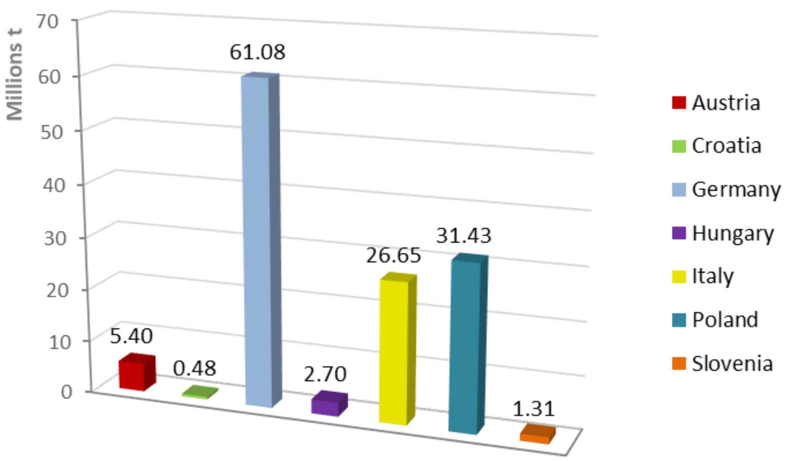


Figure 42. Total amount of produced waste (in tonnes) due to manufacturing processes (data by Eurostat)

In Austria it is expected that industrial water demand and also wastewater amount will decrease in years to come. Croatia state that 20% of industrial wastewater is directly released into natural recipients after the previous purification and remaining 30% of waste industrial water is released in natural receivers without any treatment. Nevertheless, Croatia is taking serious measures for the improvement of industrial contamination control. Furthermore, in Italy direct input of chemicals released by industrial activities in the surface water bodies is still high with potential extremely negative consequences, while in Savinja Basin and Mura Basin in Slovenia groundwater bodies are polluted due to industry with chlorinated organic solvents.
In spite of the above mentioned facts, all of the Project Partner countries recognized industrial by-products (waste and wastewater) as factors that can interfere with the aims of water resources protection. Thus they are actively trying to implement appropriate measures in order to solve this ongoing problem.

According to the data provided by Project Partners, the amount of land used as an industrial area in drinking water protection zones varies between the smallest amount in Croatia with 0.62% and largest amount of 1.82% in Hungary (**Fig. 43**). These industrial areas often encompass construction sites, industrial or commercial units, mineral extraction sites and dump sites.

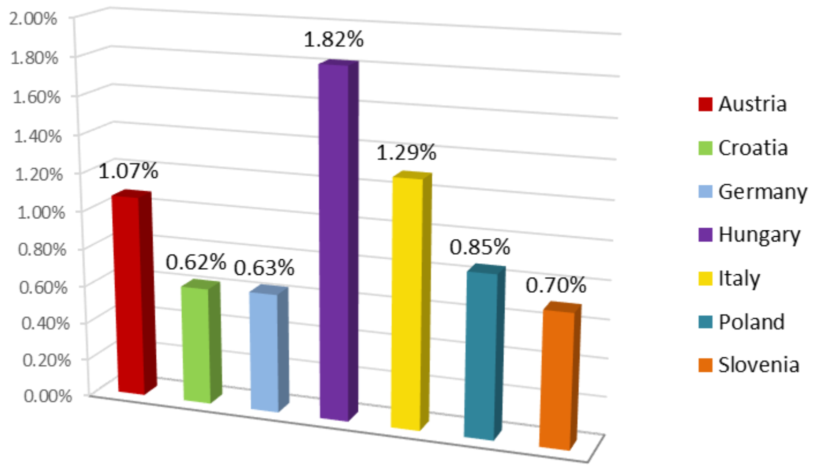


Figure 43. Industrial areas in drinking water protection zones (Corine Land Cover 2012 data and DWPZ provided by Project Partners)

Similar to the urban land use, industrial land use in DWPZ of Project Partner countries occupies only around 0.99% of the total area, which is a commendable fact concerning the aspect of water resources protection.

3.1.1.3. Agricultural land

Current management practices that are used for agricultural land within each Project Partner country can be seen in the text below.

Austria

More than 30% of the Austrian territory is used for agriculture. In the year 2010 more than 173,000 agricultural and forest operators (farmers) cultivated a total area of 7.34 million ha with an average farm size of about 19.3 ha (2014). Within the river basin areas most of the area (42% of the Danube river basin, 72% of the Rhine basin) is cultivated through feed crop farms ("Futterbaubetriebe"), whereas cash crop farms ("Marktfruchtbetriebe") (e.g. grain, sugar beet growing) and also permanent crops ("Dauerkulturbetriebe") (wine, intensive fruit growing) are mainly widespread within the eastern Danube area. Grain growing is the dominant agriculture within almost all river basins in Austria. Maize is mainly cultivated within Mur, Rhine and Drava river basin, whereas potato growing decreased due to the increase of maize in the last decades. Only within Elbe and March river basin potatoes are a little bit more cultivated. The amount of organic farming in Austria is the highest within the EU – 20% of agricultural areas (14.5% of cropland, 26% of grassland). Due to favourable climatic and hydrological conditions only about 2.3% of the agricultural areas have to be irrigated (Umweltkontrollbericht, 2016).

In principle the results of the nitrogen balance show the highest surpluses within the regions with a high livestock density (some areas in Styria and Upper Austria as well as some valleys in Tyrol and Salzburg). But these nitrate surpluses were mostly identified (except the Traun-Enns-Platte in Upper Austria) below the Austrian average amount of 39.7 kg/ha. Pollution of groundwater through nitrate loads occurs indeed mainly in the eastern part of Austria, where on the one side intensive agricultural use takes place and on the other side yearly precipitation is relatively low. These circumstances cause negative effects on groundwater recharge and dilution. With regard to phosphor loads it can be assumed that only low amounts of phosphor from surface water are leached out into groundwater bodies.

Concerning pesticides (investigation period 2011 – 2013) excesses occur mainly within the intensive agricultural areas in Upper Austria, Lower Austria, Styria, Burgenland and surroundings of Vienna (11. Umweltkontrollbericht).

In case of medium soil and weather conditions and proper application within seepage water near groundwater annual average concentrations above threshold (0.1 µg/l) are predicted only for the prohibited (since 1995) Atrazin (0.2 µg/l) due to the material transfer model GeoPEARL-Austria (BAW Petzenkirchen und Netherlands Environmental Assessment Agency). Furthermore an application in autumn leads to more discharges than in spring (NGP 2015).

Croatia

In 2011, utilized agricultural area occupied 23.4% of the total land area of the Republic of Croatia. Since 2007 the Republic of Croatia has a positive trend in the use of agricultural land with increase of 10.3%. Most represented categories of agricultural land use in 2011 were the arable land and permanent grassland. According to the Rural Development Programme of Croatia, high risk of soil erosion is present on 23.23% of arable land.

The use of pesticides in agriculture has especially harmful impact on water resources. In many areas in Croatia there is still lack of awareness of the dangers of pesticides and their influence on water resources. When using the pesticides, farmers often tend to follow the principle "more is better", not thinking of the damage they cause to the environment. Intensive use of mineral fertilizers can increase crop yield but can also have negative consequences such as lower soil fertility and degradation of water quality. Important factor in over-fertilization and intensive use of pesticides is insufficient education and informing of framers on sustainable land management. According to the Croatian Rural Development Programme 2014.-2020., together with specific education of farmers, it is necessary to encourage the use of a balanced multiannual fertilization plan corresponding to the real needs of the crop, so optimum rather than maximum amount of fertilizers is used. Croatian Advisory Service conducts the education of agricultural producers, associations, distributors, on the safe use of pesticides and adequate pesticides application. Also, there is National Action Plan to achieve the sustainable use of pesticides (NAP) for the period 2013 – 2023. It has the objective of reducing risks to human and animal health and to the environment associated with pesticide use, and stimulating integrated and alternative measures to control pests. One of the general objections of NAP is to reduce the levels of pesticide residues in food, drinking water and the environment including strengthening laboratory and administrative capacity for the implementation of monitoring and the number of active substances and metabolites that can be identified and including the use of non-chemical plant protection measures. According to The River Basin Management Plan (2016-2021), total consumption of mineral fertilizers in 2012 was 421,915 tons (N, P_2O_5, K_2O – 237,858 tons). The amount of used nitrogen was 137,152 tons (58%), phosphorus (P_2O_5) was 46,328 tons (19%) and potassium (K_2O) was 54,378 tons (23%). The Republic of Croatia is considered to belong to group of countries with low load of fertilizer per unit area.

The area under the organic farming in Croatia is still increasing - 2012 (2.40%), 2013 (3.13%), 2014 (4.03%) to 2015 (4.94%). According to the Eurostat, in 2015 organic crop area (fully converted area) was on 25,796 ha of land. Number of farms in system of ecological agriculture increased in the last decade (e.g. in 2008. there were 632 farms, while in 2012 there were 1226 farms that had implemented ecological production). Organic production, with the application of the permitted fertilizers and plan protection compounds in line with the regulations, is allowed within the II. drinking water protection zone in Croatia. Regarding irrigation problem in agricultural production, individual water captures for the irrigation of crops can have significant effect on local water resources. According to the River Basin Management Plan (2016-2021), the pressure of uncontrolled or scattered water captures for the needs of irrigation will increase as a result of climate change. Main measure for the rational, sustainable irrigation is construction of public irrigation system, evaluation of investments for these systems as part of the Long-term Programme for Construction of Water Regulation and Protection Structures and Amelioration Structures.

Germany

Agricultural land in Bavaria covers a surface area of 3.15 million ha. 34% of this area is used as permanent grassland, 65.6% is used as arable land and only small areas (ca. 0.4%) are used for further land uses, such as horticultures and Christmas tree cultivation.

The largest share of surface area in arable lands is used for grain farming (1.17 million ha; 37.3% of total agricultural land, 56.9% of arable land). The second largest share of surface area in arable lands is used for plants harvested green (0.58 million ha; 18.3% of total agricultural land, 27.9% of arable land). Additionally, industrial crops (4.3%, 6.6% of arable land), root crops (2.9%, 4.4% or arable land), set-aside areas (1.5%, 2.3% of arable land), other arable land (1.3%, 2% of arable land) (LfStat, 2015c).

Agricultural land is considered to be the main source for diffuse groundwater contamination. In order to reduce the leaching of nutrients (e.g. nitrate and phosphate) into the protected water bodies, several limitations and restrictions have been implemented in DWPZ.

On average, 32% of the land surface in DWPZ is covered with arable land while 23% is covered with grassland in Bavaria. The following values are based on a data analysis of 12 different DWPZ provided by the LfU.

Some districts in Bavaria still suffer from increased nitrate concentrations in the raw water according to LfU (2015). Especially in Lower Franconia, nitrate concentrations above the permitted threshold of 50 mg/l could be identified in 16.4% of the extracted water amount. On average, the nitrate threshold exceeded in 3.4% of the total water amount extracted for water supplying purposes in Bavaria in 2014.

The conversion of grassland to arable land is prohibited on designated inundation sites. Moreover, the conversion of alluvial forests to other land-use types is prohibited as well on these sites. Both measures are of vital importance for the retention of water as well as for the regulation of the flow velocity.

Moreover, the natural water retention represents an integral part of the Bavarian flood management programme "Aktionsprogramm 2020plus" (StMUV, 2014). As the primary part of the protection programme, natural retention is subdivided into measures close to the water body (e.g. dyke relocation, enhancing the linkage between the alluvial plain and the water body, river channel lengthening) and measures in the catchment (e.g. conversion of arable land to grassland, conservation tillage).

Hungary

In total 84% of the for-profit agricultural organisations used land and 31% of them was involved in husbandry. 68% of those organisations can be considered professional as a professional plant grower and another 17% professional animal rearer. In case of 5% the two types of farming had equal share in their economic activities.

In Hungary, the agricultural land (about 7.4 million ha) can be categorized as follows: plough field 58.5%, forest 26.2%, grassland 10.6%, orchard 1.2%, vineyard 1.1%, kaleyard 1.1%, reedbed 0.9% and fish pond 0.5%. About 75% of the potential agricultural land is used actively and half of that is managed by individual farms. They cultivate 58% of all agricultural land and 56% of plough fields within. The production area of corns and root plants decreased by 16% between 2013 and 2016, and they were replaced by vegetables, fodder and leguminous plants. Corn made up 60% of the plough fields.

Drought is a serious risk for the Hungarian agriculture, which will probably increase with global warming. In Hungary, 223,000 ha of agricultural land can be irrigated potentially, however only 99,000 ha was irrigated in 2014. Around 90% of the water used for irrigation comes from surface water and only 10% from groundwater.

Most of farming in Hungary is based on the usage of rainwater; therefore production is highly depending on the climate and climatic variations. Uncertainties in agricultural production can be compensated with irrigation thus in the next years irrigated area is planned to double.

To use more effectively the capacity of the irrigation infrastructure, the General Directorate of Water Management has made crucial steps placing great emphasis on the maintenance and upgrading of water supply systems. The design of an Irrigation Information System is also under development.

The use of pesticides in the agriculture has been steadily growing since 2000. In 2014, 29,092 tons of pesticides were sold in Hungary out of which 31% was herbicide, 22% insecticide, 20% fungicide and 27% was other type of pesticide. Based on the available data, the total amount of fertilizers used in Hungary has been growing steadily in the past years, especially those containing nitrogen.

There are 6,526,800 ha of nitrate sensitive area in Hungary, most of them in agricultural use. In respect of surface waters, the “highly nitrate-sensitive” designation was reserved for nutrient sensitive areas subjected to Government Decree 240/2000 (23 December) “on the designation of surface waters and their catchment areas that are sensitive to settlement waste water treatment” (watershed areas of larger lakes and watershed areas of drinking water reservoirs).

Hungary’s Government Decree 27/2006 (7 February) lists nitrate-sensitive areas specifying the settlements (1779 settlements) and makes reference to “Good Agricultural Practices” whereby farmers will be able to meet the criteria articulated in Directive 91/676/EC, known as the Nitrate Directive. The rules of these “Good Agricultural Practices” are set in Ministerial Decree 59/2008 (29 April). The action programme includes the pursuit and enforcement of “Good Agricultural Practices,” with aid and funding allocated for this purpose in the National Rural Development Plan and under the ARDOP.

Harmful nitrate discharge in this country comes partly from inadequate manure storage methods at livestock farms as noted above and partly from the disposal of untreated sewage from settlements, neighbourhoods, and buildings without drain canals.

Pesticide pollution is derived from agriculture either from current use, drainage water, or from previous soil contamination.

Italy

Agriculture is one of the main economic sectors in Italy: in 2010, 43% of the country territory was devoted to agriculture, including arable land, permanent grassland and meadow, permanent crops and kitchen gardens. According to the 2010 data, Italy was second among EU countries (after Romania) in terms of number of agricultural holdings, reaching 1,620,880. Agriculture consumes large amount of water in Italy, around 11,600 million m^3 in the agricultural season 2009-2010. Indeed Italy is second after Spain in terms of irrigated hectares (2.4 million) and share of irrigated area with respect to the Utilised Agricultural Area (UAA) (19%). However, the potential for irrigated surface is exploited at 66%. Large differences exist between the North, Centre and South of Italy, with the North consuming two times the water volume per hectare with respect to the Centre and the South, and presenting more than four times the share of irrigated area of the UAA. Thus 73% of irrigation in Italy occurs in the North (especially in the North West), almost 23% in the South and major Islands, and the remaining in the Central territories. Also in case of organic farming, irrigation is concentrated in the North-Western regions, but directly followed in this case by Southern regions as Sicily, Puglia and Calabria. In general, plans host most of irrigation practices (72% of total and 42% of the UAA).

The cultivation having the largest share of irrigation water, in terms of surface, is maize (21%). Temporary and permanent grass accounts for another 15% of irrigated area, followed by rice (12%) and vegetable crops (10%). However, that rice surface influencing irrigation corresponds to almost 40% of irrigation in terms of water volumes; while maize represent almost 16% of water volumes. Other crop categories (citrus, fruits, vegetables) represent each less than 10% of water volumes used for irrigation. The share in volume is more or less the same in case of organic farming.

Used water is of public origin (aqueducts and/or irrigation consortia) for the 63%, mainly in the North, while the remaining sources are managed privately (53% and 47% from underground and superficial resources, respectively). Around 62% of the system is at low efficiency (datum mainly affected by the “submersion” practice adopted for rice) while 38% has high efficiency (e.g. drip or sprinkler irrigation); organic farming is committed to use most efficient systems, with twice utilization of drip systems.

From a water quality point of view, fertilizers and pesticides remain the main problems although their gradual reduction (since 2000) is observed thanks to the diffusion of organic farming (ISPRA, 2016). Several laws and norms in the last two decades regulate the use of organic and mineral fertilizers. First, the EU Nitrates Directive (1991) fixed to a maximum of 170 kgN/ha/year the amount of manure to be applied on soil and to 50 mg/l the maximum amount of nitrates admitted in water bodies. This Directive was then reinforced by EU Directives in 2000 and 2006 (for Water in general and for underground waters, respectively) and, from 1999 to 2014, by Italian legislation aiming at regulating the impact on water resources from agriculture and the role of organic waste treatments, mainly favouring good agricultural practices and by identifying vulnerable areas. Mineral fertilizers are still the most used (45%), followed by organic fertilizers and improvers of mechanical soil characteristics (35%), and by products corrective of soil chemical-physical properties, mixed organic-mineral products, cultivation substrates, and more specific product to improve absorption of nitrates by soil and to correct physiological anomalies.

The other threats for water bodies are phytosanitary products (PP), also regulated by specific Strategies and Directives, and by cross-sectoral governing instruments as the Water Directive. From 2004 to 2014 the active ingredients in PP decrease, but in the year 2013-2014 there was an inversion of tendency. Both long term and short-term trends are opposite for organic active ingredients. The most treated crops are vineyards and tomato (more than 10kg/ha of active ingredients).

The quantitative and qualitative impacts on water from agriculture are influenced by climate change and extremes like drought and floods, and fluctuation of them, that are tackled with emergency intervention rather that prevention measures. Floods cause irreversible damages and wide economic losses, while droughts are handled by increasing irrigation and thus impacting on other sectors competing for water resources. In this sense, prevention measures should favour the implementation of hydraulics works in the upstream and riparian areas to protect fields from inundation, proper ploughing to improve soil hydraulic and drainage properties and mitigate soil saturation risks, the selection of crop varieties more drought resistant, or the use of more efficient irrigation systems to save water resources.

Poland

In the total area of the country, which is approx. 31.3 million ha, agricultural lands comprised 16.3 million ha of all lands in 2015. Approx. 14.9 million ha of lands belonged to individual households, which are the dominant units in Polish agriculture, whereas approx. 1.4 million ha of the total land area was held by farms managed by legal persons or entities which do not have a legal personality.

The dominant share of the total agricultural land area was constituted by sown areas, and amounted to 73.9%. Permanent grasslands comprised 18.3% and permanent pastures 3.0%. Set-aside land equalled 0.9% of the total agricultural lands. The share of permanent crops was 2.7%, whereas the area of kitchen gardens comprised 0.2%. Individual households held a total of 13.2 million of agricultural lands i.e. 91.0% of the total agricultural land area.

The area of sown land in 2015 equalled 10.8 million ha. Individual households used 90.0% of the total sown land area (9679.1 thousand ha) and remain close to the previous year's level. In 2015 the total number of farms which cultivated agricultural and garden produce amounted to 1216.6 thousand (86.2% of the total number of farms).

The largest crop group regarding the area of sown land was constituted by cereals with 69.9% of the total sown land area. Next in the ranking were fodder plants (13.2%) followed by industrial plants (10.6%).

When Poland joined the EU, it was obliged to adopt EU legislation concerning water protection, including Council Directive 91/676/EEC of 12 December 1991 concerning the protection of waters against pollution caused by nitrates from agricultural sources. The purpose of the Nitrates Directive was to reduce water pollution caused by nitrates from agriculture and to prevent further contamination of water. In 2012, after examining the comments of the European Commission, the number of Particularly Vulnerable Areas was verified. Due to that fact, starting from 2012, Poland has 48 PVAs, including 4 regions designated as at high risk of underground water pollution by nitrates of agricultural sources, 3 regions designated as at high risk of underground and surface water pollution by nitrates of agricultural sources, and 41 areas selected due to the risk of surface water pollution by nitrates from agricultural sources.

The areas particularly susceptible to pollutants, especially nitrogen compounds from agricultural sources, are those lands whose waters have already been polluted or are at risk of being contaminated. The Nitrates Directive defines the threshold values for the pollution of waters with nitrates. The basic qualification introduces the threshold value for the concentration of nitrates in underground waters at the level of 50 mg NO_3/l.

Drought monitoring in Poland is conducted by the Institute of Soil Science and Plant Cultivation, National Research Institute commissioned by the Ministry of Agriculture and Rural Development using the Agricultural Drought Monitoring System designed for this purpose.

The system's main task is to indicate the areas in which drought causes potential loss of crops referred to in the Act on crop and livestock insurance subsidies in Poland.

In order to evaluate the risk of drought the system of agricultural drought effects was created. It accounts for the climatic water balance and spatial variability of soil conditions. The value of climatic water balance is calculated for subsequent 60-year periods on the basis of meteorological measurements. In 2008 the system utilised data from 55 weather stations and approx. 220 rain gauges of the Institute of Meteorology and Water Management (IMGW).

Mineral fertilisers (NPK) use per 1 ha of agricultural land in the year 2013/14 in pure component amounted to 132.9 kg/ha, including nitrogen fertilisers (75.5 kg, which is 6.4% less than in the previous year), phosphorus fertiliser (23.4 kg, which is 8.6% less than in the previous year) and potassium fertilisers (34.1 kg, which is 27.7% more) (source: the CSO). Farmers used on their crops approx. 1935 thousand tonnes of mineral fertilisers (NPK) per pure component. The use of fertilisers by particular groups:

- Nitrogen – 1098.4 thousand tonnes
- Phosphorus – 341.1 thousand tonnes
- Potassium – 495.8 thousand tonnes
- Calcium – 697.2 thousand tonnes

Slovenia

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, 46.16% are meadows and pastures and 40.8% cultivated land; 7.44 are permanent crops and 6.32% overgrowth areas. 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.

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. 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).

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.

Overview of agricultural land use by Project Partner countries

Agricultural production can present a negative impact on both the quality and quantity of water resources. Intensive and non-conservational tillage, cultivation of arable land with no buffer zones along water courses, monoculture production or intensive production regardless of soil and water conservation as well as use of heavy machinery will affect the morphological structure of soil, but will also impact the hydrological regime of the groundwater. Improperly used fertilizers, pesticides or other substances as well as inapropriate manure management can lead to soil depletion and contamination of surface and groundwater resources. Inadequate irrigation of land changes the use and distribution of surface water and groundwater, but can also affect ecosystems that are dependant upon it. Draining of wetlands in order to gain more land for intensive and ever spreading agricultural production is still a significant problem, even though they have an important role in biodiversity, landscape diversity, water storage and groundwater recharge and reduction of down-stream runoff.

Eurostat defines utilised agricultural area (UAA) as area used for farming that includes the following categories: arable land; permanent grassland; permanent crops; other agricultural land such as kitchen gardens (even if they only represent small areas of total UAA). According to the data from Eurostat, Germany has 16730.7 thousands of ha of utilised agricultural area, which is the largest amount compared to other Project Partner countries (**Fig. 44**). On the other end stands Slovenia with 476.86 thousands of ha used for farming.

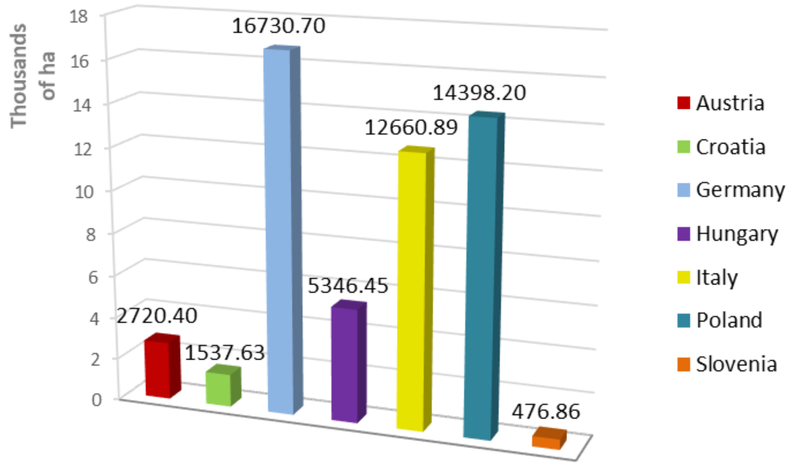


Figure 44. Utilised agricultural areas in Project Partner countries (data by Eurostat, 2015)

An overview of irrigated land within Project Partner countries is shown in **Figure 45**. The data is in 1,000 ha and is provided by Eurostat for the year 2013. As it can be seen, Italy stands out with around 4,004.5 (1,000 ha) of land that is irrigated, while on the other end Slovenia has only 4.3 (1,000 ha) of irrigated land.

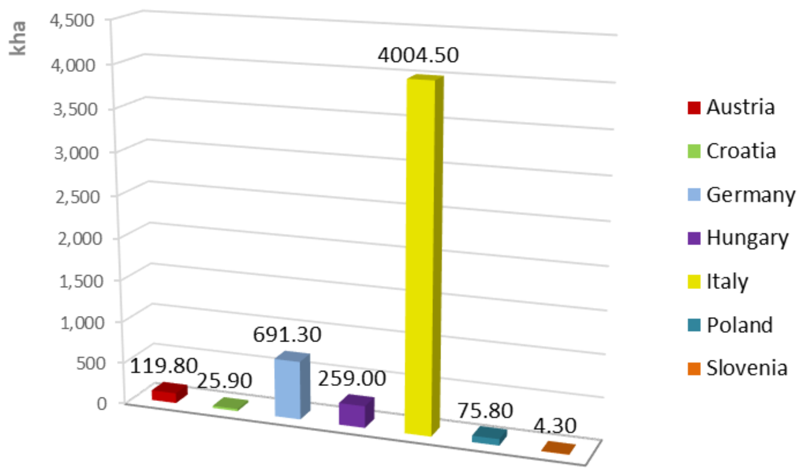


Figure 45. Irrigated land in Project Partner countries (data by Eurostat, 2013; for Austria, Croatia, Slovenia, Italy and Hungary UAA in 2013 was calculated without common land)

According to the Eurostat, the largest total utilised agricultural area (UAA) occupied by organic farming (existing organically-farmed areas and areas in process of conversion) is present in

Austria, which has around 20.25% of total utilised agricultural area occupied by organic farming (**Fig. 46**). Italy has 12.34% UAA under organic farming, followed by Slovenia with 8.69%, Germany with 6.35%, and Croatia with 4.83% of UAA under organic farming. Poland with 4.03% and Hungary with 2.79% have smallest UAA under organic farming.

At the EU level, farming is only considered to be organic if it complies with Council Regulation (EC) No 834/2007, which has set up a comprehensive framework for the organic production of crops and livestock and for the labelling, processing and marketing of organic products, while also governing imports of organic products into the EU.

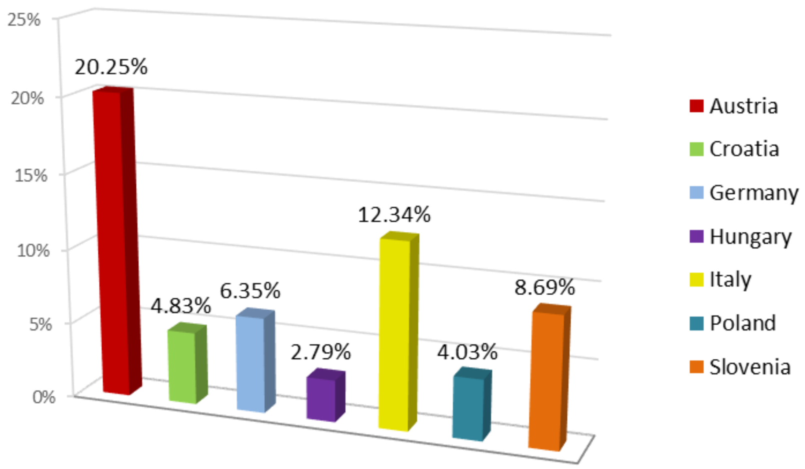


Figure 46. Area under the organic farming in Project Partner countries (data by Eurostat)

Furthermore, according to the Eurostat the amount of sold pesticides from 2011-2014 was highest in Italy (64,071 tonnes) and lowest in Slovenia (1,009 tonnes) (**Fig. 47**).

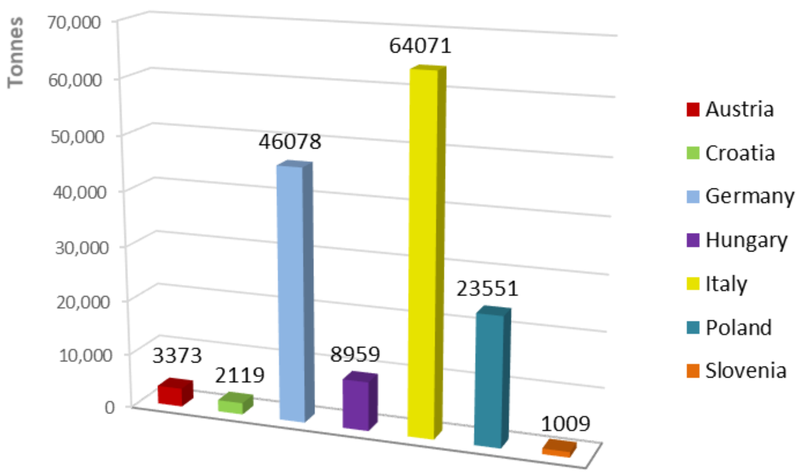


Figure 47. Sales of pesticides, 2011-14 (tonnes of active ingredient) in Project Partner countries (data by Eurostat)

Agricultural land, along with forests ocuppies the significant areas of the drinking water protection zones in Project Partner countries. According to the Corine Land Cover data, agricultural land takes up nearly half of the DWPZ in Italy (39.04%), Hungary (46.2%) and Poland

(47.02%) (**Fig. 48**). In other Project Partner countries land used for different agricultural production occupies somewhat smaller areas of the DWPZ (24.57% of land in Austria, 24.69% of land in Slovenia, 26.14% of land in Germany and 29.77% of land in Croatia). The most frequent types of agricultural land use are non-irrigated arable land followed by complex cultivation patterns and land principally occupied by agriculture.

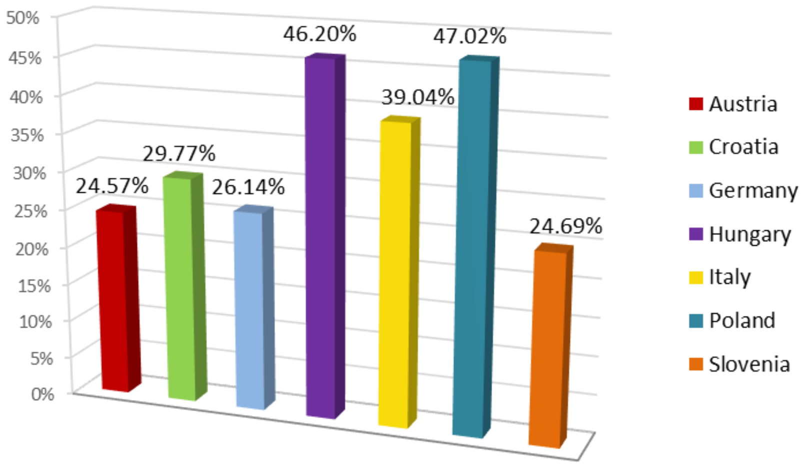


Figure 48. Agricultural land in drinking water protection zones (Corine Land Cover 2012 data and DWPZ provided by Project Partners)

Also an interesting fact is that according to the CLC data, only Croatia has the land-use category - permanently irrigated land within the DWPZ (around 0.06% of total area).

Vineyard and orchards often present the agricultural land-use category with the most amounts of applied fertilizers or pesticides. Within the DWPZ of Project Partner countries, Italy has the largest area under the vineyard production (around 1.44% of land) (**Fig. 49**). Italy is followed by Hungary with 1.04% of DWPZ land under the vineyards, while on the other hand we have Germany with only 0.10% and Poland with no vineyards recorded within DWPZ.

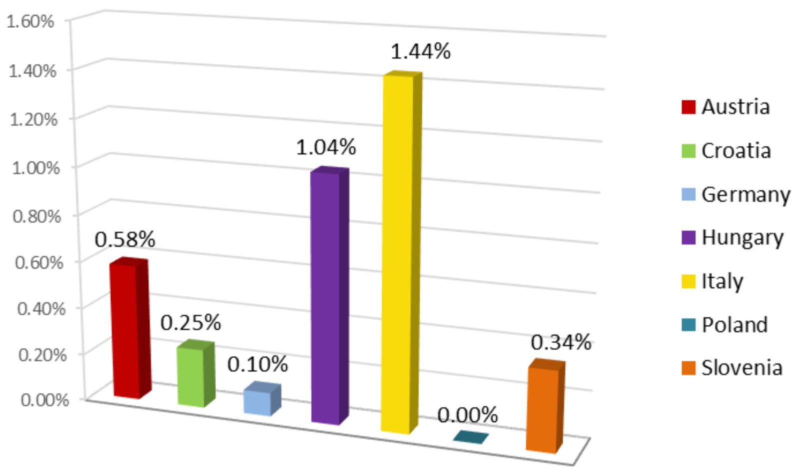


Figure 49. Vineyards in drinking water protection zones (Corine Land Cover 2012 data and DWPZ provided by Project Partners)

Land that is principally occupied by agriculture but has significant areas of natural vegetation, can present a positive management practice of agricultural land because it not only contributes to the biodiversity and landscape diversity but can also consequently contribute to the water and soil conservation. Among the Project Partner countries Croatia precedes with 9.55% of land within DWPZ used for this category (**Fig. 50**). On the other end Germany has the smallest area of land within DWPZ (0.25%) under agricultural land with significant areas of natural vegetation.

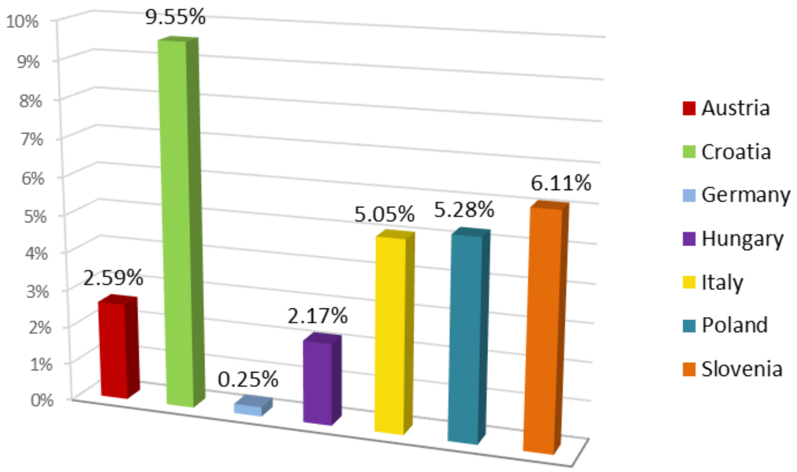


Figure 50. Land principally occupied by agriculture with significant areas of natural vegetation within drinking water protection zones (Corine Land Cover 2012 data and DWPZ provided by Project Partners)

Higher amounts of pesticides and fertilizers application on fruit trees and berry plantations can also present unfavourable impacts on water resources. This agricultural land-use category is present to a small extent in all Project Partner countries and the average is around 0.23% of land used for orchards and berry plantations (**Fig. 51**).

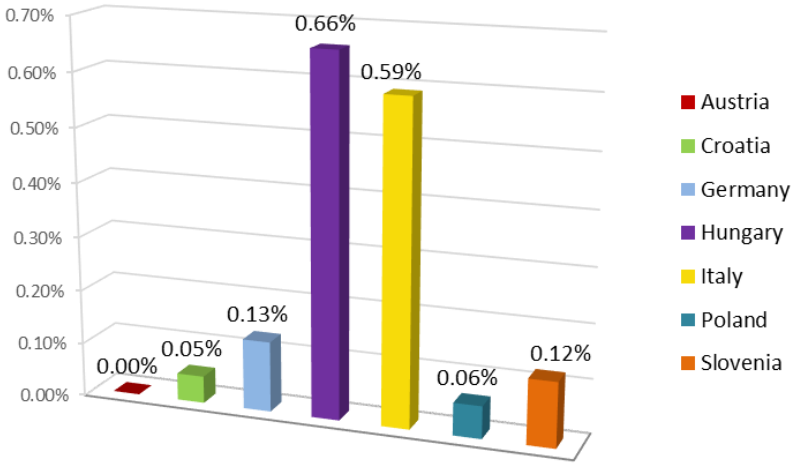


Figure 51. Land principally occupied by fruit trees and berry plantations within drinking water protection zones (Corine Land Cover 2012 data and DWPZ provided by Project Partners)

Complex cultivation patterns of arable land occupy around 15.21% of land within DWPZ of Croatia, while Germany has only 0.17% of land under this land-use category (**Fig. 52**).

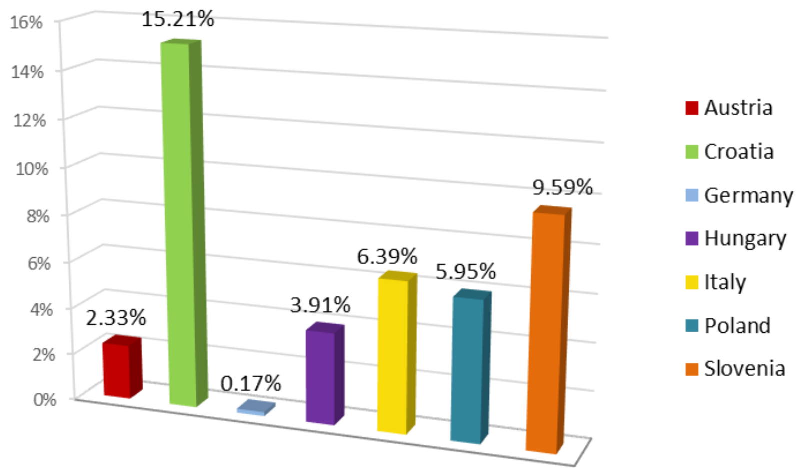


Figure 52. Complex cultivation patterns within drinking water protection zones (Corine Land Cover 2012 data and DWPZ provided by Project Partners)

Hungary, Poland and Germany have the biggest areas under the non-irrigated arable land use with the average around 30% of land within DWPZ, while Croatia with 4.52% and Slovenia with 8.53% has the smallest areas ocuppied by this land-use category (**Fig. 53**).

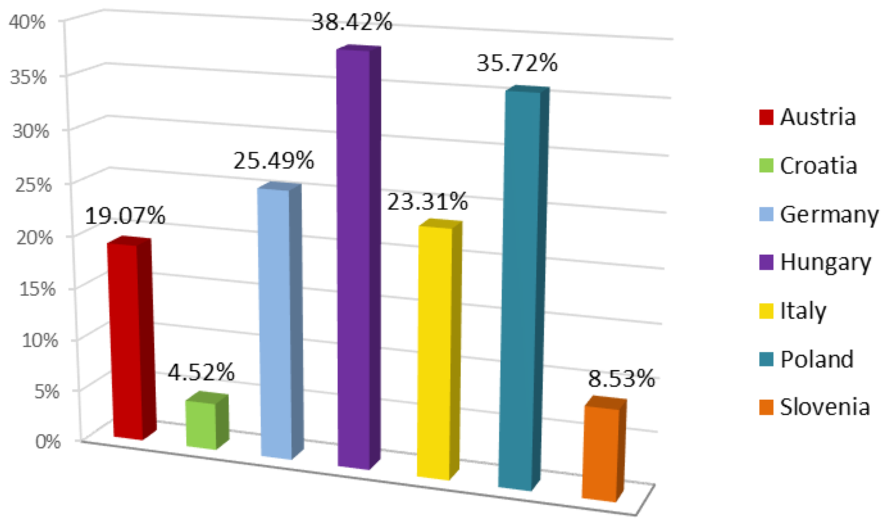


Figure 53. Non-irrigated arable land within drinking water protection zones (Corine Land Cover 2012 data and DWPZ provided by Project Partners)

Some of the significant gaps within agricultural land management are presented in the **Table 4**.

Table 4. Overview of all the mentioned problems or gaps in agricultural land-use management practices within the Project Partner countries

Country	Recognized problems or gaps in management practices
Austria	**Pollution of groundwater** through nitrate loads in the Eastern part of Austria, due to intensive agricultural use
	Negative effects of **intensive agricultural production** (combined with low precipitation rates) on groundwater recharge and dilution
	Excessive use of pesticides occurs within the intensive agricultural areas in Upper Austria, Lower Austria, Styria, Burgenland and surroundings of Vienna
	Excessive application of pesticides in autumn leads to more discharge
Croatia	**Lack of awareness** of the dangers of pesticides and their influence on water resources, sufficient education and informing of framers on sustainable land management
	Farmers often tend to follow the principle "more is better" in the application of pesticides
	Erosion risk on intensive use of arable land
	Water capture for the purpose of irrigation can have significant impacts on local water resources
Germany	Agricultural land as main source for **diffuse groundwater contamination**
	Increased nitrate concentrations in the raw water
Hungary	**Drought** is a serious risk for the Hungarian agriculture
	The use of pesticides in the agriculture has been steadily growing since 2000
	The use of fertilizers in the agriculture has been steadily growing in the past years
	Inadequate manure storage methods at livestock farms cause nitrate discharge
	Application of **untreated sewage sludge** causes nitrate discharge
	Pesticides pollution from current agricultural use, drainage water or previous soil contamination
Italy	Fertilizers and pesticides application as the main problems within agricultural land use
	Use of phytosanitary products (PP) present the threat for water bodies
	Extreme droughts and floods cause irreversible damages and wide economic losses
Poland	High risk of underground water and surface water pollution by nitrates of agricultural sources
Slovenia	Groundwater pollution by nitrates, pesticides and their degradation products due to agriculture
	Pesticide and fertilizer pollution is detected in Sava Basin and Ljubljana Marsh, Savinja Basin, Krško Basin, Sava Hills, Dolenjska karst, Drava Basin and Mura Basin
	Increased values of nitrate, atrazine, desethyl-atrazine, metolachlor and bromacil (in 2015) in drinking water

EU Common Agricultural Policy (CAP) has defined a set of policy mechanisms aimed at the protection of European environment from adverse agricultural practices. As Member States, Project Partner countries should implement CAP principles. Cross-compliance as a baseline for agri-environment measures is a mechanism that links direct payments to compliance by farmers with basic standards concerning the environment, food safety, animal and plant health and animal welfare, as well as the requirement of maintaining land in good agricultural and environmental condition. Farmers that are receiving direct payments are subject to implement Good agricultural and environmental conditions (GAECs: The obligation of keeping land in good agricultural and environmental condition refers to a range of standards related to soil protection, maintenance of soil organic matter and structure, avoiding the deterioration of habitats and water management).
Education and informing of agricultural producers, associations, distributors and broader public on the sustainable use of fertilizers and pesticides as well as encouraging of farmers to perform organic farming is a paramount for the preservation of soil and water resources in regard to agricultural production. Slovenia states how farmers who receive a subsidy, are obliged to attend lectures about plant protection products every five years and follow the plan for spreading manure, while Croatia highlights the important role of Advisory Service that conducts the educative workshops.

3.1.1.4. Forest

Current management practices that are used for forests within each Project Partner country can be seen in the text below.

Austria

The total forest cover of Austria encompasses 3,990,000 ha, what are 47.6% of the total area. About 71.6% are conifer and 28.4% are deciduous tree species. The Austrian forest ecosystems are dominated by Norway spruce (Picea abies – 59.7%), what is due to the high share of mountain forest sites and, above all, due to the establishment of spruce plantations on sites of various other forest communities. The most prominent deciduous tree species is European beech (Fagus sylvatica – 10.2%). Further important conifers are European larch (Larix decidua), Scotts Pine (Pinus sylvestris) and Silver fir (Abies alba). Prominent deciduous species are oak (Quercus robur, Quercus petraea, Quercus cerris, etc.), ash (Fraxinus excelsior) and maple (Acer pseudoplatanus, Acer platanoides, etc.).

Austria's protection forests, which comprise 19.3% of the Austrian forest area, play an important role in preventing and mitigating the effects of natural hazards, and therefore require special attention. The term "protection forest" is defined in the Austrian Forest Act. The Forest Act 1975 as amended in 2002 distinguishes between site-protective forests and object-protecting forests. For the purposes of Federal Law site-protective forests ("Standortschutzwälder" in German), are defined as the forests on sites that are endangered by the eroding forces of wind, water and gravity. These forests require special treatment in order to ensure that the soil and plant cover remains protected, and that reforestation occurs at a rate that exceeds consumption or use. They include:

- Forests on wind-blown drifting sand or drifting soil;
- Forests tending to the development of karst or on sites that are particularly prone to erosion;
- Forests on rocky, shallow grounds or steep locations if their re-forestation is possible only under difficult conditions;
- Forests on slopes where dangerous slope slides might occur;
- The plant cover in the upper timberline;
- The forest belt immediately bordering the upper timberline.

Object-protecting forests ("Objektschutzwälder") are forests that protect humans, human settlements or facilities, and farms and agriculture from natural hazards or damaging environmental impacts. These forests also require special treatment in order to ensure their protective or beneficial effects can be realised.

Forest ecosystems are used for the protection of drinking water sources (e.g. in case of the cities Vienna, Waidhofen/Ybbs, Salzburg, Innsbruck, Graz, etc.). Also the use for the protection from floods is important. There are various flood protection forests situated all over the country. Due to the mountainous character of parts of Austria, there exist very special declared protection forests, providing shelter from floods, torrents, rock-fall, land slides and avalanches. These protection forests of Austria (category without timber production - 12.5% of the total forest area) have to provide this ecosystem service and are legally decreed (Forest Development Plan – Map).

In case of the city of Vienna, the use of the forests for the protection of the karstic water sources is a clearly defined purpose, special internal guidelines regulate the silvicultural measures applied in the drinking water protection zone (DWPZ). In Waidhofen/Ybbs the regulation of silviculture within the DWPZ is part of the ongoing project, guidelines are already defined, but knowledge transfer to the stakeholders and Best Practices application still have to be fulfilled. The other cities of Austria, which use forest ecosystems for water protection purposes have individual regulations. There does not exist a binding national guidance for forestry within DWPZ.

The most important issue of silviculture in DWPZ is the transformation of homogeneous conifer plantations into mixed forest stands, intending a tree species diversity conforming with the natural forest community. This provides more stability and resiliency for the forest ecosystems, hence ecosystem services can be delivered in a sustainable way. But this can only be achieved, if Best Practices for forested DWPZ are additionally applied. The whole package encompassing the application of "Best Practices", information about natural forest communities (Forest Hydrotope Model) and the knowledge transfer to stakeholders is in PROLINE-CE the major task in the field of forestry, as there still exist shortcomings in Austria in general.

The shortcomings are related to the wide spread application of the clear-cut technique, to the also wide spread homogenous Norway spruce plantations on various forest sites and to the browsing damages caused by wild ungulates.

Within more than 2/3 of the Austrian districts more than 50% of the forest area is damaged by browsing of wild ungulates. Within 25% of the Austrian districts those damages occur on more than 75% of the forest area. The tendency of browsing damages is increasing (period 2010/2012) in comparison to the period 2007/2009 (11. Umweltkontrollbericht, UBA 2016). The stability and resiliency of the forest ecosystems is endangered through browsing damages, as natural regeneration and tree species diversity are threatened. This can be regarded as major threat for the provision of the ecosystem service “water protection”, both in relation to the protection of drinking water resources and to the mitigation or prevention of floods.

Protection from droughts can be regarded as less relevant within the Austrian territory, as the precipitation regime mostly covers the water demand of the forest ecosystems. Within the context of climate change drought events could become more frequent. The stability and resiliency of forest ecosystems in those cases depends on the tree species composition of the forest stands, which has to be adapted in DWPZ according to the potential natural vegetation. Diverse forest ecosystems show more stability, also under drought conditions.

The most important target of forestry within DWPZ in Austria can be summarized with the improvement of forest ecosystem stability and resiliency for providing sustainable ecosystem services within the context of water (water protection, water provision and water regulation). This can be achieved through the implementation of tree species diversity according to the natural forest community (e.g. application of the Forest Hydrotope Model) and through the application of Best Practices in forested DWPZ.

Croatia

Total forest and forest land area in the Republic of Croatia amounted 2,795,039.05 ha, which as regarding total inland area of the Republic of Croatia represents forest cover of 48%. Out of total forest area, productive forest land with tree cover amounts 86% and the rest is productive forest land without tree cover (productive, non-productive and unfertile land). In total forest area, 76% of forests are owned by the state, managed by the company Hrvatske šume (Croatian forests Ltd.), while the rest is privately owned. According to their purpose, forests in Croatia are classified as economic forests, protective forests and special purpose forests. Protective forest and forest land take up 832,095.82 ha or 30% of total forest and forest land area. These are forests in sensitive habitats (sloped land more than 50%, skeletal soil, riverine islands etc.), forests of high biodiversity, public water resources forests, rare or representative forest communities and forests for the protection of soil, roads and other structures against the erosion and flooding. Protective forests are also forest in lowland areas in humid depressions where water stagnates for the most of the year and disables its management and reconstruction. In line with Waters Act, all forests that are on water good are considered as protective forests. The most significant protective functions of forests are reduction of floods effects (maintaining the “natural” flow regime by reducing and delaying the stormflow peaks) and reduction of soil erosion caused by water (reduction of sedimentation of deposits incurred due to soil erosion in water stream channels and stagnant water bodies).

The Forest Management Plan in force determines growing stock of about 418.6 millions of m^3 while its yearly increment amounts about 10.1 millions of m^3. The abundance of some of the species in the total growing stock is as follows: Common beech 39.50%, Pedunculate oak 13.35%, Silver fir 9.62%, Sessile oak 7.92%, Common hornbeam 7.18%, Narrow-leafed ash 3.72%, Spruce 2.6%, Black alder 1.38%, Black locust 1.28%, Turkey oak 1.17%. According to the Croatian Rural Development Programme forest cultures in Croatia (70.021 ha), due to the prevalence of only one type of tree, are very vulnerable with respect to resilience towards climate changes and actions of unfavourable biotic and abiotic factors when compared to stable high mixed forests consisting of indigenous types of tree. Given the prevalence of only one type of tree, forest plantations cannot fulfil the stability-criteria for forest ecosystems in drinking water protection zones. They are present on 0.1% of total forest area (according to The State of the Environment Report of Croatia).

According to the Forest Management Plan, if there is a high risk of damaging of young forest cultures due to game or cattle, so young forests need to be properly protected-enclosed. Also, serious problem of forest management are forest fires. In the last 10 years 2320 forest fires have occurred and affected 84.250 hectares of forests and forest land. Croatian Rural Development Programme addresses the need for the reforestation of areas, so that the biodiversity can be restored and enhanced, water management can be improved (including fertilizers and pesticides management), soil erosion can be improved and also for the fostering carbon conservation and sequestration in forestry. Forest management plan for the period 2016-2025 prescribes revitalization and regeneration of forests damaged by calamities.

Clear-cut of forest in Croatia is regulated by Forest Act and it is prohibited (except the sanitary forest cut) in the II. sanitary protection zone.

Germany

The Bavarian Forest Act (BayWaldG) defines that each forest in mountain sites, low mountain ranges, riparian strips and karstic areas serving to prevent flood events, inundations, rockfalls, landslides and other natural hazards represents a protection forest. Thus, the protective function of forests are recognized and considered in managing actions of the Bavarian State Forestry Office and supported by the Bavarian Forest Institute.

Moreover, the interests of nature conservation and water protection are integrated in the BayWaldG and have to be considered for each forest management task. In order to sustainably ensure the quality of drinking water from forest sites, the share of deciduous trees and firs should be increased continuously. These tree species foster diversity and stability of the forest stands which is of fundamental importance for drinking water protection. The Bavarian State Forestry Department pursues the long-term strategy to continuously increase the amount of deciduous trees and firs in the state-owned forests in Bavaria. Therefore especially spruce pure stands should be converted (BaySF, 2015a). Due to their shallow root networks spruces are vulnerable to drought stress and windthrow and thus increase the overall vulnerability of the forest system (including its soils) to external stresses.

State-owned forests cover an area of 808,000 ha in Bavaria representing 11.4% of the state territory. However, state-owned forests represent only 30% of the total forest area. 56% of the total forest areas are privately owned, 12% corporate forests and 2% national forests. According to a statistical survey of the Bavarian State Forestry Department, the following tree species have been the most widespread in Bavaria in the financial year 2015 (1 July 2014 - 30 June 2015) (decreasing order of area percentage, black numbers are state-owned forests, blue numbers are total Bavarian forests):

- spruce (43%, 42%)
- beech (18%, 14%)
- pine (16%, 17%)
- other deciduous trees (11%, 15%)
- oak (6%, 7%)
- other coniferous trees (4%, 3%)
- fir (2%, 2%)

Focussing on DWPZ, 26.6% of the state-owned forests located in DWPZ have been covered with deciduous forest and firs in the considered period (2015). The 5-year-objective is to increase these areas to > 30%. Moreover, 78,580 ha of the state-owned forests are located in DWPZ. This area size increase of 2,000 ha compared to 2014 (BaySF, 2015b). Further 25% of the state-owned forests are considered to have further water protection functions.

Since the beginning of the 1990's the Bavarian State Forestry Office operates a monitoring network of forest climate stations in selected forest catchments. This network has been linked to the monitoring network for mass fluxes into the groundwater in 1996 in order to implement a comprehensive forest monitoring network. The implementation and operation of this network has legally been strengthened by an administrative agreement between the Bavarian State Forestry Office and the Bavarian Water Authority (RASPE et al., 2008).

While a sustainable development of state-owned forests can be fostered by the government as well as by the 2,700 employees working for the Bavarian State Forestry Office, a sustainable development and continuous controls of privately owned forests are difficult to handle. Moreover, the ownership structure makes this process even more difficult since, on average, for each owner there is an area of 2 ha forest.

Hungary

According to the Hungarian Central Statistical Office forests area occupies 1,940,720 ha in Hungary (data for the 2015.). Area for forest management (includes areas for wood production, special functions, nature protection and area directly used for forest management) takes up around 2,060,819 ha. Forests can be found predominantly in the hills and mountains and less in the lowland, which latter makes 2/3 of the area of Hungary (central and eastern parts). The area of forests has been growing steadily in the last decades. The two major type of the forest ownership are state forests and private forests. The forest management is determined by the function of a given forest. In that respect, the most widespread type is the for-profit “economic” forests that make 59% of the forest area. It was followed by the “protection” forest with 34%. That type includes all forests that are designated for nature and landscape conservation, preventing soil erosion, game reserves, forests serving water management functions or protecting artificial objects (roads, railways, buildings, etc.). Forests designated for nature conservation gives 42% of all forest areas. Invasive black locust is also considered as a forest-making species in the forestry statistics.

The General Directorate of Water Management recently initiated a project proposal on the practical feasibility of wastewater reuse. The project would be implemented in dry pilot areas such as the “Kecskemét-Tiszaalpár” plot. Within the framework of the project such possibilities as energy production, agricultural use, irrigation etc. would be examined aiming to reuse wastewater of Kecskemét and Kiskunfélegyháza.

Floodplain forests play a crucial role in flood management having the capacity to slow down the flow of waters. The negative process taking place in riverbed caused higher flood levels and decreased our flood protection facilities. This fact and high cost of flood protection developments needed to improvement of the conveyance capacity of the flood bed in Hungary. One of the cheaper solutions is to remove of the vegetation which caused run-off barriers. This implementation helps to provide better run-off conditions. In some zones clear-cut is planned while in other places undergrowth of the forests on floodplain will be taken away.

Drinking water resources especially that are results of infiltration of surface water are often covered by softwood forests. Such area can be found e.g. in the Szentendre island that is the drinking water source protection area for wells that serve potable water to Budapest. The potable water comes from the surface water as infiltrated mainly from Danube through the bank.

The establishment of agro-forestry systems is considered a new potential development area in terms of diversification. The agro-forestry systems are extensive land-use systems where trees are attended and agricultural activities are pursued simultaneously, thus a mosaic of agricultural and forestry systems is created. The agro-forestry systems are of great ecological, landscape and social value since they combine extensive agricultural and forestry systems aimed at the production of excellent quality wood and other forestry products.

Concerning agro-forestry systems grazing forests have traditions in Hungary. This new measure is considered as a great possibility to introduce new land-use systems. For farming point of view, introducing agro-forestry system in certain special regions of Hungary (floodplains, regions of threat to wind and water erosion) are expected to achieve major positive environmental effects. In agro-forestry system tree plantation in a broad network or tree lines, keeping animals, provide for the multi-purpose use of the given land. The selection of species that fit the needs and the conditions of the area, and, to secure the continuation of agricultural land use, the planting of arboreal plants and herbs for the creation of wooded grazing areas, grassland protecting shrubbery and tree lines and groups of trees, extensive grazing, broad network of trees for wood production for industrial purposes, forest fruit (apple, cherry, walnut, mulberry, apricot, pear, almond, sour cherry, chestnut, plum), medicinal herb and honey production.

Italy

According to the last national inventory on forest and forest carbon sink (INFC, 2015) the Italian forested surface, based on the international definition adopted by the Global Forest Resources Assessments (FRA), cover 10,982,013 hectares (i.e. 34% of the national territory), showing an increase with respect to the 10,345,282 hectares estimated in the previous inventory (INFC, 2005), and a +300% of coverage in the last 60 years, due to the gradual abandonment of the mountainous areas and of agro-silvopastoral systems.

The forested surface (forestland) consists of the macrocategory “forest” (84% of the total and 29% of the national territory), and of the macrocategory “other forestlands”, made of shrublands and Mediterranean maquis.

In terms of landscape composition, 44.4% of forests are close to agricultural areas, 28% adjacent to grassland, pastureland and uncultivated lands, 8.7% are near low or no vegetated zones, and 4.7% and 0.9% close to water bodies and wetlands, respectively. For the “forest” macro-category of forested lands, the density range from 62.6% of Liguria region to 7.5% of Puglia, while 67.5% of forests have a total coverage of 80%. For the macrocategory “other forestlands”, 60.3% of the surface presents coverage higher than 50%, and 38.6% higher than 70%.

Forests are made for about 75% by needleleaf communities (most diffused forest formations: Sessile, Pubescent and English oaks, common beech, chestnut and Turkey, Hungarian, Macedonian and Valonia oaks), except for several alpine areas in Valle D’Aosta and Trentino Alto Adige, and for 15% by coniferous dominated by spruce (586,082 hectares that correspond to about 6.7% of forests in Italy); the remaining 10% consist of mixed communities. The main management practice is coppice (41%, 3,663,143 hectares) with prevalence of coppice with standards (35%), mainly represented by forest stands near to the utilization period or aged.

High stands occupy 36% of Italian forests (3,157,965 hectares), with slightly prevalence of even-aged (15.8%) rather than multi-aged (13.5%) and they are mostly represented (50%) by mere coniferous, especially spruce, silver fir, European larch, Mountain and Mediterranean pines. The most productive coniferous are in the North-East. Moreover, cultivation typologies considered special (chestnut, black walnut, cork oak) represent a significant genetic and economic local resource, and they cover around 200,000 hectares (INFC, 2005).

Forest plantations cover 1.12% (122,252 ha) of forests, whose 84% are pure broadleaved with a prevalence of poplar (66,269 ha) and noble hardwood and Eucalyptus (40,985 ha).

The net removal of CO_2 from the atmosphere by Italian forests is 34 Mt/year, considering losses due to wood harvest, fires and other biotic and abiotic disturbances. According to the INFC (2005), the 81.3% of Italian forestlands is available for wood harvesting, corresponding to about 35.5 Mm^3 of wood. However, the wood volume effectively harvested through silvicultural operations is less than 9 Mm^3 (whose more than 60% is wood for energetic use) according to FAOSTAT, and around 13.5 Mm^3 according to INFC (2005). Data about harvesting, probably underestimated, mainly by FAOSTAT that does not consider the utilization of small forest properties (< 3ha) for which cutting is declared but without information about the harvested volumes, are between 25% and 38% of yearly production, and largely lower than the average of EU-28 countries that is around 65% of the yearly production (MCPFE, 2015).

Around 1,854,659 hectares of forestlands (17.7% of the total) are intersected by infrastructures. In terms of property, 63.5% are private, 32.4% public and around 4% unclassified.

Some important restrictions interest Italian forestlands: 81% of them (87% of forests) are under hydrogeological constraints (Royal Decree 3267/1923; i.e. soil working or movements are not possible without demonstrating they do not alter the hydrogeological equilibrium of the area), so that 77% of forests' soils are not interested by instability. The 27.5% of forestlands are under environmental restrictions (mainly in the Centre and South): National Parks, Regional Reserves and Natura 2000 network (SIC and ZPS) occupy 7.6%, 6.7% and 22.2% of the forestlands.

Forests are strategic for soil instability/landslide mitigation and water cycle regulations. Forest cover in general reduce runoff and erosion thanks to interception of rainfall from canopy vegetation and increase water storage in soils by reducing evaporation; moreover, tree roots have a stabilization role on soil particles. However, usually forests are also the dominant land cover/use on steepest slopes, where hydrogeological instability and superficial water flow are facilitated by gravity. This is the reason why correct forest management is crucial to avoid for example that woody debris increase weight on the hillslope or are transported by runoff and create barriers in the river channels. Finally, protecting forests by fires is crucial as fires effects consist not only of direct damage of vegetation but also on alteration of physical and chemical soil properties, as loss of organic matter, increase of bulk density, reduction of soil porosity and infiltration capacity, and increase of soil water repellence.

The most used species to consolidate hillslopes are: *Acer campestre*, *Robinia pseudoacacia*, *Carpinus betulus*, *Quercus pubescens* and *Sorbus domestica*, while along riparian areas, to reinforce river banks or adjacent areas, the most appropriate species are: *Salix alba*, *Alnus glutinosa*, *Morus alba*, *Sambucus nigra*.

Poland

Poland is one of the leading countries in Europe when it comes to forested area. They occupy 29.2% of the territory of the country - an area of 9.1 million hectares.

Forest cover of the country increased from 21% in 1945 to 29.2% now. From 1995 until 2011 the forest area increased by 388 thousand ha. The basis of the work of afforestation is the "National Programme of Increasing Forest Cover", assuming an increase in forest cover to 30% in 2020 and to 33% in 2050.

Polish forests grow on the weakest soils, mainly due to the development of agriculture in previous centuries. This affects the distribution of types of forest habitat in Poland. More than 55% of forest area is occupied by woods. In other areas there are forest habitats, mostly mixed. They represent a small part of alder and riparian forests - a little more than 3%.

On the lowland and upland pine frequently occurs. In the mountains prevails spruce (west) and spruce with beech (east). The dominance of pine trees results from the way forest management was done in the past. Once monoculture (single crop species) were a response to large industrial demand for wood. Such forests have proved to be very resistant to climatic factors. They also easily fell victim to the expansion of pests.

The share of other species, mostly deciduous, in the Polish forests is systematically increasing - there are oaks, ashes, maples, sycamores, elms, and birch, beech, alder, poplar, hornbeam, aspen, linden and willow.

According to the Law on Forests of 28 September 1991, forests can be considered protective forests, if they:

- protect soil before washing or sterilizing, refrain removal of the ground, pull up the rocks or avalanches,
- protect the resources of surface and underground water, regulate hydrological relations in basin and watershed areas,
- reduce the formation or spread of the sands,
- are permanently damaged as a result of industrial activities,
- are the seed stands or animal refuges and position plants subject to species protection,
- have a special status for natural science or for the defence and security of the country, are located:

- within the administrative boundaries of cities and at a distance of 10 km from the administrative borders of cities with more than 50,000 inhabitants,
- within the protection zone around the sanatoria and health resorts,
- within the upper limit of the zone forests.

Forest affect the flow of water in river basins, affecting the reduction of flood risk and mitigating the effects of drought by increasing, compared with agricultural land, capacity to retain rainwater, as well as affecting the improvement of the quality of water flowing through the ecosystem. This feature is particularly important in the situation where the trend is the sequential growth of steppe areas, which are the cause of climate change and the development of industrial infrastructure. This is evident in areas with very permeable soils and poor habitats (most forest areas), as well as rich habitats fed by rainwater and groundwater. Forests contribute to increasing rainfall and the formation of misty deposits. Forests also decrease evaporation from the soil surface. Forest soil owes its porosity accumulation of humus in the litter, entering roots deep into the soil and the soil fauna. Small retention applied in the forests refers to activities related to the detention of the greatest amount of water in its surface and nearly-surface circulation. This is done using procedures that are divided into:

- Technical: small water tanks, valves, weirs,

- Non-technical: reforestation, forestation, plant shelterbelts, ponds, rural, ponds, wetlands.

In the 2007-2013 Financial Framework two large projects were completed:

- “Increasing retention capacities of forest ecosystems and development of actions designed to counteract the causes of drought in forest ecosystems in the lowlands"

The project aims at water retention in areas administered by the State Forests within the basin streams, while maintaining and supporting the development of the natural landscape. The project included its range lowland ecosystems all over the country. It was attended by 176 forest districts from the area of 17 Regional Directorate of State Forests.

- “Increasing retention capacities of forest ecosystems and development of actions designed to counteract the causes of drought in forest ecosystems in the mountain areas”

The objective of the project was to slow down the outflow of water from mountain areas by increasing the retention basin. This minimizes the negative effects of natural phenomena, such as floods and destructive activities of flood and drought in mountainous forest areas.

In the 2014-2020 Financial Perspective the continuation of the implementation and execution of abovementioned projects is foreseen through:

- The comprehensive project of adaptation of forests and forestry to climate change - a small retention and preventing water erosion in the lowlands;
- A comprehensive project of adaptation of forests and forestry to climate change - a small retention and preventing water erosion in mountainous areas.

Slovenia

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%.

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.

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

- 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.

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. 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).

The importance of forests on the total discharge from the catchment area and the water quality increases with the proportion of the forested 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).

Overview of forests and forest land by Project Partner countries

Forests have multiple, significant roles within the protection of water resources. They not only directly contribute to the biodivesity and protect the land by reducing the soil erosion caused by water, but also regulate and mitigate climate changes, effect the flow regime by reducing and delaying the stormflow peaks, therefore mitigating flood hazards. Forest clear-cuts may cause increased surface runoff and hence endanger both settlements and their drinking water resource. Stability, resilience and natural regeneration possibility are crucial features of forest ecosystems that are dependant on structural diversity of forest stands. Strategic and sustainable forest management that implements the use of the autochthonous plant material in forest stands, maintains good vertical and horizontal forest stand divesity, prevents forest fires, establishes protective forest buffers along watercourses and improves protective roles of forests in general, is one of the prerequisits for sustainable water resources protection.

Among other Project Partner countries Slovenia stands out with 58.2% of total country territory covered with forests. Germany (32%), Hungary (25%), Italy (34%) and Poland (29.2%) all have similar quantity of forested areas. Around 48% of total country area is under the forests in Croatia and Austria (**Fig. 5**4). Since the majority of Project Partner countries have significant areas under the forest coverage, it can be seen as a positive factor regarding water resources protection, given that forests positively affect the hydrological regime and mitigate surface runoff which is especially important for flood prevention and mitigation.

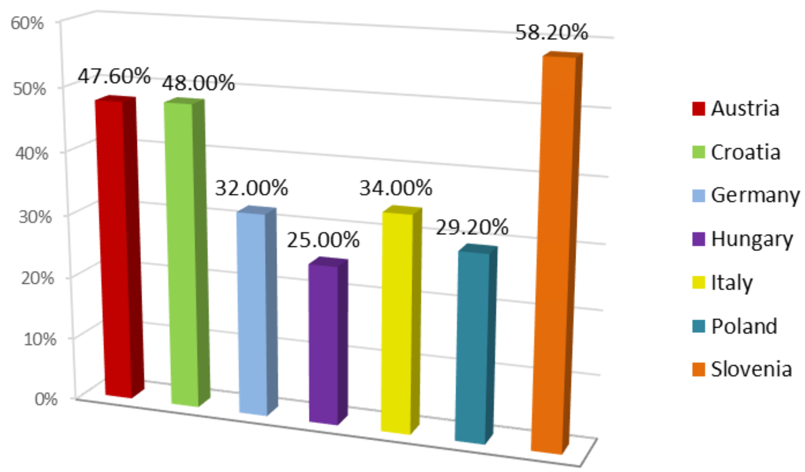


Figure 54. Forests within Project Partner countries (based on data provided by Project Partners)

According to the data provided by Project Partners, the amount of land covered with forest (**Fig. 55**) in drinking water protection zones varies between 21.79% in Italy and 61.04% in Slovenia. The majority of area is covered with broad-leaved forests, coniferous forests and mixed forests, while the transitional woodland-shrub and agro-forestry areas occupy smaller areas within the DWPZ.

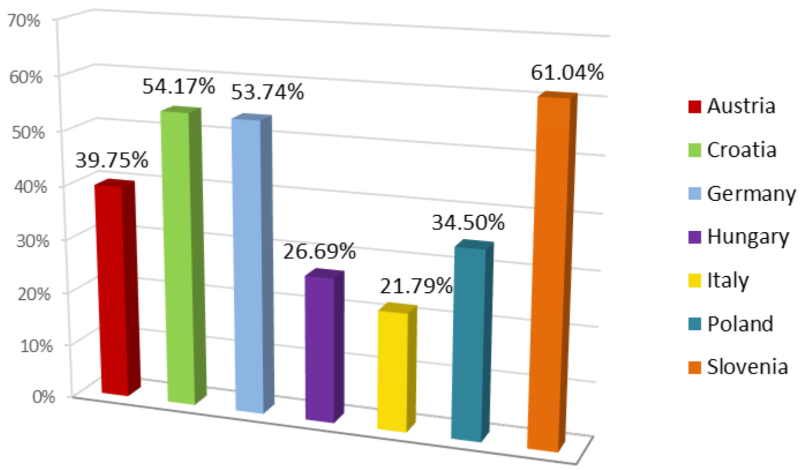


Figure 55. Areas of DWPZ that are covered with forest (Corine Land Cover 2012 data and DWPZ provided by Project Partners)

3.1.1.5. Pastures

Current management practices that are used for pastures within each Project Partner country can be seen in the text below.

Austria

Livestock farming is a prominent land-use type in Austria, what is due to the dominance of alpine landscapes. The related grassland is either used as hayfields or as pastures, in some cases hayfields are partially used as pastures. Another type of grassland is forage cropping (e.g. red clover etc.). In the accessible flatlands and alpine valleys of Austria grassland covers 1,600,000 ha and is mainly used for livestock feeding. More than 60% of the Austrian farmers have a pure grassland focus. At those grasslands mainly farm manure is used, only 5% of the farmers use mineral fertilizers. Liquid manure is a wide spread form of fertilizing grasslands.

A very important type of pastures are the so-called mountain-pastures, situated in the Alps, where livestock is allowed to graze only during summer season, what is due to climatic conditions (extended snow cover). Those mountain pastures (=Almen) in Austria sum up to 8,770 and cover an area of 460,000 ha.

The challenge of grasslands and mountain pastures in relation to DWPZ is in most of the cases the potential microbial contamination of the source water, caused by farm manure or e.g. cow dung. In some exceptional cases also nitrate leaching to the aquifers could be a threat for source water quality. Within DWPZ it is necessary to regulate the activities of livestock-farming, what especially becomes mandatory in karstic catchment areas.

Within the DWPZ of the City of Vienna, cattle-grazing is regulated in a way, that dolines and sink-holes are fenced so that cattle cannot approach these highly vulnerable sites. Through these measures the critical dung of cattle is intended to be kept in distance to the areas, which have direct connection to the aquifer. In order to avoid the direct entrance of precipitation water also technical constructions were used, like e.g. dams which prevent precipitation water from directly flowing into dolines or sinkholes. The water can subsequently infiltrate slowly via the soil matrix, so that the potential contaminants are reduced (soils are acting like a filter).

Also the erosion processes caused by livestock trampling (above all cattle) can become a threat for source water quality. For avoiding such erosion processes, fencing of erosive sites was done for keeping livestock away from there. A subsequent planting with autochthonous vegetation is a further step towards prevention of such erosion processes.

Croatia

Although natural pastures occupy a large part of total agricultural area (especially in the Adriatic region where natural pastures comprise about 775,000 ha, i.e. 70% of the of the Adriatic part of the Croatian) it is estimated that their utilization is very low (around 10%). According to the “Agriculture that protects nature, Protection of nature through measures of Rural Development Programme of the Republic of Croatia 2014-2020”, decreasing number of grazing animals in the last decade is leading to the disappearance of grasslands rich in plant and animal species. Also, cattle that used to graze the pastures is kept indoors in longer period through the year.

Croatian Ministry of agriculture issued conversion prohibition (in agricultural purpose) of permanent grassland and pastures in specific NATURA 2000 areas.

Germany

Since 1988 the Bavarian Ministry of Agriculture provides the cultural landscape programme (KULAP) giving advisory and financial support for sustainable and landscape preserving actions. Moreover, the Bavarian Ministry of the Environment provides a contract-based nature conservation programme (VNP) also supporting similar aspects. Different measures are prescribed with a fixed compensation payment per hectar of implemented measures. These programmes foster the conversion of arable land to grassland as well as the preservation of grassland on specific sites making grassland topics to a central theme of the Bavarian agricultural and environmental policy.

Grasslands cover more than one third of the land used for agricultural purposes in Bavaria. Already 34% of the agricultural land are permanent grasslands. The most frequent species groups on Bavarian grasslands are grasses (73%), herbs (20%) and leguminous plants (7%). In the following, the results of the Bavarian grassland monitoring from 2002 to 2008 serve as a base to describe the characteristic values of grassland use in Bavaria.

Basically, grasslands are used as pastures (73.7%), meadows (16.6%) and mountain pastures (6.7%) in Bavaria. As measured by the amount of cuts per year, 16% of grassland sites in Bavaria has been used extensively (between 1 and 2 cuts per year) while 17% have been used very intensively (≥ 4 cuts per year) (LfL, 2011).

To sustainably protect the ecosystem services of grasslands in DWPZ, grazing activities are prohibited in zone II. Further limitations of grazing activities are generally implemented for zone III to limit the extensive soil degradation through livestock trampling and to sustain the turf qualities and the physical properties of the soil system (LfU, 2003). Moreover, to use the water retention capacity of grasslands their preservation is also integrated in the WHG. Thus, the conversion of grassland to arable land is prohibited on riparian strips and inundation areas.

However, a tendency of grassland losses (-5% from 2003-2012) could be observed during the last decade (BfN, 2014). This tendency can further increase since future land-use conflicts in DWPZ may arise from the adapted definition of permanent grasslands. Following the announcement of the European Court of Justice (ECJ) a permanent grassland is an “agricultural land which is currently, and has been for five years or more, used to grow grass and other herbaceous forage, even though that land has been ploughed up and seeded with another variety of herbaceous forage other than that which was previously grown on it during that period” (ECJ, 2014). This definition has been introduced by the ECJ as a result of a legal dispute of a German farmer who considered reseeding actions on his grassland sites would break the five-years regulation so that he keeps the status “arable land” for these sites. Generally, farmers try to avoid the status of permanent grasslands due to a lower sales value and the ban on plowing. Thus, the implementation of ecologically valuable permanent grasslands is difficult since the economic value of arable land sites and permanent grasslands as well as the legal restrictions on both land-use entities mostly are of top priority. Moreover, a plowing up of grasslands can release great amounts of nutrients which can be leached into protected water bodies and thus pose a threat to the water quality.

Hungary

Animals stock increased by 0.8% since 2013. About 90% of the livestock is concentrated in large farms with more than 500 animal units – that ration has not changed since 2010. The main breeds are cattle, sheep, pig and poultry. The numbers of livestock in the end of 2015 were as follows: 821,000 cattle, 1,2 million sheep, 3.1 million pig and the number of poultry (all breeds combined) was 37 million. The major types of livestock breeding are extensive and non-extensive breeding. Sheep, horses and partly cattle are kept extensively using pastures for grazing. It is almost exlusively the cattle that is bred also non-extensively in stables. Pigs are not relevant respecting pastures. Also recently, according to Hungarian legislation, grazing of any livestock breed is forbidden in forests. According to a new scheme (agro-forestry systems) amendment of this rules will be change in floodplain forests.

Pastures make 688,200 ha or 7.4% of the area of Hungary. As follows from the number of livestock, pastures are grazed predominantly by sheep and cattle, and less by horse and other livestock. Livestock grazing has an important role in the conservation management of Natura 2000 grassland areas. Those areas are semi-natural habitats transformed from natural steppes through hundreds of years by livestock grazing. Due to the geographical position, Hungarian grasslands can be considered the westernmost Eurasian steppe or steppe-like areas hosting a diverse flora and fauna with significant populations of steppe species that cannot be found more to the west. Thus agri-environmental support schemes was – and probably will be – available for nature friendly grazing to conserve those wild flora and fauna. Of course, such management has positive impact also on water quality.

In addition, there are legal obligations on grazing and livestock breeding on drinking water basis regulating the number of animals, treatment of manure, etc. in line with WFD.

Italy

Livestock farming represent almost 1/3 of the Italian agricultural production, corresponding in 2013 to more than 17.5 million Euros, with meat representing more than 60% of production value, followed by milk, eggs and honey (CREA, 2016). Livestock farming is mainly intensive, with farms well distributed but animal heads concentrated in few areas (the North). Because of this concentration, many parts of the Country's territory are suffering from pressures on the environment and on the economic costs, because of the need to be compliant with severe Laws and Directives as the Nitrate Directive (1991). To give an idea, Lombardy hosts 25% of bovines and more than 50% of swines, while more than 40% of sheep and goats are concentrated in Sardinia. However, livestock sector is not only intensive and concentrated on the plans but it is also active in hilly and mountainous areas of the Centre and the South to value local production contributing also to environmental protection. In the last decade, there was an increase of farm size, and especially in the North West the share of livestock farming over the whole agricultural sector almost doubled rising by 17% and reaching 31%.

The Legislative Decree 152/2006 (known as “Environmental Code”) and its integrations in the Legislative Decree 128/2010, are the main texts on pollution and also regard the livestock sector and implement the EU Water and especially Nitrates Directives concerning the need of monitoring both superficial and underground water bodies, the definition of vulnerable areas, the identification of good practices and the adoption, implementation and monitoring of actions. If the livestock activity is conducted within a vulnerable area to nitrates, the yearly average nitrogen load should be less than 170 kgN per hectare, included the manure applied and left on pasture. In general, during autumn and winter both mineral and organic fertilizers are prohibited, and storage facilities or removal of livestock manure are required during periods of prohibition. The use of fertilizers and manures should be limited to the crop needs, and application on saturated or flooded soils, on soils with very shallow groundwater or covered with snow or ice, or on steep slopes (>10%) is not permitted. The application should be as much homogeneous as possible and respecting distances from water bodies. All data about fertilizers and manure should be registered by farmers together with information about farming practices.

For farms exceeding in the production of animal-source nitrogen, the limit of 170 kgN per hectare per year was changed (in 2011) to 250 kgN/hectares but only for bovine and swines, and only if farmers, on at least 70% of the UAA, conduct long-season cultivations that uptake nitrogen. To manage livestock manure it is required that 2/3 is applied by the end of June, and the remaining by the end of October, so to maximize nitrogen use efficiency.

Poland

The development of research in the field of animal breeding and animal production should focus on the following five directions.

- The use of advanced molecular technologies in the genetic improvement of the production and functional properties of domestic animals

Increased requirements in the sphere of the quality of animal products have necessitated changes in the evaluation of animals. The use of the molecular genetics method in the wider scope will be the key element of this aspect. The intense development of molecular technology facilitates the introduction of polymorphism assessment for the entire genom for the selection of animals, which is one of the most fundamental changes in breeding.

- The possibility of shaping the quality of animal materials and products in terms of consumers' expectations

Striving to meet the society's needs and requirements in the field of the high quality of products should be aimed at creating food safety along the entire food chain, from the producer to the consumer. Growing consumer requirements concerning animal products, including their nutrition value and health benefits, and their sensory properties, necessitate the search for new possibilities to improve the quality of obtained animal materials and products, and to introduce new processing technologies. In the case of slaughter animals, it is instrumental to improve their musculature and reduce the fat content. An aspect which is currently important in food production is the acquisition of materials and products beneficial to the condition of the human body. Milk and dairy products rank high in this respect.

- The use of biotechnological methods in animal breeding, pharmaceutics, and biomedicine

The practical implications related to animal reproduction biotechnology reach far beyond animal breeding and production. They cover the field of biomedicine and pharmaceutics, and provide tools for preserving biodiversity, saving endangered species and reviving extinct species.

Transgenesis (i.a. xenotransplantation) and cloning belong to the biotechnological methods in animal reproduction which display the largest number of potential possibilities.

Two basic directions of using the transgenesis of animals in biomedicine are due to be continued and developed. The first one is aimed at using transgenic animals as research models for human diseases, while the objective of the second one is the use of cells, tissues and organs from transgenic pigs in broadly understood regenerative medicine.

- The preservation of animal biodiversity with the use of in situ and ex situ methods in sustainable agriculture conditions

In situ protection is regarded as a preferred method of preserving the biodiversity of the farm-animal population in traditional production systems. It facilitates the preservation and adaptive use of the animal genetic pool in production sites, thus preserving their cultural values.

Over recent years, there has been growing attention to the introduction of an effective and economically efficient ex situ protection strategy as a supplemetary method. It constitutes additional security against the loss of the animal genetic pool resulting from erosion or crisis situations.

- Environmental protection and increased welfare as part of the development of state-of-the-art animal production

Together with the intensification of animal maintenance systems, problems involving animal welfare and environmental protection have occurred. Environmental protection was not an issue when animal maintenance was not concentrated to such a degree as it is today. The issues of providing the minimum level of farm-animal welfare and reducing the environmental impact of breeding methods were raised in late 1970s, at the same time becoming new determinants in the development of breeding technology.

Ecological agriculture is an alternative in the field of environmental protection and the improvement of animal welfare which should be developed in Poland. Small farms could serve this purpose. Livestock buildings and equipment should not only consume energy but also save it, or even generate it. The use of solar collectors, photovoltaic cells, wind generators, biogas plants of varying power, adjusted to the scale of production, is currently becoming an opportunity for these facilities.

Slovenia

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.

Overview of pastures by Project Partner countries

European meadows and pastures as land covers rich in plant and animals species often represent endangered habitats that are included in Natura 2000 ecological network. They should be maintained only by grazing and mowing. However, high concentration of livestock at the pasture leads to grass damage, soil erosion, higher surface runoff and organic pollution transport. On the other end negligence, abandonment or change of traditional management systems of grassed parcels (meadows and pastures) leads to their degradation, increase of aggressive invasive species and soil and water quality changes. Furthermore, inadequate drainage of pastures will result in decreased water retention capacity of the catchment, decreased level of groundwater and can lead to disbalance of groundwater recharge in infiltration zones. The gaps within pasture management in Project Partner countries are presented in the **Table 5**.

Table 5. Overview of mentioned problems or gaps in pastures management practices within Project Partner countries

Country	Recognized problems or gaps in pasture management practices
Austria	Manure application can result in microbial contamination of the source water
	Nitrate leaching to the aquifers could be a threat for source water quality
	Mandatory regulation of livestock farming activities within DWPZ, especially in karst areas
	Erosion processes caused by livestock trampling
Croatia	Decreasing number of grazing animals leading to the disappearance of grasslands rich in plant and animal species
Germany	Tendency of grassland losses increases since future land-use conflicts in DWPZ may arise from the adapted definition of permanent grasslands
	Difficult implementation of ecologically valuable permanent grasslands
	Ploughing of grasslands can release great amounts of nutrients which can be leached into protected water bodies and thus pose a threat to the water quality

According to the Corine Land Cover data, there are only few lands used as pastures within the drinking water protection zones of Project Partner countries. In Italy they cover just 1.5% of land within the DWPZ (**Fig. 56**). In other PP countries the amount of land covered with pastures varies around 3 to 6%. Only Germany stands out as the country with almost 15.4% of pastures present in DWPZ.

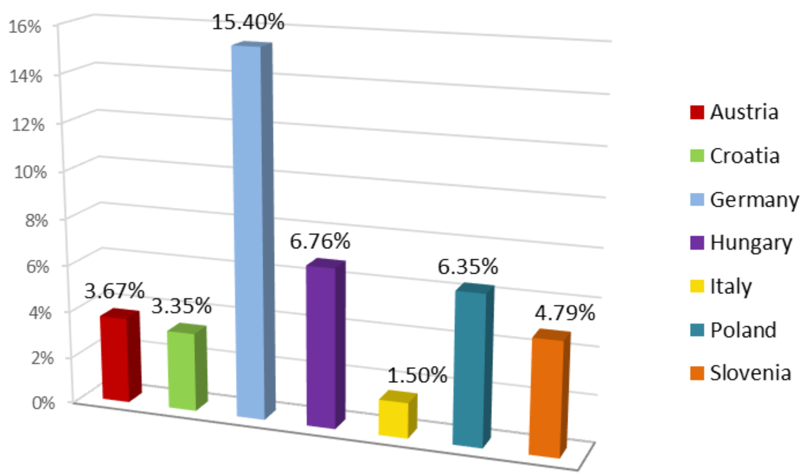


Figure 56. Pastures in drinking water protection zones (Corine Land Cover 2012 data and DWPZ provided by Project Partners)

3.1.1.6. Transport units

Austria

A mandatory part in the course of planning, construction and maintenance of motorways in Austria is the environmentally compatible removal of wastewaters. The drainage and purification of surface waters stemming from the motorway is constantly brought up-to-date in cooperation with the experts of the water authorities. For this purpose so-called retention-basins were and are constructed beside the motorways.

The water-retention-systems prevent an eventual contamination of the groundwater bodies. All waters flowing from the motorway during precipitation or thawing events enter these retention systems and are cleaned there. First after this cleansing process the waters are transported for infiltration into the ground or enter streams (brooks or rivers).

The purification plants also serve for the prevention of accidents. This means that in case of a leakage of environmentally hazardous materials, those matters can be stored in the retention basins and subsequently can be brought to a professional disposal. This contributes to safeguarding the quality of the streams and groundwater resources (ASFINAG, 2016).

Freezing on motorways is prevented by the application of thawing salts, in most of the cases NaCl. During some extreme events also $CaCl_2$ is mixed with NaCl, what provides more security for the drivers, as the mixture can thaw ice and snow also under conditions of lower temperatures, but it also causes more rust-damages on the cars. In Austria about 200,000 tons of thawing salts are applied during one winter season, sometimes even more (depending on the weather conditions). The influence of thawing salts on water resources is given, it can be critical if roads or motorways are crossing DWPZ. An alternative would be the application of KCl_2 in DWPZ, which is not that harmful to plants or to water quality, but has a strong alkalizing effect.

Transport units which drive huge construction materials are accompanied by a special task force, which provides the security of the units. The distance to the trucks is secured, also the signals for other motorway users are provided. Transport units which drive hazardous materials (chemicals, radioactive material, etc.) have to fulfil the laws regulating these transportations.

Croatia

The total length of roads in 2015 was amounted to 26,706.0 km (according to the National List of environmental indicators). In the period from 2011 to 2015 the total number of motor vehicles decreased by 4.6%. Most passengers are transported by road and railway transport, and the most goods by road and sea water and coastal transport. In regard to 2011, in 2015 a total length of railway lines (2,604,260 km) reduced for 4.3% what is recognized as negative trend, because this mean of transport is more environmental friendly.

The network of inland waterways of the Republic of Croatian is 1016.9 km. Inland ports open to international public transport are: Osijek, Sisak, Slavonski Brod and Vukovar. The Republic of Croatia has 7 international airports: Zagreb, Split, Dubrovnik, Zadar, Osijek, Rijeka and Pula and 3 national airports: Brač, Mali Lošinj and Osijek for aircraft in commercial air transport. Pipeline transport includes transport of oil and gas. The 2015 length of the oil pipeline amounted to 610 km and has not changed since 2005. The length of the gas pipeline in 2015 was amounted to 26,932,693 km. Road transport makes more than 90% of all emissions of pollution from traffic, while other modes of transport (rail, air transport, marine and inner marine transport) make about 10%. It is estimated that considerable pollution is caused by traffic in protected areas (particular at karst springs). Still, total pollution from traffic is small in comparison with other sources of pollution.

Germany

Road maintenance tasks are performed by the public authorities. In this context, the responsibility of a public authority depends on the road types, e.g. the municipalities are responsible for the maintenance of country roads. The maintenance tasks comprise the road drainage, road cleaning and the care of green areas along the roads. Moreover, the public authorities are responsible for winter services (snowplow, de-icing salt) and road lighting in built-up areas. These tasks can be further delegated to private companies or to citizens.

Basically, seepage of rainwater represents a usage of water and thus has to be permitted by law. However, the Bavarian ministry of the environment implemented an exemption regulation for the seepage of rainwater regulating that specific seepage actions do not require an official permission by the responsible public authority. To be exempted from permissions, specific requirements of the technical guidelines legislated by the ministry (Technische Regeln zum schadlose Einleiten von gesammeltem Niederschlagswasser in das Grundwasser - TRENGW) have to be met. An important requirement is to ensure an extensive seepage through overgrown topsoil. The exemption regulation is not valid for any kind of seepage measures in water protection zones.

In 2005, the Supreme Building Authority of the Bavarian State Ministry of the Interior implemented a revised ordinance for the creation of roads and road drainage (Richtlinie für die Anlage von Straßen, Teil Entwässerung - RAS-Ew). The updated version of this ordinance integrates the concerns of water protection and nature conservation thus setting enhanced requirements for road drainage systems. The ordinance further gives a basis for the planning, assessment and implementation of drainage systems. Moreover, the ordinance refers to state-of-the-art guidelines published from the German Association for Water, Wastewater and Waste (DWA). These technical guidelines give practical references for the assessment of rainwater retention basins (DWA, 2013), the planning, construction and operation of features for the seepage of rainwater (DWA, 2005) and recommendations for handling rainwater (DWA, 2007). Moreover, the ordinance for structural measures on roads in water protection zones (Richtlinien für bautechnische Maßnahmen an Straßen in Wasserschutzgebieten - RiStWag) sets specific requirements for road drainage in water protection zones. Thus, drainage systems have to be adapted to the protective effect of the groundwater cover, the protection requirements of the related water protection zone and the traffic volume.

Different drainage systems exist for road drainage within or outside built-up areas. While drainage ditches and basins are typical measures implemented outside built-up areas, drainage channels are frequently used drainage systems in built-up areas since adjacent buildings often do not allow an implementation of open drainage systems (e.g. ditches and basins). However, open drainage systems have to be preferred as far as possible.

Further risks for water quality can arise out of the restructuring or demolition of outdated transport-related structures, e.g. bridges. In this context, especially the demolition requires a particular attention since water pollutants, such as red lead used for corrosion resistance, can be leached and enter the water body. Moreover, requirements have to be set for temporary storages for demolition materials to preserve a diffuse contamination of the concerned water body.

A further source of risk results from the maintenance of water on transport unit construction sites and the reinjection of process water assuming specific requirements for the water treatment. In this context, further requirements can be set for the management of reinjection activities e.g. if a rise of water from underlying (protected) aquifer layers has to be avoided.

Hungary

Hungary has one of the highest motorway densities in all of Europe and the third highest road density, after Belgium and Holland. Highways reach the borders of the country and the different regions of Hungary. Hungary has a central location in Europe, at the crossroads of four main European transportation corridors. Major Hungarian towns are connected to the capital city, Budapest, by motorways.

Due to its central location, Hungary has an extensive railway network. Rail transport carries more than 20% of total freight, which is well above the EU average. Several main train lines connect Hungary with the main ports of Western Europe and the Adriatic with regular services. The total length of the Hungarian railway system is 7,729 km, of which double-track is 1,335 km (17.3%) and the electrified railway network is 2,628 km (34%). Záhony and its region is the junction and reloading center for European standard-gauge railways and the wide-gauge system of the CIS states.

Hungary has excellent waterway connections, as the Danube crosses through the whole country from north to south. The Danube-Rhine-Main canal in Europe links the North Sea and the Black Sea: several scheduled block train lines connect Hungary with the seaports on the North Sea, and on the Adriatic.

Runoff from transport areas may carry rubbish, petroleum compounds, salts, and contaminants from air deposition (e.g. heavy metals) including greenhouse gases as well. The contaminants from transportation can be detected in surface and groundwater as well. Eco-friendly de-icing alternatives are more and more used in the last decades like Calcium Chloride or Magnesium Chloride (both in liquid form), just sand or zeolite granulates on pavement. Also the anti-icing technology instead of de-icing is spreading. Anti-icing brine solutions are applied prior to snowfall to prevent snow and ice from bonding to the pavement.

Italy

ACI (Automobile Club d'Italia-Italian Car Club) reports in detail the features of the national road network updated at 2011 discriminating on the basis of road type or its location. At National level, the entire network road extends for 154,000 km; in the specific, highway network extends for about 7,000 km (27% in North-West [NW] Italy, 23% in North-East [NE], 18% in Central [C] Italy, 22% in South [S] and 10% in Insular [I] areas), primary roads for 20,423 km (about 10% for NW, NE and C, and about 33% for S and I), secondary roads are about 8000 km while provincial ones extend for over 100,000 km. On average, the ratio between road length (km) and surface (km^2) returns at national level a value about equal to 0.5 while the ratio between road length and population is about 0.25. Concerning the management of wastewaters from roads, the reference legislation is represented by 152/2006 Law; in the specific, the article 113 addresses the matter. According it, control and management of wastewaters produced by precipitation that, through runoff processes, wash out impervious surfaces has to be regulated at Regional level. Moreover, Regions regulate treatments and permissions for "acque di prima pioggia" (first rains) and washing waters considered most polluted. In particular, the identification of activities for which more significant hazards may arise in terms of stormwater contamination are required. In this regard, the regional regulation adopted by Lombardy (L.R. 4/2006) could represent a valuable example. It defines "acque di prima pioggia" as the first 5 mm fallen on the draining surface while to discriminate between two distinct events, it considers an interarrival time longer than 96 hours. After, it defines in detail activities subject to regulation (i.e. chemical, concrete, leather, paper, textiles industries or car repair services). Then, it prescribes that first rains or washing waters, in these cases, should be separated from the remaining, stored in specifically sized tanks and subject to treatments that allow the reduction of pollutants below required thresholds. For what concern the activities carried out to prevent freezing on the roads, for example the main highway company operating in Italy, Autostrade s.p.a., drew up the “Plan for Management of Snow Emergencies” in which are reported in detail procedures for operators and drivers to follow in case of snow; moreover, the location of deposits for calcium chloride (168) and of vehicles (i.e. snow blades, salt spreaders) is indicated. Finally, five color codes allow communicating to drivers the hazard level.

Poland

Paragraph 21 of the Regulation of the Minister of the Environment of 18 November 2014 depicts the conditions to be met during placing waste in water or ground and on substances particularly harmful to the aquatic environment (Dz. U. 2014, item. 1800) and specifies requirements, to be met when draining rainwater from the area of the roadway.

Wastewater management of roads has to meet the requirements mentioned in the preceding paragraph and taking flood wave created as a result of heavy rainfall on land roadway, characterized by a high ratio of impervious surface.

The acquisition of flood wave occurs through the use of storage tanks for rainwater catchment areas, conditioned by the adopted design solutions, determining their active capacity. Storing flood wave in tanks allows the use of appropriate technical equipment to drain rainwater to the external receiver in an amount that is not threatening to the flows occurring in it.

Meeting the requirements of Section 21 of the Regulation of the Minister of Environment of 18 November 2014. (Dz. U. 2014, item. 1800) also determines the use of the purification devices (clarifiers, separators, petroleum hydrocarbons) and the necessary technical parameters resulting from the adopted design solutions, allowing for reduce pollution to the values required by Regulation.

Similar solutions are used in case of objects that support highways and expressways. Such objects are: MOP-s (service areas) and OUD/OUA (road/highway maintenance circuits). Additional factor that may have an effect on water pollution is wastewater with high loads of pollutants generated in those facilities. This type of wastewater includes sanitary sewage. The solution to the problem of sanitary sewage is connecting it to the existing local sewer or the use of biological sewage treatment plant, allowing the required reduction in pollution loads.

Additional sealed septic tanks, preceded by dedicated separator petroleum hydrocarbons, allow receiving wastewater from places that generate strong pollution on OUD / OUA (brine factories, petrol station, car wash or buildings, workshop and garage). Similar solution, based on the use of a sealed holding tank, is applied to the MOP-s, the places designed as stop/rest areas for vehicles transporting hazardous materials. Applied fittings allow to redirect a leak from the tanker, caused by unsealing of the tank.

Proper prevention of slippery roads in winter requires conducting specialized meteorological services for roads. This is done by using the appropriate chemicals, such as the wetted salt and brine; production of which is placed on OUD/OUA objects. In cases of substantial temperature decrease, a mixture of sodium chloride and calcium chloride is used. The use of chemicals reduces winter nuisance and improves road safety.

Slovenia

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.

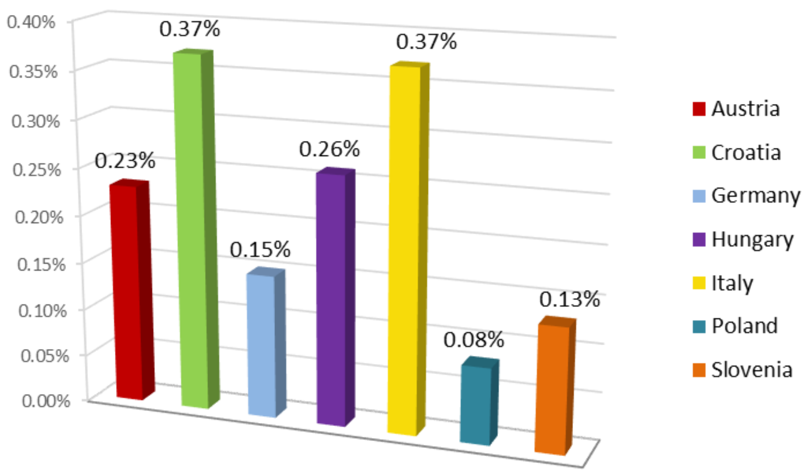
In winter freezing is prevented with solvents (salt) and sands. Environmentally unfriendly solvents are allowed to use only in the minimum necessary quantities. For sanding solvents only such device should be used, that enables accurate dosing quantities. The dosing quantities of solvent should take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

Overview of transport units by Project Partner countries

Although transport infrastructure is of great importance for the development of socitey, economy and spatial mobility of people and goods, it also poses potential negative impacts on environment and human health.

Since the pedestrian or veichle communication paths are linear structures that usually only intercept DWPZ, they take up really small amount of space within them. Therefore roads, rail networks and associated land cover only 0.03% (Germany) to 0.32% (Croatia). Only airports and ports cover slightly bigger areas due to their spatial structure (e.g. 0.14% of land within the DWPZ in Hungary and 0.12% of land in Germany). Total transport areas that include roads, railroads, ports, airports and associated land within DWPZ are given in the following graph.



Figures 57. Transport in drinking water protection zones (Corine Land Cover 2012 data and DWPZ provided by Project Partners)

Overview of land-use categories within drinking water protection zones by Project Partner countries is given on the following pages.

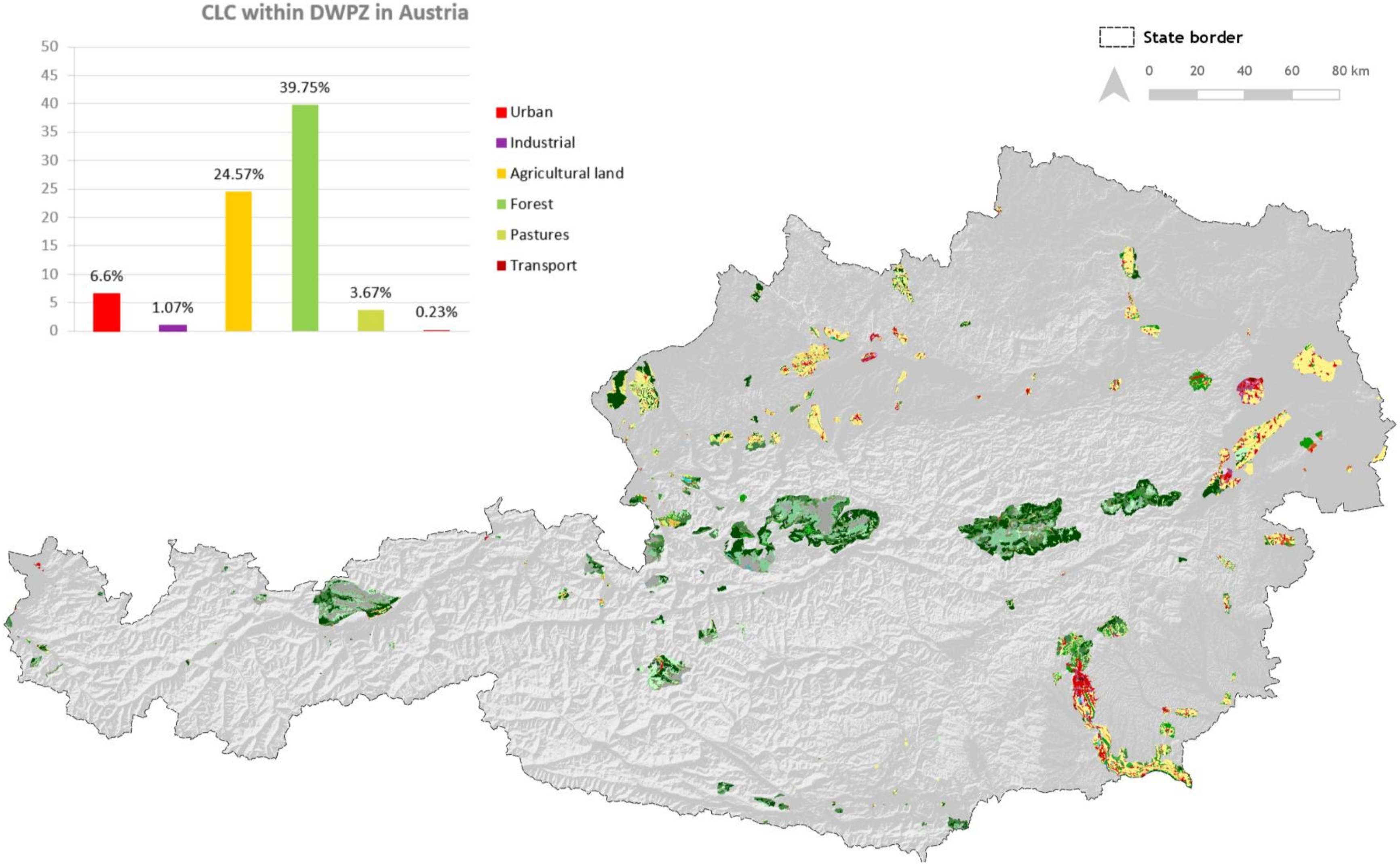


Figure 58. Land-use categories within drinking water protection zones of Austria

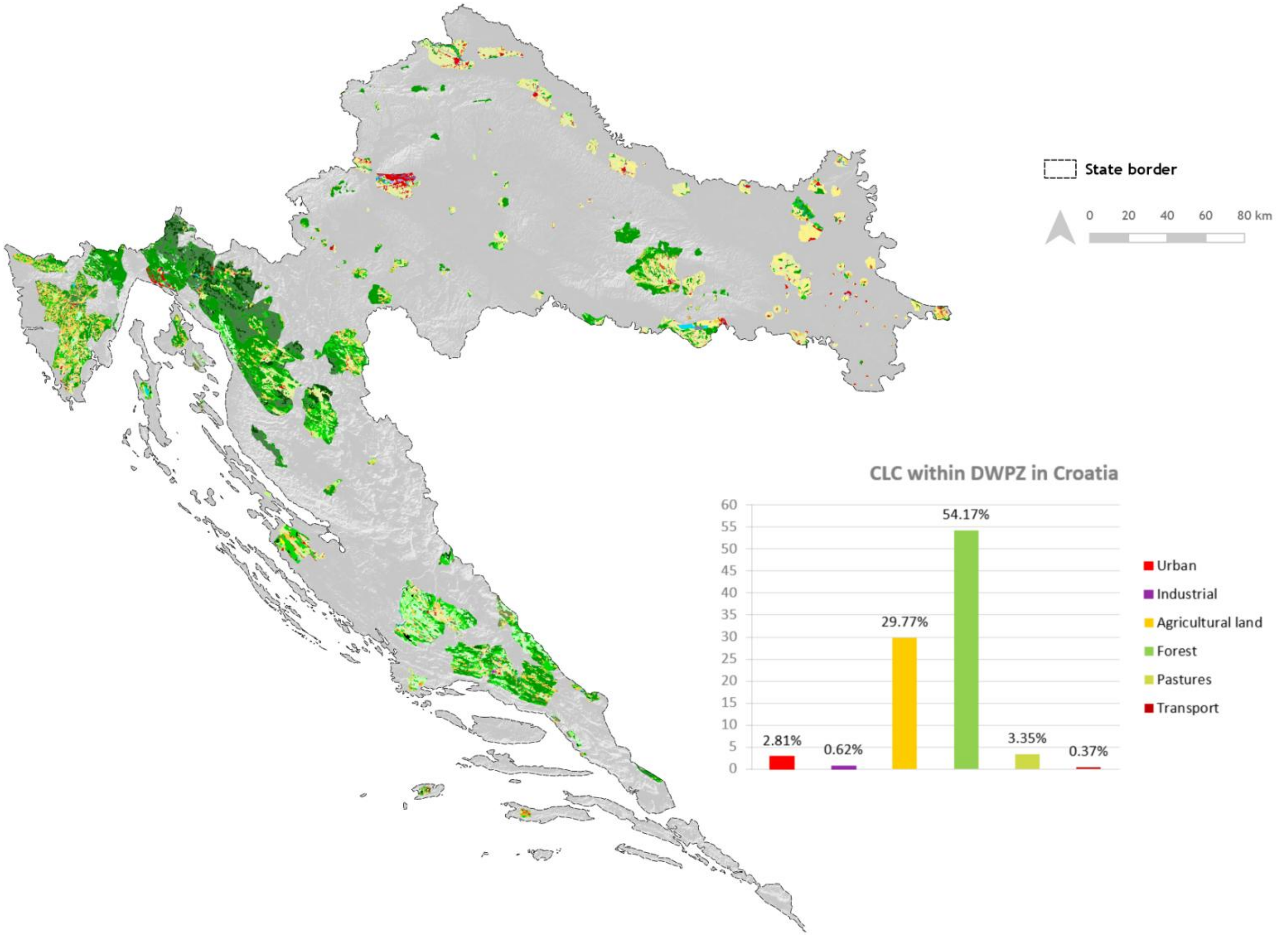


Figure 59. Land-use categories within drinking water protection zones of Croatia

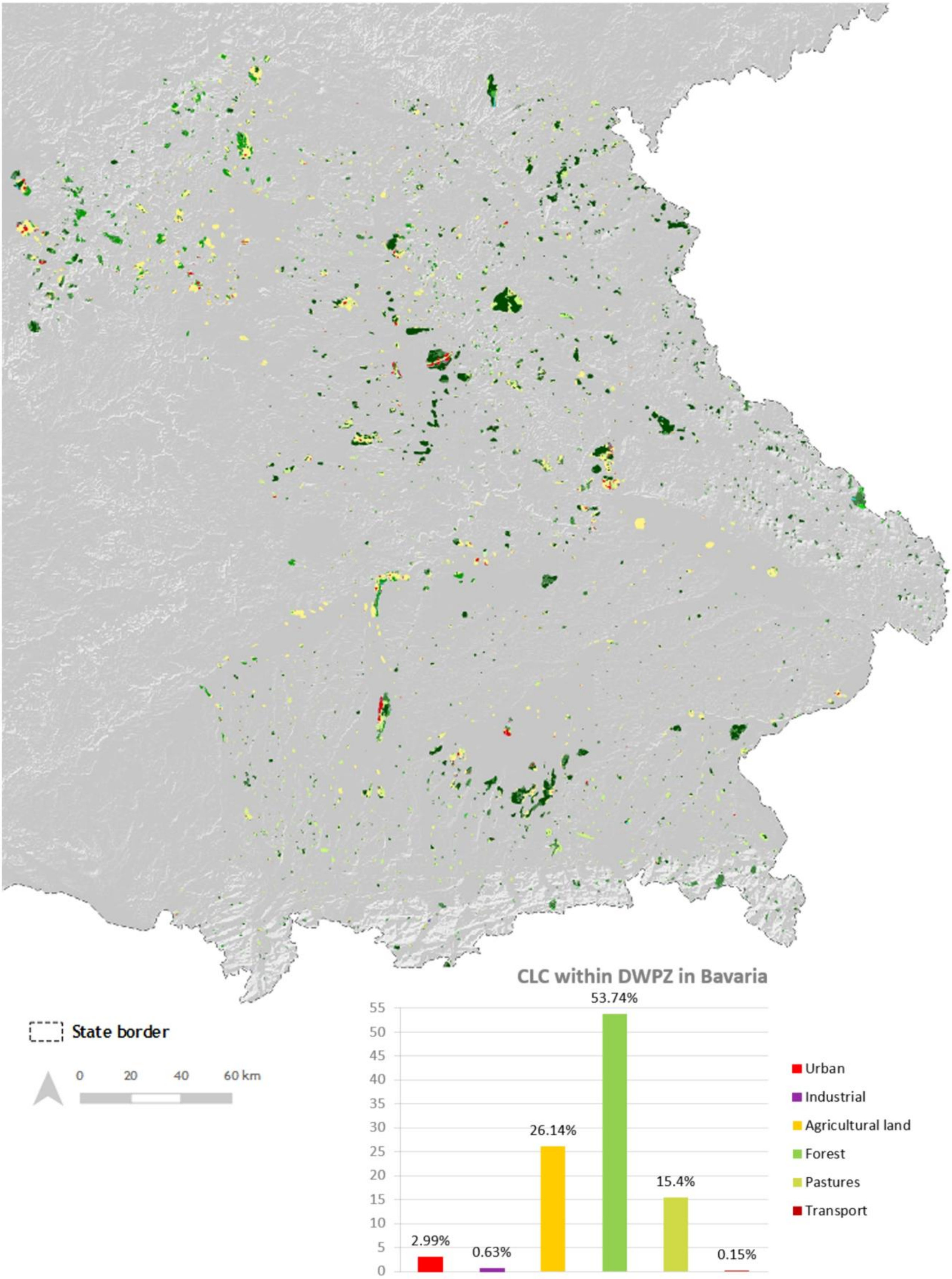


Figure 60. Land-use categories within drinking water protection zones of Germany (Bavaria)

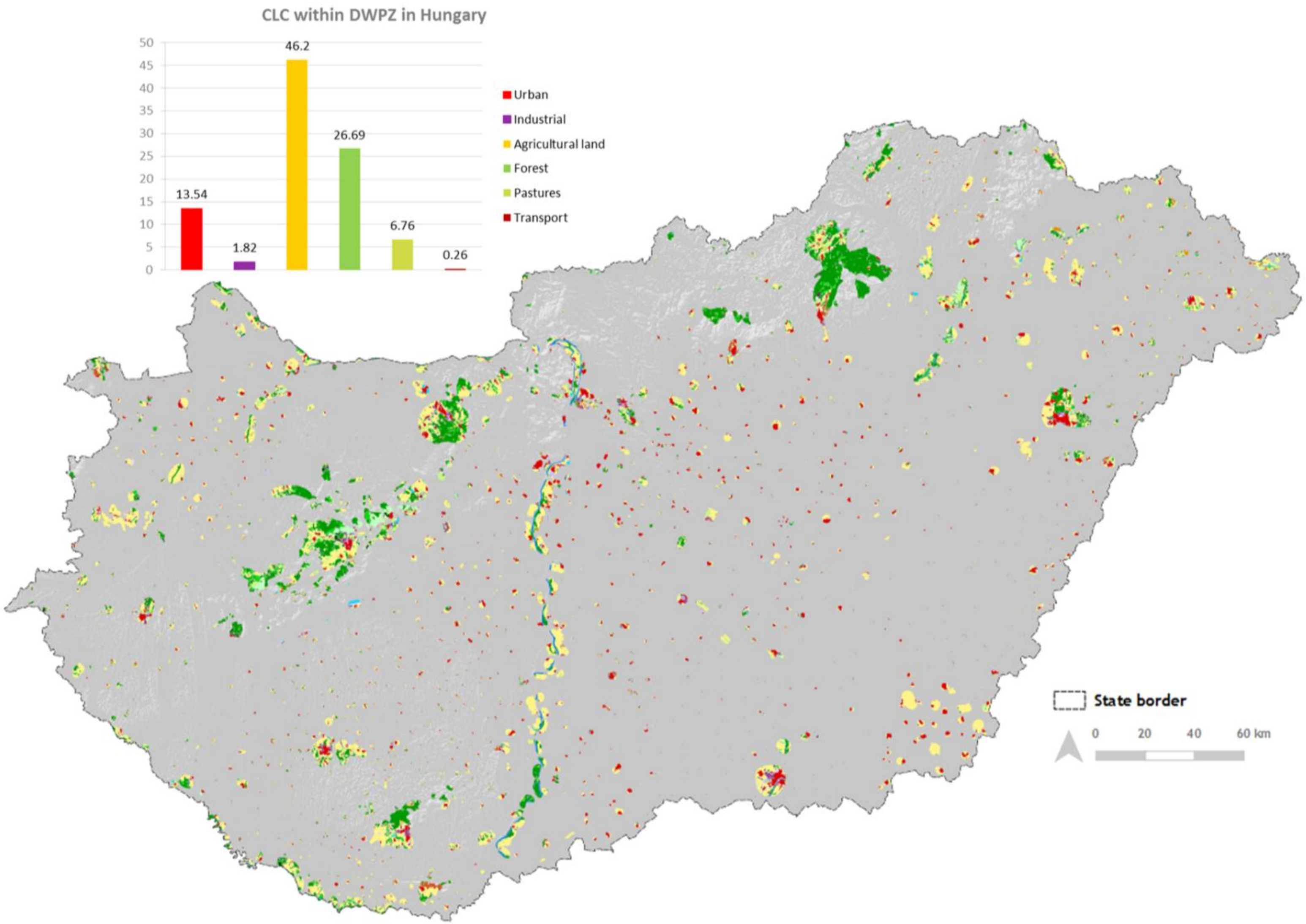
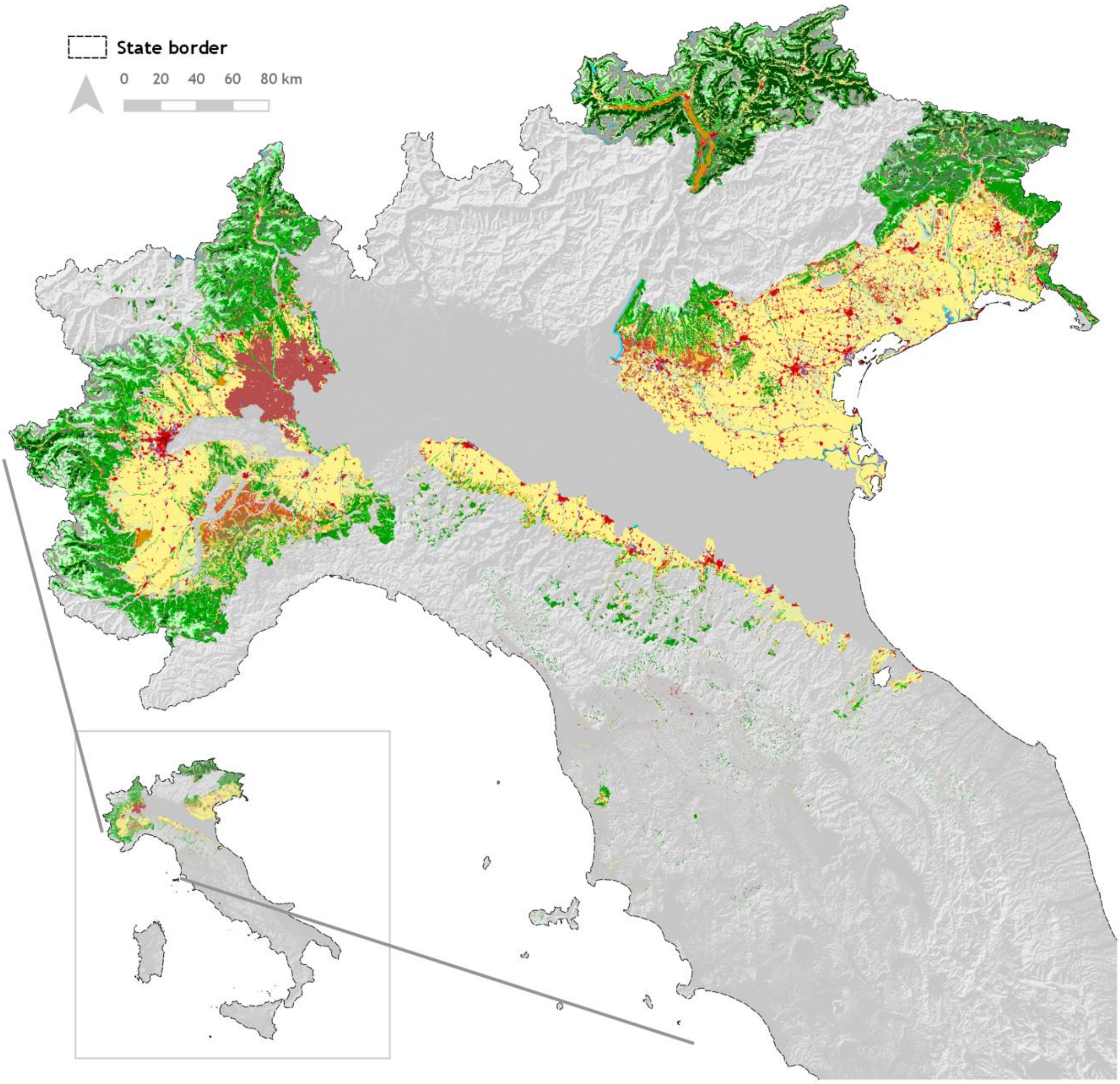


Figure 61. Land-use categories within drinking water protection zones of Hungary



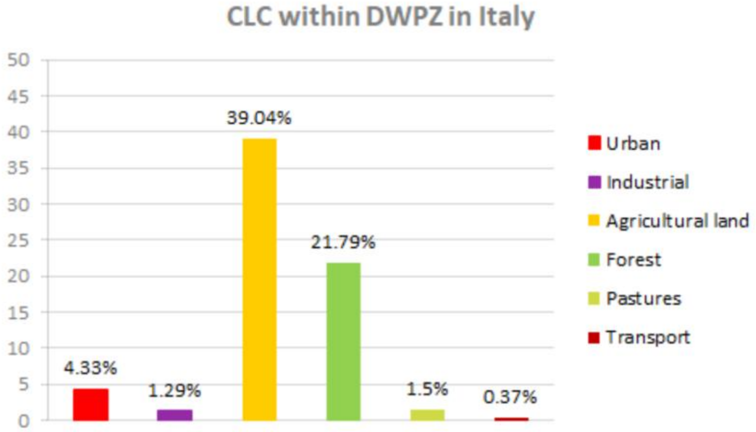


Figure 62. Land-use categories within drinking water protection zones of Northern Italy

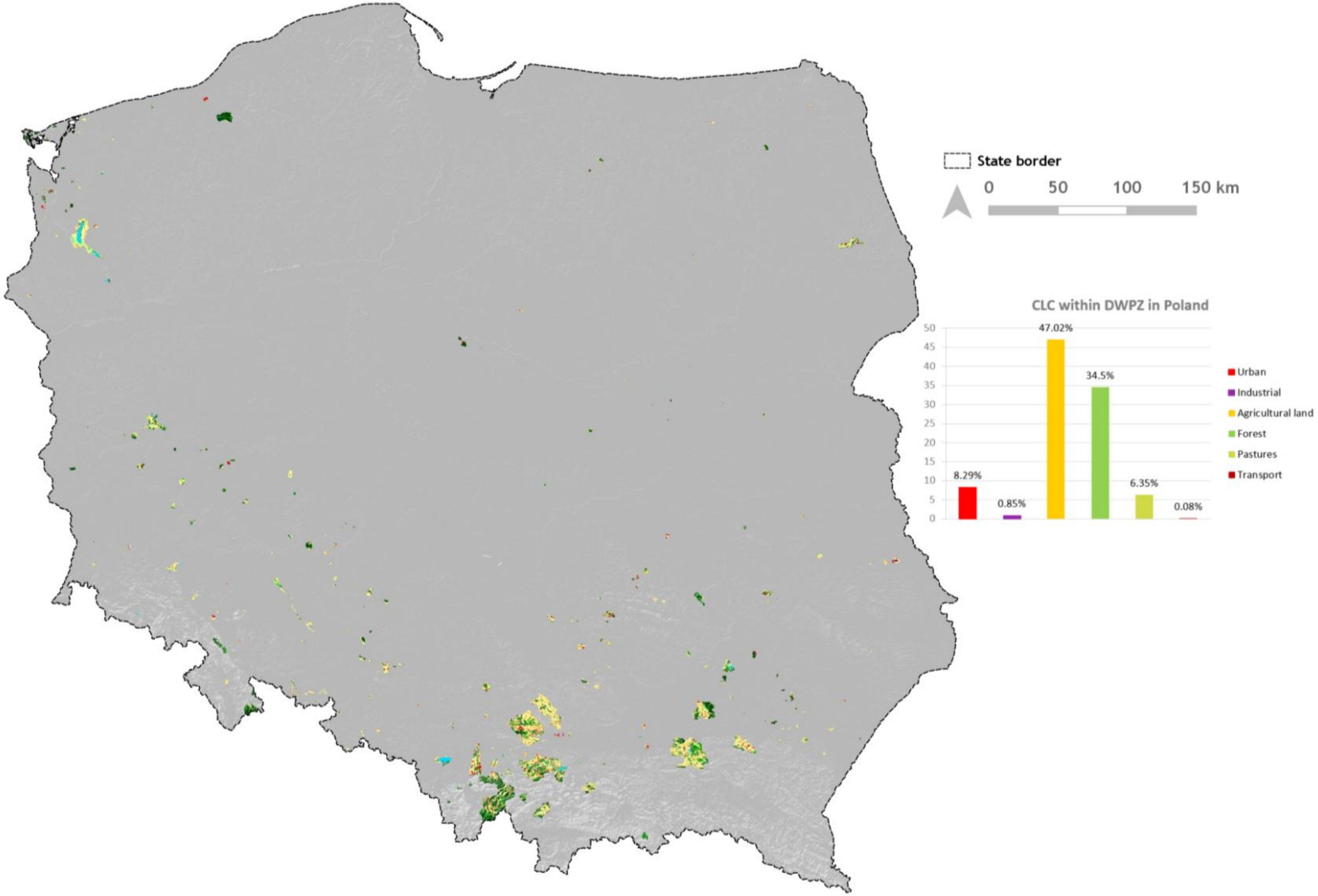


Figure 63. Land-use categories within drinking water protection zones of Poland

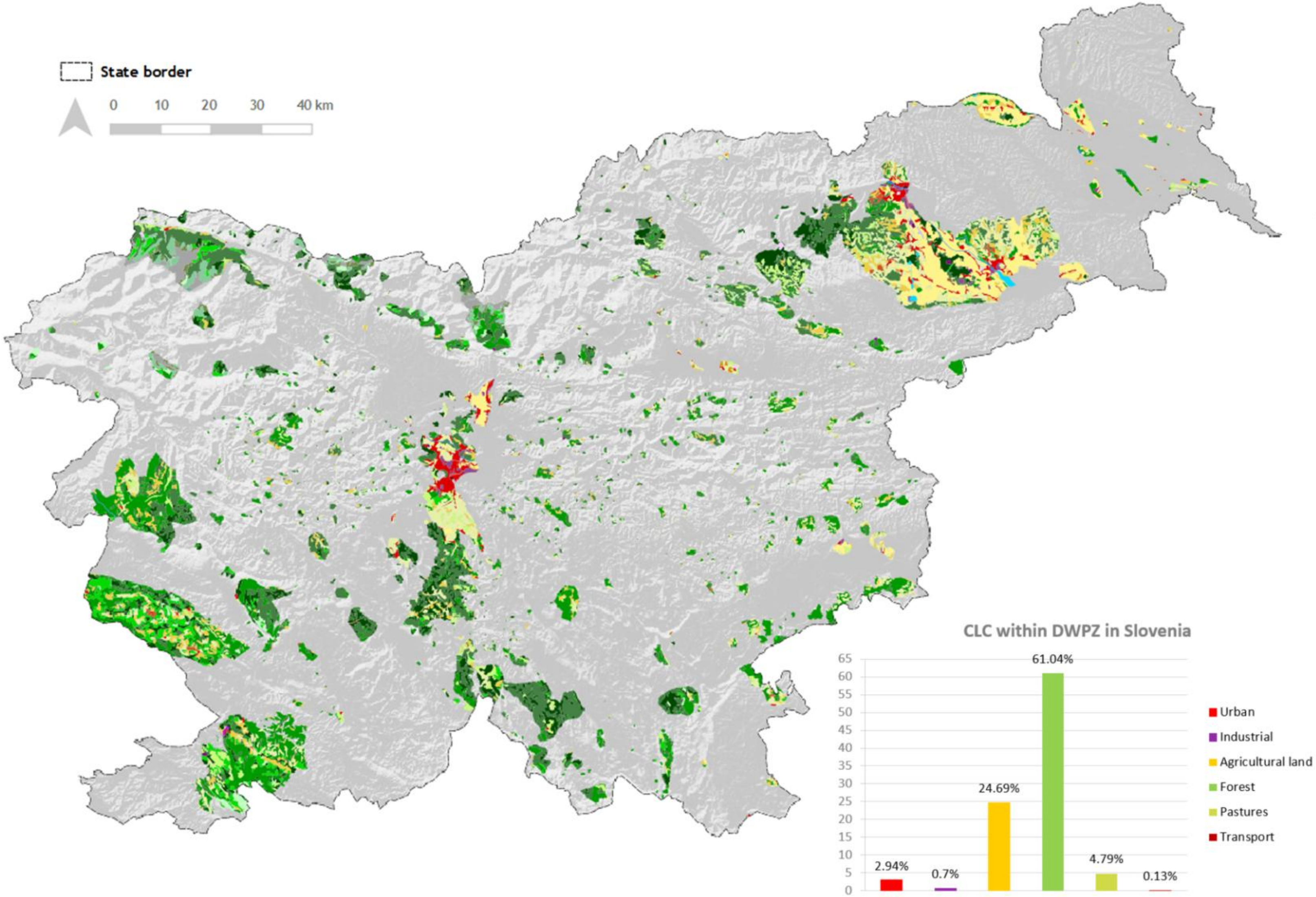


Figure 64. Land-use categories within drinking water protection zones of Slovenia

4. SWOT analysis and evaluation of gaps

4.1. Strengths

The countries have pointed out various advantages which span from financial stimulation for organic farming and sustainable land use in DWPZ, up to legislation implementation and chemical status monitoring.

Austria has good quality and quantity of groundwater. It takes a leading role in Europe concerning waste management. The amount of organic farming in Austria is the highest within the EU and thanks to the favourable climatic and hydrological conditions, irrigation is only necessary during dry years. The country has a high share of forested DWPZ. It is commendable that the governmental bodies show an adaptability to close ski-stations within important DWPZ (e.g. Villach Alps in Carinthia).

Croatia has recently put in place new legislation to support water management, including the transposition of EU legislation. The country has issued a new River Basin Management Plan (2016-2021) which provides a key step forward in river basin management. A land parcel identification system (Arkod) has been developed that will keep track of actual land use in agriculture. Good chemical status is achieved for > 90% of surface water bodies and > 80% of groundwater bodies.

Germany offers advisory and financial support for farmers (e.g. KULAP) for the implementation of adequate land-use measures to enhance the protection function in DWPZ. The country gives legally implemented financial compensations for burdens resulting from official requirements in DWPZ and support by state offices for concerned farmers and foresters. Such an approach works extremely positive on the involved population, raises the awareness and draws people. The development of supplying networks from different drinking water production areas to ensure a continuous water supply with clean drinking water and forming joint boards that ensure drinking water supply in remote areas is another success. Germany ensures minimum ecological flow through transition systems in vulnerable areas (e.g. transition system Danube River - Main River).

Hungary has a developed advisory system and support of EARDP for farmers to implementation agro-environmental measures. The country implements DWPZ for drinking water sources with limitations of spatial planning and activities in those areas as well as taking into consideration the protective function of aquifer protection layers in the planning process of DWPZ. Hungary has a well-established system for regulation of groundwater and surface water abstraction (water permits). A good organizational structure is indispensable for successful implementation.

Italy has improved the chemical status of the majority of its transition, surface and groundwater bodies that have been recognized as “good”. The chemical monitoring of groundwater is currently carried out with measuring campaigns characterized by continuous improvement and definition and financed by programs and Monitoring networks (surveillance and operational) to properly fulfil targets established by European Directives 2000/60/EC and 2006/118/EC. The first cycle was finished in 2015. The new regional law on urban planning that has not yet been approved is oriented towards zero rural land use and regeneration processes of urban areas that include environmental protection issues.

Poland has stated that they have finished harmonizing their national strategy for water management with the requirements set in EU Water Framework Directive and of the Groundwater Directive. The country is implementing the National Program of Municipal Sewage (extension of the sewerage network and municipal wastewater treatment plants), flood safety and measures defined in the Water Framework Directive (compliance with environmental objective, monitoring of surface water and groundwater).

Slovenia is establishing limitations of farming activities in DWPZ I with paying compensations for crop loss and educating farmers. They have used the recent flood events to increase the awareness of the public. The country is managing forests following the sustainable 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. They are implementing DWPZ for drinking water sources with limitations of spatial planning and activities in those areas.

4.2. Weaknesses

The majority of the states (sans Austria and Germany) have issues with monitoring, insufficient financing, water losses and quality, low wastewater purification and reusage, unstable governance and administrative structures, poor legislation implementation and most importantly, a lack of awareness and education for the importance of unpolluted water. The latter is quite concerning as it is the root of all bad management practices. The population should become informed on the fine workings of the water cycle and the interconnection between soil, vegetation i.e. agriculture and water bodies.

The issues that Austria is dealing with are different regulations between the federal states and no binding legislative rules for DWPZ in the Austrian Federal Forest Law. Slovenia and Hungary suffer from conflicts of interest in DWPZ areas. Italy and Poland have problems with the lack of public awareness of groundwater importance. Germany and Austria have erosion problems. Croatia is at the EU bottom in regards to waste management and low waste water treatment percentage (only 35% of the population is connected to the active wastewater treatment utilities). Germany, Hungary, Poland and Slovenia suffer from insufficient inspection, lack of resources for a stable model of water management and poor greening activities implementation. Due to intensive agriculture, Austria has increased values of nitrate and pesticides in the source water, while Slovenia is unsuccessfully implementing the Nitrate Directive.

Hungary and Slovenia have unstable public administrative and governance structures in the water sector that often fluctuate. Polish rural areas have no sewage system and the quality of the majority of surface water is bad. Croatian groundwater monitoring results are not completely reliable, as well as Hungarian water databases. Poland suffers from poor surface water quality, while Italian transition and ground waters are classified as being “not good”. Slovenia has trouble with pesticide usage which is not monitored. Poland uses its wastewater for agriculture, especially the potato industry. Hungary has issues with insufficient education and disinterest of the local population in some regions.

Croatia has only 47% of the population connected to the public sewage system, while water abstraction and distribution losses are alarmingly high (42%). Croatia suffers from groundwater pollution due to excessive nitrates and pesticides use that can be traced to inadequately constructed landfills (such as Jakuševac near Zagreb) as well.

Forest clear-cut operations, browsing damages due to increased stock of wild ungulates, ski-stations with their artificial snow facilities and mining activities cause problems in the Austrian DWPZ.

4.3. Opportunities

The countries share the plan to use EU funds in order to co-finance water projects, the need to improve the communication between the decision-makers and experts, to invest further in organic farming, to develop education and raise awareness amongst the local population, implement stricter laws in a variety of cases (ranging from pesticide application to EU directives), upgrade water management and flood risk management measures, ensuring minimum ecological flow in drought-endangered river basins and minimalizing water utility losses.

Austria has pointed out the importance of water efficiency programmes and proper water management according to the state-of-the-art methods, especially in dry and karstic areas, that are necessary in the future and include the improvement of the monitoring system. Integrative flood risk management is needed as well as an adaptive forest management for drinking water protection in DWPZ.

Croatia has developed an action plan for water protection against nitrate pollution from agricultural sources. In the Pannonian area (main agricultural area) groundwater quality monitoring will be aligned with the need to monitor the status of water in relation to nitrate pollution from the agriculture.

Germany is planning to extend the existing DWPZ considering the protective function of aquifer protective layers as far as possible. They are fostering the conversion of arable land to grassland and the conversion from forest monocultures to mixed forests. The country plans to increase the amount of decentralized rainwater infiltration and retention (unsealing, green roofs).

Hungary will use a combined approach in addressing droughts and floods with multiuse reservoirs. In order to enhance the water protection, they will construct the “greening” schemes and promote precision agriculture.

Italy will start with the realization of an interdisciplinary scientific project on valuation of groundwater resources and ecosystem services. They stated that the trends of industrial water abstractions in the last forty years show a progressive and continuous reduction. There is a need for the implementation of good practice for maintenance of biodiversity, landscape, soil protection and water resources (Recovery of local varieties with lower water consumption, Adaptation measures to climate change, Improving irrigation efficiency, Ensure compliance with Water Framework Directive).

Poland plans to finance national and regional scientific and applied interdisciplinary research on land-use activities in order to protect drinking (potable) water, promote economic water and energy management and implement the National Water-Environmental Programme.

Slovenia aims to improve the use of ecosystem services and eco farming with eco products.

4.4. Threats

The majority of the Project Partner countries recognized the climate change as a significant factor that might have adverse repercussions such as more frequent extreme flooding and drought events that will further interfere in land use (cultivation practices, crops growth, settlements, water resources management, flood protection infrastructure etc.). Also, the consequences of climate change still represent the relatively unknown fact that cannot be defined with certainty.

Furthermore, regarding the water resources quality and quantity, causes of adverse change of these characteristics are in many instances not fully identified or understood, especially in case of complex hydrogeological conditions that are predominant in karst terrains. Hence, the absence of adequate implementation of protection measures and monitoring, insufficient horizontal and vertical legislative and management strategies harmonization as well as the sectoral cooperation, can be declared as ongoing threats.

Lack of investments into sewage infrastructure, wastewater treatment facilities as well as the control and maintenance responsibility of local self-government units are major issues in some countries (Germany, Hungary, Slovenia, Croatia, Italy). Croatia states that due to the lack of sewage systems coastal agglomerations discharge large amounts of wastewater into sea, while damaged private sewers are issue in Germany.

Intensification of agricultural activities (crop cultivation, irrigation) and related application of fertilizers and pesticides may lead to degradation of soil quality and morphology (erosion, compaction), but also to the potential contamination of water resources. Germany, Croatia, Austria, Italy and Hungary pointed out these threats.

In addition, inadequate management of privately-owned forests and control difficulties of fire hazards are posing great threats towards forest ecosystems, consequently increasing the surface runoff that leads to severe floods, less groundwater recharge and water contamination. Austria, Croatia and Germany mentioned these issues.

Germany and Hungary illustrate the seriousness of grassland losses during the last decade and all the more present spreading of invasive species that contribute to the deterioration of ecosystem services.

Some of the countries pointed out specific land-use practices such as ski infrastructure maintenance (Austria); raw material extraction (Austria); industry (Croatia), intensive water abstraction causing saline intrusions (Croatia), inadequate waste disposal, insufficient remediation of contaminated sites (Germany) that are negatively affecting water resources.

One of the important factors of water management and protection is education and information of public on sustainable land-use practices. Authority failure in these positive management policies is a serious problem in Poland.

5. DPSIR analysis

For better development of water strategies which will contribute to sustainable management of water resources, the DSPIR methodology has been applied. The DPSIR method represents an analytical framework for determining the most important Driving forces, Pressures, States (ecosystem services), Impacts, Responses (measures) that involve analysing the pressures and impacts of human activity on the quality and quantity of water resources and flood/drought risks (Kristensen, 2004).

Table 6. Impact of land-use activities on water quality, *quantity and* floods/droughts - DPSIR approach for the present/past state

IMPACT OF LAND USE ON WATER RESOURCES QUALITY AND QUANTITY				
1. AGRICULTURE		Driving forces	**Use of fertilizers (especially nitrate consumption)**	
		Pressures	Diffuse nitrate loads (runoff and percolation)	
		State	Due to high nitrate concentrations in soils emissions of nitrous oxide is increasing	
			Values of nitrates exceed the thresholds in some areas (strengthened by less precipitation)	
		Impacts	Deterioration of groundwater quality	
			Negative effects through nitrous oxide emissions on climate protection	
		Responses	Evaluation and amendment of the Nitrate Action Plan every 4 years;	**KTM 2, 12**
			Optimisation of Nitrate Directive	
			Optimization of the application of fertilisers (according to time and amount due to soil samples);	
			Waiver of fertilisers, especially within sensitive areas.	
			Agri-environmental measures	
			Strengthening of consultancy and research programmes;	
			Acceleration of organic farming (5. Organic Action Programme, 2015);	
			Effectiveness of Common Agricultural Policy should be improved towards sustainability:	
			Shift of the water intake area to forested catchments (if possible)	
		Valid in	Austria, Croatia, Germany, Hungary, Italy, Slovenia	
		Driving forces	**Use of pesticides**	
		Pressures	Diffuse load of pesticides within intensive agricultural areas	
		State	Values of some pesticides (especially Triazine) exceed the thresholds within intensively used areas	
		Impacts	Water quality problems with surface waters	
		Responses	Erosion protection buffer zones	**KTM 12, 3**

	Acceleration of the Austrian Agro-Environmental Programme (ÖPUL)	
Valid in	Austria, Croatia, Hungary	
Driving forces	**Inappropriate livestock waste and manure management**	
Pressures	Diffuse contamination of pathogens and N into groundwater and soil through leaching	
State	Presence of excess pathogens and N in ground waters and soils	
Impacts	Impact on human health	
	Water unfit for drinking and irrigation	
Responses	Optimisation of Nitrate Directive	**KTM 2, 12**
	Support for investments in storage of manure and training of farmers	
Valid in	Croatia, Hungary, Italy	
Driving forces	**Water abstraction for irrigation purposes**	
Pressures	Decrease dilution of salts into groundwater	
	Decrease in water table height and land subsidence enhancing sea water intrusion into aquifers	
State	Increased of salinity and conductivity above drinking water standards	
Impacts	Over exploitation of water resources	
	Salinization of soils and desertification	
Responses	Investments for improving the state of irrigation infrastructures or techniques	**KTM 7, 8, 11**
	Water pricing policies	
	Water sources differentiation	
	Desalinization treatments	
Valid in	Croatia, Italy	
Driving forces	**Increase of livestock density**	
Pressures	Build-ups of excess nutrients and heavy metal in the soil	
State	Values of nutrients and heavy metals concentration above the drinking water standards	
Impacts	Impact on human health	
	Unfit for drinking and irrigation	
Responses	Optimisation of Nitrate Directive	**KTM 2, 12**
	Support for investments in storage of manure and training of farmers	

		Valid in	Italy	
		Driving forces	**Excessive or uncontrolled irrigation**	
		Pressures	Increased runoff of nutrients, pesticides and salts	
			Waterlogging in poorly drained soils enhances evaporation and salinization	
		State	Values of nutrients, pesticides and salinity above the drinking water standards	
		Impacts	Salinization of soils and desertification	
			Human health	
		Responses	Farming practice regulation	**KTM 8, 11, 12**
			Agri-environmental scheme	
			Creation of buffer/sink zones for nutrients	
			Water pricing policies	
		Valid in	Italy	
		Driving forces	**Open croplands between main crops**	
		Pressures	Nutrient leaching through mineralisation of harvest residues	
			Erosion and soil degradation processes	
		State	Growing trends of nitrate concentrations; solute transport to receiving waters	
		Impacts	Deterioration of water quality	
			Impact on human health	
			Surface water eutrophication	
		Responses	Implementation of catch crops	**KTM 2, 12, 14, 17**
		Valid in	Germany	
		Driving forces	**Conventional soil tillage**	
		Pressures	Nutrient leaching (runoff) and reduced humus content	
		State	Increased nutrient concentration in receiving waters (e.g. nitrate)	
			Reduced water purification	
		Impacts	Deterioration of water quality	
			Impact on human health	
			Surface water eutrophication	
		Responses	Fostering conservation tillage	**KTM 2, 12**

			Non-turning techniques	
		Valid in	Germany, Hungary	
		Driving forces	**Harvesting perpendicular to the slope**	
		Pressures	Preferential flow paths and erosion, increased solute transport to receiving waters	
		State	Increased nutrient and herbicide concentration in receiving waters; less purification	
		Impacts	Deterioration of surface and groundwater quality	
		Responses	Implementation of legal restriction	**KTM 2, 12, 17**
			Fostering harvesting parallel to the slope	
		Valid in	Germany	
		Driving forces	**Agricultural areas in floodplain**	
		Pressures	Diffuse pollution to surface waters	
		State	Eutrophic surface waters or not good chemical status	
		Impacts	Deterioration of surface waters quality	
		Responses	Land-use change	**KTM 2, 3**
			Organic farming	
			Riparian buffer strips	
		Valid in	Hungary	

IMPACT OF LAND USE ON WATER RESOURCES QUALITY AND QUANTITY				
2. URBAN AREAS		Driving forces	**Contaminated sites (“Altlasten”)**	
		Pressures	Punctual pollution of groundwater	
		State	Punctual high values of pollutant in groundwater	
		Impacts	Punctual deterioration of groundwater quality	
		Responses	Implementation of appropriate measures;	**KTM 4**
			Remediation of contaminated sites	
		Valid in	Austria, Poland	
		Driving forces	**Floods (along rivers & torrents)**	
		Pressures	Temporary increased turbidity values caused by heavy rainfall events	
		State	Floods are increasing and water quality can be influenced negatively	

		Impacts	Destruction of buildings and infrastructures	
			Erosion processes	
		Responses	Integrative flood risk management (monitoring of the risk management plan);	KTM 6, 7, 23
			Acceleration of natural water retention measures;	
			Best Practice implementation (avoidance of discharge – and erosion-increasing measures, adaptation of land-use in areas close to rivers/torrents, conservation and improvement of protection forests);	KTM 12, 13 15
			Strategy for flood events caused by heavy rainfall;	
			Provision and protection of flooding and retention areas;	
			Limitation and prohibition of building area zoning;	
			Mandatory consideration of hazard maps within spatial planning (area zoning);	
			Preference for non-structural measures;	
			Improvement of ecological functions of water bodies;	
			River basin or catchment-oriented planning of measures	
		Valid in	Austria	
		Driving forces	**Lack of sewage systems in some areas / Insufficient dimensioning of sewage systems**	
		Pressures	Potential contamination, discharge of contaminant compounds during floods	
		State	High pollutant compounds in the water bodies	
		Impacts	Lower quality of surface and groundwater	
		Responses	Investment and constructions efforts towards better sewage systems must continue	KTM 15, 16, 21
		Valid in	Croatia, Hungary, Germany, Italy, Slovenia	
		Driving forces	**Areas without waste water treatment facilities**	
		Pressures	Concentration of hazardous substances above allowed standards	
		State	Values of nutrients, pathogens and other contaminants above the maximum allowable concentration for drinkable water	
		Impacts	Deterioration of water quality	
		Responses	Effluent treatment needs to be increased	KTM 16, 21
			Construction of additional treatment facilities	
		Valid in	Croatia, Hungary, Italy, Poland, Slovenia	
		Driving forces	**Concrete and artificial surfaces**	
		Pressures	Discharge of surface pollutants (e.g. from traffic, construction sector)	
		State	Increased amount of pollutants contained in water	

		Impacts	Deterioration of water quality (both surface and ground water)	
		Responses	More efficient control of wastewater discharge	KTM 21
			Separate system for meteoric waters (infiltration into ground) and waste waters (discharged to WWTP)	
			Increase the amount of green surfaces and blue infrastructure in urban areas	
		Valid in	Croatia, Hungary, Germany, Italy, Poland, Slovenia	
		Driving forces	**Increase in population density**	
		Pressures	Increase in the volume of waste water and sewage to be treated	
		State	Alteration of phosphorous, nitrogen, dissolved oxygen, BOD, COD and pathogens concentration in treated waters	
		Impacts	Unfit for drinking and irrigation	
			Impacts on human health	
			Eutrophication	
		Responses	Optimization of urban waste water management systems	KTM 21
			Increase effluent treatment	
		Valid in	Italy	
		Driving forces	**Sewage overflows in case of extreme rainfall events**	
		Pressures	Diffuse pathogens and organic matter contamination	
		State	Presence of pathogens and into ground waters	
		Impacts	Impacts on human health (i.e. vector borne diseases)	
		Responses	Optimization of urban waste water management systems	KTM 21
			Improvement of urban drainage system	
		Valid in	Germany, Italy	
		Driving forces	**Intensity of tourism supply**	
		Pressures	Volume of sewage to be treated exceeding waste water systems capacity	
		State	Alteration of phosphorous, nitrogen, dissolved oxygen, BOD, COD and pathogens concentration in treated waters	
		Impacts	Unfit water for drinking and irrigation	
			Impacts on human health	
			Eutrophication	
		Responses	Optimization of urban waste water management systems	KTM 21
			Increase effluent treatment	
			Suistanable tourism	

		Valid in	Italy	
		Driving forces	**The potential effects of Climate Changes are not taken into account in action planning**	
		Pressures	New artefacts or updating of existing ones (e.g. drainage networks) could not address new needs	
		State	Few experiences at urban level for Municipal Adaptation Plans (e.g. Bologna, Ancona)	
		Impacts	Higher costs for induced hazards, for future updates	
		Responses	Providing incentives (economic or legal) to increase awareness and initiatives about the effect of climate changes	KTM 24
		Valid in	Hungary, Italy	
		Driving forces	**Lack of Emergency Municipal Plans for many towns in Central and Southern Italy**	
		Pressures	Procedures, roles and strategies are not specified for anthropic or natural induced disasters	
		State	Municipalities with approved Plan (39% in Campania, 54% in Calabria,49% in Sicily and 66% in Lazio) (source: National Civil Protection webpage, update October 2016)	
		Impacts	Higher risks for civil population in case of disaster	
		Responses	Providing incentives through legislation or economic support to draw up the plans	KTM 14
		Valid in	Italy	
		Driving forces	**High leakage of water supply systems**	
		Pressures	Overabstraction of water	
		State	Quantity status deterioration	
		Impacts	Ecological flow cannot be guarantied	
		Responses	Establishment of reconstruction programme and financing strategy	**KTM 8, 9**
		Valid in	Croatia, Hungary	
		Driving forces	**Heat pumps (water-water)**	
		Pressures	Emissions of warmer water into aquifer	
			Discharge into sewer	
			Not professional wells – possible direct pollution channels	
		State	Higher GW* temperatures	
			Lower GW* quantity	
			GW* pollution (mainly mineral oils)	
		Impacts	Deterioration of groundwater quantity and quality	
		Responses	Strict implementation of legislation (water return, wells in compliance with standards)	KTM 21
			Banning of heat pump system without permission	

Valid in	Slovenia		
Driving forces	**Cemeteries**		
Pressures	Application of pesticides to cemetery paths		
State	GW pollution with pesticides		
Impacts	Deterioration of groundwater quality		
Responses	Optimized use of pesticides	**KTM 21**
Valid in	Slovenia		
Driving forces	**Construction of big buildings or construction areas with underground facilities**		
Pressures	Deep construction pits		
State	Higher vulnerability due to diminishing the unsaturated zone thickness		
	GW pollution: heavy metals, oil spill		
Impacts	Deterioration of groundwater quality and locally also quality		
Responses	Measures for pollution prevention	**KTM 21**
Valid in	Slovenia		

* GW – groundwater

3. FOREST	Driving forces	**Clear Cut application**	
	Pressures	Humus decomposition, soil erosion, increased surface flow, further erosion processes	
	State	Decreasing water protection functionality of the involved forest sites	
	Impacts	Increased turbidity in the source water, increased matter concentration in the source water	
		Microbial contamination of the source waters, source waters are not able to be used for water supply	
	Responses	Avoidance of clear-cut applications	**KTM 13, 17**
		Application of continuous cover forest systems	
	Valid in	Austria (DW+FL), Croatia, Hungary	
	Driving forces	**Forest ecologically unbalanced (high) wild ungulate densities**	
	Pressures	Browsing damages on deciduous tree species and silver fir	
		Fraying damages in case of various tree species	
		Bark stripping damages in case of various tree species	
	State	Destabilisation of the forest ecosystems through lacking natural regeneration	
		Extinction of tree species	
		Decreasing water protection functionality of the involved forest ecosystems	

Impacts	Forest decline, growth of weed species instead of trees at forest sites, erosion processes, rock-fall, avalanches, increased flood damages, contamination of the source water through elevated turbidity, SAC, nitrate, DOC,	
Responses	Balancing the wild ungulate densities to a forest ecologically sustainable level	KTM 13, 17,22
	Increased hunting activities with the purpose of forest ecology	
	Resettlement of wild predators like wolves, lynx, etc.	
Valid in	Austria (DW+FL)	
Driving forces	**Extended application of the tractor skidder method in the course of timber yield**	
Pressures	Soil compaction on at least 20% of the forest sites; long lasting soil compaction	
State	Water protection functionality in terms of infiltration capacity and water storage capacity disappeared at minimum 20% of the forest site	
Impacts	Surface Flow in the course of heavy rainfall events; erosion processes like gully formation, soil erosion.	
	Increased danger of flood creation through increased surface flow	
	Contamination of the source water with various substances (clay, nitrate, DOC, increased turbidity, etc.)	
Responses	Avoidance of the tractor-skidder method	KTM 13, 17,22
	Application of alternatives	
Valid in	Austria (DW+FL)	
Driving forces	**Incorrect management (e.g. unregulated cut)**	
Pressures	Mobilisation of salts and sediments from subsoil	
State	Increase of salinity and total dissolved solids above drinking waters standards	
Impacts	Unfit water for drinking, irrigation and specific industrial uses	
Responses	Improved management	KTM 17
	Zonation of land to preserve habitat	
	Increased conservation areas	
Valid in	Italy	
Driving forces	**Forest fires**	
Pressures	Alteration of soil physical, biological and chemical characteristics	
State	Increased water repellency of soil and loose of soil structure	
Impacts	Post-fire increase of runoff and erosion processes that also transport soil contaminants then infiltrating into low slope areas	
Responses	Improved management, including preventive measures	KTM 17
	Fire fighting	

Valid in	Croatia, Italy	
Driving forces	**Harvesting with heavy machinery**	
Pressures	Soil compaction and deterioration of soil structure	
State	Decreased infiltration capacity and water recharge	
Impacts	Decreased water availability and provision for supplying purposes	
Responses	Implementation of a resource-friendly exploitation system	**KTM 13, 23**
Valid in	Germany, Hungary	
Driving forces	**Coniferous monocultures**	
Pressures	High water storage capacity of the trees and year-round interception; shallow root network	
State	Decreased groundwater recharge	
Impacts	Decreased water availability and provision for supplying purposes	
Responses	Fostering a conversion to mixed forests	**KTM 13, 23**
Valid in	Germany, Hungary	
Driving forces	**Removal of deadwood**	
Pressures	Reduced formation of humus	
State	Decreased water purification	
Impacts	Increased leaching of free nutrients and air pollutants	
Responses	Fostering an adequate deadwood management	**KTM 6**
Valid in	Hungary, Slovenia	
Driving forces	**Spreading of invasive species**	
Pressures	Plantation of alien species	
State	Less water protection capacity purification	
Impacts	Fewer ecosystem services	
Responses	Promotion of plantation of native species	**KTM 18**
Valid in	Hungary	
Driving forces	**Agro-forestry scheme**	
Pressures	Agricultural activity in the forest (e.g. grazing)	
State	Pollution from agricultural activities	
Impacts	Higher nutrient content of the waters	
Responses	Control on agricultural activities to keep extensive usage	**KTM 2, 3**
Valid in	Hungary	

4. PASTURES	Driving forces	**Livestock grazing close to dolines, swallow holes and streams**		
	Pressures	Entrance of faeces and faecal micro-organisms to the aquifer		
	State	Source waters contaminated with faecal micro-organisms		
	Impacts	Source water cannot be used for drinking water supply		
		Source water creates serious health damages among people		
		High costs for the treatment of the raw water		
	Responses	Prevent livestock from grazing close to dolines, swallow holes or streams	KTM 2	
		Construction of dams etc. what prevents precipitation water from direct and fast entrance into dolines and swallow holes		
	Valid in	Austria		
	Driving forces	**Intensive application of liquid manure to the grassland**		
	Pressures	Leaching of the liquid manure (nitrate and faecal micro-organisms) to the aquifer		
	State	Source waters contaminated with faecal micro-organisms, nitrate, etc.		
	Impacts	Source water cannot be used for drinking water supply; or source water creates serious health damages among people; or high costs for the treatment of the raw water		
	Responses	Limitation of the application of liquid manure: prohibition or reduction in quantity and limitation to days when plants can provide a high nitrate uptake rate	KTM 2	
	Valid in	Austria		
	Driving forces	**Plowing up of grassland**		
	Pressures	Deterioration of soil structure and vertical connectivity		
	State	Decreased water retention		
	Impacts	Enhanced overland flow contribution to direct runoff		
	Responses	Implementation of measures for advisory and financial support to avoid conversion of grassland	KTM 23	
	Valid in	Germany, Hungary		
	Driving forces	**Intensive use of heavy machinery on grasslands**		
	Pressures	Soil compaction and deterioration of the turf and the vertical connectivity		
	State	Decreased water retention due to decreased infiltration capacity		
	Impacts	Enhanced overland flow contribution to direct runoff		
	Responses	Extensification of land-use activities on grasslands	KTM 23	
	Valid in	Germany		

		Driving forces	**Intensive grazing activities**	
		Pressures	Soil compaction and deterioration of the turf and the vertical connectivity	
		State	Decreased groundwater recharge	
		Impacts	Decreased water availability and provision for supplying purposes	
		Responses	Implementation of adapted grazing strategies	**KTM 23**
		Valid in	Germany, Hungary	
		Driving forces	**Intensive manuring of grasslands**	
		Pressures	Diffuse N contribution	
		State	Values of nitrates and pathogens above legally permitted limit values in some areas	
		Impacts	Deterioration of groundwater or surface water quality	
		Responses	Control on manure management Prohibition in DWPZs	**KTM 2**
		Valid in	Hungary	

5. STONE QUARRIES / GRAVEL PITS		Driving forces	**Active stone quarries / gravel pits situated within DWPZ**	
		Pressures	Potential contamination of the aquifer through chemicals and mineral oil products	
		State	Total loss of Ecosystem Services (ES) within the area of stone quarries / gravel pits	
		Impacts	Source waters, which cannot be used for drinking water supply Increased surface runoff in the DWPZ causing increased flood intensities and erosion in case of heavy rainfall events	
		Responses	Abandonment respectively avoidance of active stone quarries /gravel pits within DWPZ	**KTM 13, 17**
			Rock-faces have to be kept in original slope for preventing the extension of the stone quarry area through the abandonment process	
		Valid in	Austria (DW+FL**)	

** DW+FL – Driving Forces with impacts on drinking water protection and flood prevention

6. TOURISM		Driving forces	**Alpine shelter huts without sewage systems**
		Pressures	Sewage waters entering the aquifer
		State	Contamination of the source water with bacteria, chemicals and other matter stemming

			from the sewage waters	
			ES water provision is destroyed	
		Impacts	Source waters have to be discharged to the streams or simply cannot be used for drinking water supply; Or: High treatment costs for the contaminated waters	
		Responses	Equipping alpine shelter huts with sewage systems	KTM 1, 21
			Adequate technical solution adapted to the site-specific situation of each hut.	
		Valid in	Austria	
		Driving forces	**Ski station with artificial snow-making (ASM) in DWPZ**	
		Pressures	High water consumption for ASM Construction of reservoir-lakes in areas which are sensitive in terms of conservation Snow-groomers with poor maintenance status cause mineral oil spills Restaurants and huts without sewage systems	
		State	Potentially: water shortage in parts of the DWPZ; problems with nature conservation targets of EU	
			Entrance of mineral oil into the aquifer; entrance of sewage water into the aquifer	
		Impacts	Conflicts with nature conservation on both governmental and non-governmental level	
			Source waters have to be discharged to the streams or simply cannot be used for drinking water supply; Or: High treatment costs for the contaminated waters	
		Responses	Adaptation of ASM to the general water availability of the region	KTM 1, 13, 21
			No construction of reservoir lakes in areas which are sensitive in terms of nature conservation	
			Strict maintenance guidelines for snow groomers and other technical devices; Sewage systems for restaurants and huts	
			Abandonment of ski stations or parts of ski stations situated within an important DWPZ, if possible	
		Valid in	Austria	

7. INDUSTRIAL AREAS		Driving forces	**Lack of industrial effluents treatments systems** **Accidental/catastrophic discharge**
		Pressures	Direct discharge of industrial waste waters into surface bodies
		State	Values of nutrients, metals, salts and priority contaminates too high for drinkable water
		Impacts	Unfit for drinking and irrigation Water and soil contamination

		Responses	Implementation of appropriate sewage system and devices for wastewater treatment	**KTM 15, 21**
			Optimization of waste management systems and storage	
		Valid in	Italy	
		Driving forces	**Industrial waste waters**	
		Pressures	Emissions of pollutants to ground and surface waters	
		State	Pollutants in ground and surface waters (e.g. heavy metals, organic pollutants)	
		Impacts	Deterioration of ground and surface water quality, impact on human health	
		Responses	Implementation of appropriate measures	**KTM 1, 21**
			Better monitoring	
		Valid in	Croatia, Slovenia	
		Driving forces	**Old industrial locations**	
		Pressures	Soils contaminated with industrial sector-specific pollutants	
		State	Contamination of groundwater	
		Impacts	Deterioration of groundwater quality, impact on human health	
		Responses	More stringent persecution of contaminated site remediation	**KTM 4**
		Valid in	Croatia, Slovenia	

8. TRANSPORT		Driving forces	**Road and parking cleaning and maintenance**	
		Pressures	Diffuse salts and metals contribution trough runoff and percolation	
		State	Values of metals, salts and priority contaminates concentration for drinkable water	
		Impacts	Unfit for drinking and irrigation Water and soil contamination	
		Responses	Implementation of appropriate sewage system and devices	**KTM 21**
		Valid in	Italy	
		Valid in	Austria	
		Driving forces	**Road accidental spills**	
		Pressures	Diffuse salts and metals contribution trough runoff and percolation	
		Pressures	Emission of fuel, oil and other dangerous substances	
		State	Contaminated soil, possible infiltration of fuel, oil or other dangerous substances into groundwater	

		Impacts	Deterioration of soil and water quality	
		Responses	Effective action plan in case of spills, low reaction time and fast intervention	**KTM 21**
		Valid in	Croatia, Slovenia	
		Driving forces	**Road traffic**	
		Pressures	Waste waters from roads and highways	
		State	Heavy metal pollution in soils, ground and surface waters	
		Impacts	Deterioration of water quality Impact on human health	
		Responses	Strict implementation of decree on the emission of substances in the discharge of meteoric water from public roads (OG RS 47/2005)	**KTM 21**
			Implementation of National environment protection strategy and action plan (NN 46/02)	
		Valid in	Croatia, Slovenia	
		Driving forces	**Sealed surfaces**	
		Pressures	Decreased infiltration capacity	
		State	Decreased water retention	
		Impacts	Deterioration of non-structural flood protection	
		Responses	Implementation of extensive seepage measures with overgrown topsoils	**KTM 23, 24**
		Valid in	Germany	

*** IA – industrial areas

IMPACT OF LAND USE ON FLOODS AND DROUGHTS				
1. AGRICULTURE		Driving forces	**Land-use change**	
		Pressures	Reduction of green areas and increase bare soil areas	
		State	Increase of evaporation Reduction of infiltration and evapotranspiration	
		Impacts	More drought event during summer time	
			More flood events during winter time	
		Responses	Construction of modern water supply system	
			Construction of the dike system and protection system	**KTM 4, 6**
			Prevention of land-use change	

	Valid in	Croatia, Italy	
	Driving forces	**Cultivation intensity**	
	Pressures	Increase of water consumption/water demand	
	State	Decrease water availability	
	Impacts	More droughts for the downstream of river networks	
	Responses	Implementation of new irrigation methods (artificial irrigation instead of gravity irrigation)	**KTM 6**
		Sustainable soil working (ploughing) to maintain hydraulic properties.	
	Valid in	Italy	
	Driving forces	**Insufficient dimensioning of defensive embankments in rural areas**	
	Pressures	Bank collapse/breach during floods	
	State	High risk during high waters which are more common due to climate changes	
	Impacts	Increased flood risk, decreased population safety, high impact on crops and cultures	
	Responses	Further investments into flood protection infrastructure	**KTM 23, 24**
	Valid in	Croatia	
	Driving forces	**Open croplands between main crops**	
	Pressures	Surface sealing through aggregate destabilization and particle transport	
	State	Decreased infiltration capacity and water retention	
	Impacts	Enhanced overland flow contribution to direct runoff	
	Responses	Implementation of catch crops	**KTM 23, 24**
	Valid in	Germany	
	Driving forces	**Conventional soil tillage**	
	Pressures	Soil compaction	
	State	Decreased infiltration capacity and water retention	
	Impacts	Enhanced overland flow contribution to direct runoff	
	Responses	Fostering conservation tillage, non-turning techniques	**KTM 23, 24**
	Valid in	Croatia, Germany, Hungary	
	Driving forces	**Harvesting perpendicular to the slope**	
	Pressures	Preferential flow paths and erosion, increased overland flow	
	State	Decreased water retention on the field	

	Impacts	Enhanced overland flow contribution to direct runoff and sealing of structural measures (e.g. sewer systems)	
	Responses	Implementation of legal restrictions fostering harvesting parallel to the slope	**KTM 23**
	Valid in	Germany	
	Driving forces	**Understanding of role of drainage in agriculture**	
	Pressures	Reduced maintenance of agricultural drainage systems	
	State	Clogged and inefficient Reduced retention capacity of agricultural land	
	Impacts	Increased runoff and related flooding	
	Responses	Improved practice of agricultural drainage	**KTM 12, 23**
	Valid in	Hungary, Slovenia	
	Driving forces	**Drainage of agricultural areas (especially excess water inundated areas)**	
	Pressures	Diffuse pollution to surface waters Indirect discharge from groundwater	
	State	Eutrophic surface waters or not good chemical status of surface water Deterioration of groundwater quantity	
	Impacts	Deterioration of surface waters quality Groundwater level decrease	
	Responses	Greening of frequently inundated areas (land-use change to grassland, wetland, agro-forestry)	
		Natural water retention measure	**KTM 23**
	Valid in	Hungary	
	Driving forces	**Water waster irrigation systems (existing)**	
	Pressures	Overabstraction	
	State	Quantity status deterioration	
	Impacts	Ecological flow cannot be guaranteed	
	Responses	Technical development for water saving	
		Metering and controlling	**KTM 8**
	Valid in	Hungary	
	Driving forces	**Development of irrigation**	
	Pressures	Increasing water abstraction	
	State	Quantity status deterioration	
	Impacts	Ecological flow cannot be guarantied	

	Responses	Control on development to ensure water savings and metering	**KTM 8**
	Valid in	Hungary	
	Driving forces	**Climate change**	
	Pressures	Prolonged drought	
	State	Quantity status deterioration	
	Impacts	Ecological flow cannot be guarantied	
	Responses	Drought mitigation measures	**KTM 7**
	Valid in	Hungary	
	Driving forces	**Poor supervision of hydraulic structures**	
	Pressures	Inadequate agricultural practice in the vicinity of dykes	
	State	Decreased dyke stability	
	Impacts	Reduced flood safety	
	Responses	Improved supervision and response to inadequate practice	**KTM 26**
	Valid in	Slovenia	
	Driving forces	**Orchards, vineyards perpendicular to flood flow direction Increased hydraulic resistance (roughness)**	
	Pressures	Increased hydraulic resistance (roughness)	
	State	Increased flood levels	
	Impacts	Flooding	
	Responses	Improved agricultural practice	**KTM 12**
	Valid in	Slovenia	
2. FOREST	Driving forces	**Incorrect forest management (e.g. unregulated cut, no wood harvest)**	
	Pressures	Presence of woody debris on hillslopes	
	State	Increase of sediment/debris loads on flowing water	
	Impacts	Floods due to debris/sediment creating barriers within channels	
	Responses	Improved forest management, avoidance of clear-cut applications	**KTM 13, 17**
	Valid in	Croatia, Germany, Hungary, Italy, Austria	
	Driving forces	**Forest fires**	
	Pressures	Alteration of soil physical, biological and chemical characteristics	
	State	Water repellency of soil and loose of soil structure	
	Impacts	Increased runoff and erosion processed that favour overland transport and deposition of sediments within hillslope channels and increase flood risk	

Responses	Improved forest management Fire fighting		**KTM 17**
Valid in	Croatia, Italy		
Driving forces	**Extreme meteorological events in forests (sleed, strong winds)**		
Pressures	Destruction of large wood areas near water courses		
State	Trees falling in the watercourses with clogging potential		
Impacts	Increased flood levels and potential for debris flow development		
Responses	Adequate forest practice and active response in the case of large scale events		**KTM 8, 17, 23**
Valid in	Croatia, Slovenia		
Driving forces	**Harvesting with heavy machinery**		
Pressures	Soil compaction and deterioration of soil structure		
State	Decreased infiltration capacity and water retention		
Impacts	Enhanced overland flow contribution to direct runoff		
Responses	Implementation of a resource-friendly exploitation system		**KTM 23**
Valid in	Germany		
Driving forces	**Removal of deadwood**		
Pressures	Reduced formation of humus and alteration of the surface structure		
State	Decreased water retention		
Impacts	Enhanced probability of overland flow contributions to direct runoff		
Responses	Fostering an adequate deadwood management		**KTM 23**
Valid in	Germany, Hungary		
Driving forces	**Missing understorey vegetation**		
Pressures	One single storey crown		
State	Less water retention due to less interception losses		
Impacts	Enhanced probability of surface runoff		
Responses	Implementation of adequate measure, e.g. natural regeneration		**KTM 23, 24**
Valid in	Germany		
Driving forces	**Increased surfaces under forests**		
Pressures	Impact on droughts – with increased water use by the forests		
State	Reduced discharges in dry periods		
Impacts	Competitive use of water with other sectors		

	Responses	Target de-forestation	**KTM 30**
	Valid in	Slovenia	
	Driving forces	**Forestry activities (harvesting, road construction, road drainage, towing)**	
	Pressures	Constructions in the forest areas increasing runoff and erosion process	
	State	Increased release of sediments increased drainage along the infrastructure (roads)	
	Impacts	Erosion process in the forests and sediment deposition downstream	
	Responses	Adopted standards for the road construction and harvesting in the forests for reduced erosion processes, implemented measures (i.e. check dams)	**KTM 29**
	Valid in	Slovenia, Austria	
	Driving forces	**Forest ecologically unbalanced (high) wild ungulate densities**	
	Pressures	Browsing damages on deciduous tree species and silver fir	
		Fraying damages in case of various tree species	
		Bark stripping damages in case of various tree species	
	State	Destabilisation of the forest ecosystems through lacking natural regeneration	
		Extinction of tree species	
		Decreasing water protection functionality of the involved forest ecosystems	
	Impacts	Forest decline, growth of weed species instead of trees at forest sites, erosion processes, rock-fall, avalanches, increased flood damages, contamination of the source water through elevated turbidity, SAC, nitrate, DOC,	
	Responses	Balancing the wild ungulate densities to a forest ecologically sustainable level	**KTM 13, 17,22**
		Increased hunting activities with the purpose of forest ecology	
		Resettlement of wild predators like wolves, lynx, etc.	
	Valid in	Austria (DW+FL)	
3. URBAN AREAS	Driving forces	**Insufficient dimensioning of sewer systems**	
	Pressures	Limited drainage capacity	
	State	Decreased water retention	
	Impacts	Increased flood risk	
	Responses	Investment efforts and constructions of additional sewage systems	**KTM 1, 16**
	Valid in	Croatia, Germany (+IA), Hungary	
	Driving forces	**Urban development in flood prone areas**	
	Pressures	Increased discharge and runoff	
	State	Decreased retention	
	Impacts	Increased flood risk, decreased population safety	

Responses	Investment efforts and constructions of additional sewage systems and development of improved retention capacity	KTM 6, 7, 23, 24
Valid in	Croatia, Hungary, Slovenia	
Driving forces	**Inefficiency of river banks**	
Pressures	Bank collapse/breach during flood events	
State	Many river banks have inadequate strength/capacity and their quality has been deteriorated by human action (e.g. theft of bank material - sand or gravel)	
Impacts	Increased flood risk, decreased population safety	
Responses	Investments into construction of proper banks, better monitoring, better preparation for flood events	KTM 6, 7, 23, 24
Valid in	Croatia	
Driving forces	**Closed karst field in mountain areas**	
Pressures	Increased rainfall/snowfall in mountain areas (e.g. Velebit and Jadranska magistrala)	
State	Reduction of infiltration and evapotranspiration	
Impacts	High threat and flood risk in case of high rainfall/snowfall, inadequate flood protection structures do not exist in many areas	
Responses	Proper drainage of karst terrains has to be devised (e.g. hydrotechnical melioration)	KTM 6, 7, 23, 24
Valid in	Croatia	
Driving forces	**Sealed surfaces**	
Pressures	Decreased infiltration capacity	
State	Decreased water retention	
Impacts	Deterioration of non-structural flood protection	
Responses	Implementation of retention measures, e.g. desealing, green roofs or sewerage storages	KTM 23, 24
Valid in	Germany (+IA), Hungary	
Driving forces	**Centralized rainwater infiltration**	
Pressures	Increased discharge in sewer systems	
State	Decreased water retention	
Impacts	Deterioration of non-structural flood protection	
Responses	Implementation of decentralized infiltration measures, e.g. desealing, green roofs or sewerage storages	KTM 23, 24
Valid in	Germany (+IA)	
Driving forces	**River channelization**	
Pressures	Increased flow velocity and limited space	
State	Decreased river retention capacity	
Impacts	Increased risk of flood damages during channel overflow	

		Responses	Fostering river restoration	**KTM 6, 23, 24**
		Valid in	Germany (+IA), Hungary	
		Driving forces	**Austerity measures**	
		Pressures	Reduction of maintenance of hydraulic structures	
		State	Increased vegetation of streams and deterioration of hydraulic structures	
		Impacts	Reduced conveyance of watercourses	
		Responses	Increased financing of measures	**KTM 28**
		Valid in	Slovenia	
		Driving forces	**Competing activities in the field of water use**	
		Pressures	Water for electricity production more important than flood management	
		State	Flooding due to electricity production focused water management	
		Impacts	Artificial flooding (operation of power-plants)	
		Responses	Development of protocols with adequate priority	**KTM 27**
		Valid in	Slovenia	
		Driving forces	**Utilization of space**	
		Pressures	Poor management practice in the field of interventions that have impact on water retention and conveyance	
		State	Local impoundment, watercourses crossing with different infrastructure, heavily urbanized watercourses	
		Impacts	Local flooding	
		Responses	Legal framework and its implementation regarding the watercourses in urban environment	**KTM 27**
		Valid in	Slovenia	
		Driving forces	**Urbanization and related Urban drainage requirements**	
		Pressures	Urban drainage collection systems	
		State	Urban flooding due to intensive precipitation and inadequate urban drainage (stochastic development), poor legislation.	
		Impacts	Urban flooding	
		Responses	Adaptation of the DWA-A-138E type of standard on national level	**KTM 26**
		Valid in	Slovenia	
		Driving forces	**Urbanization in mountain regions**	
		Pressures	Construction on erosion prone zones (erosion, deposition)	
		State	Erosion control works in the mountains not meeting the requirements regarding the erosion processes downstream	
		Impacts	Erosion processes activated (bedload, suspended load) deposition and related flooding	

		Responses	Restoration of old erosion control practices and development of new practices (including erosion transport process monitoring)	**KTM 17, 27**
		Valid in	Slovenia	
		Driving forces	**Urbanization on karstic polje**	
		Pressures	Construction on flood prone zones	
		State	Urban developments on karstic polje	
		Impacts	Flooding	
		Responses	Re-allocation plans, strict implementation of rules regarding the construction on polje	**KTM 27**
		Valid in	Slovenia	
		Driving forces	**Low interinstitutional cooperation**	
		Pressures	Diverging views on water and flood management	
		State	Conflicts in management of watercourses	
		Impacts	Flooding due to increased vegetation of watercourses	
		Responses	Improved interinstitutional cooperation	**KTM 27**
		Valid in	Slovenia	
4. INDUSTRIAL AREAS		Driving forces	**Expansion of industrial areas**	
		Pressures	Reduction of green areas and increase of obstacles	
		State	Reduction of infiltration and drainage ability of flows	
		Impacts	Increase flood events, retention times and inundation deep	
		Responses	Construction of pumping stations which will operate during flood events	**KTM 6, 7, 23**
		Valid in	Hungary, Italy, Slovenia	
		Driving forces	**Water consumption**	
		Pressures	Increase water demand for industrial sector	
		State	Reduction of water availability on the surface freshwater	
		Impacts	Water deficit and droughts for downstream of river networks	
		Responses	Differentiate water supply sources (i.e. freshwater/groundwater)	**KTM 13**
		Valid in	Italy	
		Driving forces	**Existing industrial areas in flood prone zones**	
		Pressures	Investments/ measures in the protection of existing industrial facilities	
		State	Industrial facilities exposed to flooding	
		Impacts	Inducing reduction of flood retention volumes without compensation	
		Responses	Self-protection for industrial areas	**KTM 23**
		Valid in	Hungary, Slovenia	

	Driving forces	**Development of new industrial areas adjacent to watercourses**	
	Pressures	Usually cheaper land in flood prone areas, interesting for land developers	
	State	Construction of industrial areas in the flood hazard zones, with landfilling process	
	Impacts	Reduced retention volumes and induced flooding downstream	
	Responses	Protection of existing flood prone areas and development of industrial facilities elsewhere (also target brownfields investments)	**KTM 23, 27**
	Valid in	Slovenia	
5. RECREATIONAL SECTOR	Driving forces	**Growth of recreational sites**	
	Pressures	Increase of artificial areas, thus, reduction of green area	
	State	Reduction of infiltration and drainage ability of flows	
	Impacts	Increase of floods events	
	Responses	Limit growth rate by limit the number of license	**KTM 9, 13**
	Valid in	Italy	
	Driving forces	**Demand of recreational sites**	
	Pressures	Increased water demand	
	State	Reduction of water availability	
	Impacts	Increase water shortage and droughts	
	Responses	Limit water demand by taxes or apply Coase theorem by producing "water rights"	**KTM 9, 13**
	Valid in	Italy	
6. ANTHROPOGENIC	Driving forces	**Emit GHGs**	
	Pressures	Increase of GHGs in the atmosphere, thus, increase temperature	
	State	Snows melt more during winter time; increase of evaporation during summer time	
	Impacts	Increase of floods during winter time; increase of droughts during summer time	
	Responses	Limit CO2 emission by national strategy and international volunteer agreement (COP 21)	**KTM 24**
	Valid in	Italy	
7. TRANSPORT UNITS	Driving forces	**Development of transport infrastructure**	
	Pressures	Sealed surfaces relate to transport infrastructure	
	State	Developed transport infrastructure without retention measures	
	Impacts	Increasing runoff	
	Responses	Development of retention capacity	**KTM 13, 15, 21**
	Valid in	Croatia, Slovenia	
	Driving forces	**Sealed surfaces**	

	Pressures	Decreased infiltration capacity		
	State	Decreased water retention		
	Impacts	Deterioration of non-structural flood protection		
	Responses	Implementation of extensive seepage measures with overgrown topsoils	**KTM 23, 24**	
	Valid in	Germany		
	Driving forces	**Transport infrastructure crossing watercourse (bridges, culverts)**		
	Pressures	Reduced hydraulic conveyance		
	State	Some bridges and culverts conveyance capacity is not meeting the requirements. Also issue of clogging (debris, sediments)		
	Impacts	Local flooding		
	Responses	Rebuilding the conveyance capacity of the transport – watercourse crossing	**KTM 31**	
	Valid in	Slovenia		
	Driving forces	**Cabled/piped transport infrastructure under bridges**		
	Pressures	Improving economy of the cabled/piped infrastructure (cheaper construction)		
	State	Cables and pipes under bridges limiting their designed hydraulic conveyance		
	Impacts	Local flooding		
	Responses	Strict design standards. Supervision of bridges and culverts regarding their actual status	**KTM 31**	
	Valid in	Slovenia		
8. ENERGY PRODUCTION	Driving forces	**Maximizing the benefits of the hydropower production**		
	Pressures	Operational procedures of hydropower systems aimed at power production with limited focus on flood retention mechanisms		
	State	Power production focused management		
	Impacts	Flooding		
	Responses	Development of agreed operational protocols increasing retention potential (where feasible)	**KTM 23, 26, 27**	
	Valid in	Croatia, Slovenia		
	Driving forces	**Hydropower production**		
	Pressures	Reduction of the sediment transport (suspended and bedload) in reservoirs		
	State	Reduced amount of sediments in watercourses downstream Sediment accumulation in reservoirs reducing their capacity		
	Impacts	Erosion processes in watercourses down streams lacking the sediments		
	Responses	Adequate monitoring, Erosion control works downstream	**KTM 17**	
	Valid in	Croatia, Slovenia		

9. PASTURES		Driving forces	**Intensive use of heavy machinery on grasslands**	
		Pressures	Soil compaction and deterioration of the turf and the vertical connectivity	
		State	Decreased water retention due to decreased infiltration capacity	
		Impacts	Enhanced overland flow contribution to direct runoff	
		Responses	Extensification of land-use activities on grasslands	**KTM 23**
		Valid in	Germany	
		Driving forces	**Intensive grazing activities**	
		Pressures	Soil compaction and deterioration of the turf and the vertical connectivity	
		State	Decreased water retention due to decreased infiltration capacity	
		Impacts	Enhanced overland flow contribution to direct runoff	
		Responses	Implementation of adapted grazing strategies	**KTM 23**
		Valid in	Germany	
		Driving forces	**Plowing up of grassland**	
		Pressures	Deterioration of soil structure and vertical connectivity	
		State	Decreased water retention	
		Impacts	Enhanced overland flow contribution to direct runoff	
		Responses	Implementation of measures for advisory and financial support to avoid conversion of grassland	**KTM 23**
		Valid in	Germany	
		Driving forces	**Pastures**	
		Pressures	Pasture on steep hillsides causing erosion with the runoff process	
		State	Erosion due to the pasture activities	
		Impacts	Erosion damage and deposition of the eroded material downstream	
		Responses	Good agricultural practice (reduced pasture on specific areas, especially cattle), development of check dams, sediment traps.	**KTM 29**
		Valid in	Slovenia	

Table 7. Impact of floods/droughts on water quality and *quantity* - DPSIR approach for the present/past state

IMPACT OF DROUGHTS ON WATER RESOURCES QUANTITY AND QUALITY			
DROUGHTS		Driving forces	**Over-abstraction during low hydrological conditions**
		Pressures	Reduction of groundwater availability; increased risk of saltwater intrusions in coastal aquifers; increased tourism and agricultural water demand
		State	Saltwater intrusions into groundwater aquifers
			Karst springs drying up
		Impacts	Water shortage, cessation of GW abstraction, water not available for irrigation in agriculture
		Responses	Quantitative GW monitoring
			Adjustments of abstraction
		Valid in	Croatia
		Driving forces	**Drought during low hydrological conditions**
		Pressures	Reduction of quality of drinking water; water unfit for human consumption
		State	Saltwater intrusions into groundwater aquifers
		Impacts	Water shortage; cessation of GW abstraction; aquifer pollution
		Responses	Climate change modelling and adaptation scenarios
		Valid in	Croatia
		Driving forces	**Low water discharge**
		Pressures	Changing surface water – groundwater interaction
			Changing mixing processes between hydrological systems
		State	Decreased water recharge
			Decreased amelioration of water quality through mixing
		Impacts	Decreased water quantity, especially bank filtration sites
			Deterioration of water quality
		Responses	Implementation of low flow management measures
		Valid in	Germany - Bavaria
		Driving forces	**No (or low) precipitation during main recharge periods**
		Pressures	Increased pressure on available water resources

			Increasing concentrations of (anthropogenic) pollutants in e.g. soils
		State	Decreased groundwater recharge
			Decreased water purification
		Impacts	Decreased water quantity, e.g. for water supply and irrigation
			Increasing pollutants in soil systems which may be flushed after new rainfall event
		Responses	Implementation of emergency supply measures
			Implementation of adapted (land) management actions
		Valid in	Germany - Bavaria
		Driving forces	**Drying out of irrigation ditches**
		Pressures	Increased pressure on available water resources (e.g. groundwater)
		State	Increased pressure on available water resources (e.g. groundwater)
		Impacts	Decreased water quantity for irrigation purposes
		Responses	Implementation of emergency supply measures
		Valid in	Germany - Bavaria
		Driving forces	**Climate change (impact on water quantity)**
		Pressures	Rising temperatures, increasing number of hot days
			Changing seasonal distribution of precipitation, increasing probability intensity, frequency, durarion, extent and severity of climatic extremities such as drought
			Decreased available water resources
			Prolongated drought
			Reduction of surface water resources, increasing demand for groundwater resources
		State	Degraded ecosystems
		Impacts	Increased evapotranspiration
			Significant drought damage
			Aridification
			Increasing trend of droughts
			Prolongated drought or water scarcity
			Significant drought damage
		Responses	Greening buffer strip to overshadow waters and break wind
			Different types and methods of water storage (reservoirs, natural water retention, water retention in canals, oxbows etc.).
			Monitoring development: drought monitoring based on meteorological parameters and soil water content.

			Irrigation canals development to irrigate more areas and prevent drought damage
			Improvement of governance: database development on water resources and water uses
			Improvement water resource management – implementation of more effective allocation mechanisms
			More appropriate legislation and effective authorisation
			Restrictions in water uses
		Valid in	Hungary
		Driving forces	**Unequal spatial and temporal distribution of natural water resources**
		Pressures	Dry areas
		State	Drought-tolerant vegetation
		Impacts	Poverty, backward areas
		Responses	Water transfers to areas suffering from water shortage
		Valid in	Hungary
		Driving forces	**Agriculture**
		Pressures	Agricultural structure is not in line with natural conditions
			Intensification of production yield
		State	Degraded ecosystems
			Increasing trend of droughts
		Impacts	Landscape degradation
			Increasing agricultural water demand
		Responses	Water transfers to areas suffering from water shortage
			Landscape management measures: finacial incentives to promote land use change
		Valid in	Hungary
		Driving forces	**Governance**
		Pressures	Lack of experts, equipment, monitoring etc. due to underfunding of water institutional system
			Lack of financial incentives
			Lack of integrated water policy and planning
			Institutional problems dealing with water quality and quantity issues
			Environmental, economic and social objectives are not in accordance
		State	Degraded ecosystems

			Periodic regional and local water shortages
			Status of waters do not meet expectations of the society, economy and ecosystems
		Impacts	Overexploitation
		Responses	Strenghten water authorities and responsible organisations
			Facilitate and promote stakeholder engagement in the decisionmaking process and controll of allocations
			Establishement of appropriate economic regulatory instruments: water supply fee, water resource fee etc.
			Strategic planning
			Capacity building of stakeholders
			Transboundary cooperation, knowledge transfer
		Valid in	Hungary
		Driving forces	**River regulation**
		Pressures	Riverbed incision
		State	Degraded ecosystems along rivers
		Impacts	Water level lowering
		Responses	Pumping of water where gravitational water supply is not possible
		Valid in	Hungary
		Driving forces	**Human activity**
		Pressures	Illegal water exploitation and water uses
		State	Degraded ecosystems
		Impacts	Unknown exploitation
		Responses	Improvement of governance: adequate control measures
		Valid in	Hungary
		Driving forces	**Climate change (impact on water quality)**
		Pressures	Rising temperatures, increasing number of hot days
			Changing seasonal distribution of precipitation, increasing probability intensity, frequency, durarion, extent and severity of climatic extremities such as drought
			Decreased available water resources
			Prolongated drought
		State	Changing ecosystems
			Water quality degradation
		Impacts	Accelerated eutrophisation
			More concentrated pollutants

			Water unsuitable for use
		Responses	Water quality monitoring and database development
			Water transfer to dilute pollution
			Emission reduction
			Changing allocation mechanism
		Valid in	Hungary

IMPACT OF FLOODS ON WATER RESOURCES QUALITY AND QUANTITY			
FLOODS		Driving forces	**Higher flood risk, endangered population/industry and agriculture**
		Pressures	Increasing of flood peak water level (same discharge flows higher water level)/Increasing of sediment in the riverbed and floodplain
		State	High dense of vegetation (cause run-off barriers)
			The riverbed and the flood plains are silted up (too much sediment)/The riverbed and floodplains capacities are low/Floodplains are narrow (need wider floodplain to provide more space for the floods)/The dykes are low, the recounted designed flood water level is higher than the dyke crest level.
		Impacts	Invasive plants appeared in the floodplain, which reduce the flood capacity.
			The flood peak levels are higher than before, sometimes higher than the dyke crest level, the dangerous flood phenomenon are more frequent.
		Responses	Changing land use in floodplains
			Conversion and maintenance of vegetation
			Dredging of riverbed
			Dyke strengthening, and heightening
			Dyke relocation
			Demolition and changing of run-off barriers, removing of summer dykes in the floodplains
			River meandering
			Making natural wet habitat with flood function
			Making free zones in the floodplain
			Flood peak reduction with flood emergency storages
		Valid in	Hungary
		Driving forces	**Flash floods**
		Pressures	Surface sealing, decreased infiltration
			Transport of surface pollutants to water resources
		State	Decreased groundwater recharge

			Increasing concentration of hazardous substances in water resources
		Impacts	Decreased water quantity
			Deterioration of water quality
		Responses	Sturctural and non-structural (e.g. agricultural practices) measures
		Valid in	Germany - Bavaria
		Driving forces	**River training for the purpose of floood safety**
		Pressures	Increased flow velocity, change of the river bed level (erosion, deposition process).
		State	Hydraulic/hydrological peaking
		Impacts	Increased discharges for specific return period
			Changed level and recharge capacity of groundwater
		Responses	Watercourse maintenance with consideration on river to groundwater communication
			Comment: River training impact on the changes of river infiltration rate with an impact on river bank filtration
		Valid in	Slovenia
		Driving forces	**Maintenance of hydraulic structures and river canals**
		Pressures	Increased flooding due to the non maintained hydraulic structures
			Direct intrusion of flood water into wells, drinking water treatment facitilites
		State	Vegetated streams
		Impacts	Flooded wells and othe water supply infrastructure
		Responses	Maintainance of hydraulic structures and river sections accoring to defined mainenance practice
			Comment: Indirect impact - well maintained hydraulic structures prevent flooding of wells, resources
		Valid in	Slovenia
		Driving forces	**Pollution sources on flood areas**
		Pressures	Flood induced pollution
		State	Drinking water resources (groundwater) pollution risk in the case of flood events
		Impacts	Polluted drinking water resources (different time span)
		Responses	Identification of the flood induced pollution potential (sources) from the flood areas. Local measures for their protection, transfer of sites out of the flood prone zones.
		Valid in	Slovenia
		Driving forces	**Changed river hydromorphology - bedload and sediment transport**

		Pressures	Changed river hydromorphology – bedload and sediment transport
		State	Colmatation of river beds and aquifers
		Impacts	Decreased infiltration rate
		Responses	Adequate management of hydromofphological processes
		Valid in	Slovenia
		Driving forces	**Urban drainage flooding - sewerage (incl. Combined Sewer Overflows)**
		Pressures	Pollution pressures from urban drainage in the case of flood events
		State	Unsustainable urban drainage
		Impacts	Pollution of drinking water resources (reservoirs, ground water)
		Responses	Development of Sustainable Urban Drainage (SUDS)
		Valid in	Slovenia
		Driving forces	**Land use - agriculture**
		Pressures	Turbidity Natural background and impact of land use
		State	Increased turbidity in the case of intensive precipitation
		Impacts	Pollution of water resourcees with turbidity
		Responses	Treatment of natural background (i.e. microfiltration) and measures addressing land use and agricultural practice
		Valid in	Slovenia
		Driving forces	**Floating debris and waste releases (activation) during the flood events**
		Pressures	Floating debris – transport and deposition
		State	Floating debris and waste releases during the flood events
		Impacts	Pollution pressures on drinking water recharge areas
		Responses	Prevention of floating debris and waste release, remowal of waste and debris depositions after the flood events
		Valid in	Slovenia
		Driving forces	**Slope instability and erosion process effects induced by floods** **(also other phenomena i.e. debris flow)**
		Pressures	Pollution of water supply due to damage on water supply systems
		State	Drinking water pollution induced by damaged WSS
		Impacts	Polluted drinking water in the supply system
		Responses	Avoiding instability zones, Special geotechnical measures – slope stabilisation, technical measures fo WSS construction

		Valid in	Slovenia
		Driving forces	**Abandoned groundwater wells and boreholes**
		Pressures	Pollution through the abandoned groundwater wells and boreholes
		State	Direct pollution of groundwater resource for drinking water supply
		Impacts	Polluted groundwater resources
		Responses	Adequate decomposition of strucutures after their usage (old wells, boreholes..) and olf flood protection structures
		Valid in	Slovenia
FLOODS		Driving forces	**Sewage outflow during flood events**
		Pressures	Leekage of wasterwater
		State	Microbiological pollution (bacteria from faeces); heavy metals; nitrogen and phosphorous compounds
		Impacts	Deterioration of groundwater quality; negative impact on human health
		Responses	Increase dimensioning of sewer systems
			Separate systems for meteoric water and waste waters
		Valid in	Croatia
		Driving forces	**Pesticide and chemicals leaching from agricultural areas during flood events**
		Pressures	Diffuse emissions of pollutants (pollution from agricultural sources)
		State	Nitrate and phosphorous compounds in groundwater
		Impacts	Deterioration of groundwater quality, impact on human health
		Responses	Ecological agriculture
		Valid in	Croatia
		Driving forces	**River floods**
		Pressures	Inundation of structures with hazardous substances, e.g. waste water treatment plants
		State	Increasing compounds of (wastewater) pollutants in water resources
		Impacts	Deterioration of water quality
		Responses	Structural measures, backflow prevention
		Valid in	Germany - Bavaria
		Driving forces	**Ecological status of floodplain**
		Pressures	Increasing of sediment, dangerous materials in the riverbed and floodplain - increasing of water quality risk
		State	The riverbed and the flood plains are silted up (too much sediment) - eutrophication

			process
		Impacts	Invasive plants appear in floodplains
		Responses	Changing land use in floodplains
			Conversion and maintenance of vegetation
			Dredging of riverbed
			River meandering
			Making natural wet habitat with flood function
			Making free zones in the floodplain
		Valid in	Hungary

6. Conclusions

Transnational synthesis report D.T1.1.2, illustrates daily challenges of Project Partner countries in accomplishing synergy between water resources protection, land-use management and flood mitigation.

Drinking water is abstracted from various resources, overall the main ones are groundwater and surface water (including bank filtration). It can be stated that drinking water quality in Project Partner countries, as well as in the majority of EU, is generally very good. To assess drinking water quality in water supply zones, a very large number of analyses have to be carried out, namely on microbiological, chemical and indicator parameters. Although majority of the Project Partner countries have well developed monitoring systems, efforts must continue in order to improve the situation even further.

In the course of this report, two types of analysis were used to acquire methodical evaluation of land-use and flood/droughts impacts on water resources, SWOT and DPSIR. Possible areas for change (weaknesses and threats) were identified along with solutions to the existing issues (opportunities and strengths). Agriculture has been identified as a land-use type that causes most significant pressures on water quality and quantity, mainly because of the conventional soil tillage and inadequate application of pesticides and fertilizers. Likewise, urban areas with sealed surfaces and insufficient sewage systems, as well as poor forest management pose a serious risk from the aspects of water protection and defence against hazardous effects of floods. The overview of three most common driving forces in the form of land-use activities that exert pressures on water resources, floods and droughts, causing the change of their state, are given in the tables bellow. According to the recognized land-use impacts, Key Type Measures (KTM) were assigned with the aim of reducing significant pressures to the extent required to achieve good status of water resource or preventing its deterioration.

Based upon the results of conducted analyses, improvements of existing long-term strategies, policies and management approaches, particularly those related to the drinking water preservation, can be devised.

Some of the positive management practices recognized in Project Partner countries were just to name a few: adaptability to manage DWPZs, good chemical status of ground- and surface water bodies, advisory support and financial compensation for land users in DWPZ, well-structured system for ground- and surface water regulation, legislation implementation that improved the overall chemical status of water resource.

Furthermore, the common endeavour of Project Partner countries were integrative flood management, adaptive forest, grassland and agriculture management. The countries share the plan to use EU funds in order to co-finance water projects; the need to improve the communication between the decision-makers and experts; to invest further in organic farming; to develop education and raise awareness amongst the local population; to implement stricter laws in a variety of cases (ranging from pesticide application to EU directives); to upgrade water management and flood risk management measures, ensuring minimum ecological flow in drought-endangered river basins and minimalizing water utility losses.

The general conclusion is that vertical and horizontal compliance of legislative documents on all hierarchy levels, have to be achieved primarily within Project Partner countries, in order to be upgraded to a transnational level. Nonetheless, Project Partner countries should integrate already existing EU regulations and policies in full. Furthermore, continuous multisectoral liaison is essential, as well as the implementation of transparency and equality policies which will allow all relevant stakeholders (land users) to be engaged in the decision-making processes. Pivotal factor is the education of broader public or land users whose role in carrying out the sustainable, resource-friendly practices and measures is equally important as is the expert ones.

Table 7. Most common driving forces and responses (KTM) – Impacts of land use on water resources quality and quantity

Agriculture			Forest		
Use of fertilisers especially nitrate consumption	Use of pesticides	Inappropriate livestock waste and manure management and use	Clear Cut application	Coniferous monocultures	Removal of deadwood
KTM 2, 12	**KTM 12, 3**	**KTM 2, 12**	**KTM 13, 17**	**KTM 13, 23**	**KTM 6**
Pastures			**Urban areas**		
Ploughing up of grassland	Intensive grazing activities	Intensive manure application	Lack of sewage systems in some areas / Insufficient dimensioning of sewage systems	Sealed surfaces	Areas without waste water treatment facilities
KTM 23	**KTM 23**	**KTM 2**	**KTM 16, 21**	**KTM 21**	**KTM 16, 21**
Industrial areas			**Transport**		
Industrial waste waters	Old industrial locations	Lack of industrial effluents treatments systems	Lack of industrial effluents treatments systems	Road traffic	Road and parking cleaning and maintenance
KTM 1, 21	**KTM 4**	**KTM 15, 21**	**KTM 21**	**KTM 21**	**KTM 21**

Table 8. Most common driving forces and responses (KTM) – Impacts of land use on floods and droughts

Agriculture			Forest		
Conventional soil tillage	Understanding of role of drainage in agriculture	Land-use change	Incorrect forest management	Forest fires	Extreme meteorological events in forests
KTM 23, 24	**KTM 12, 23**	**KTM 4, 6**	**KTM 13, 17**	**KTM 17**	**KTM 8, 17, 23**
Pastures			**Urban areas**		
Intensive use of heavy machinery on grassland	Intensive grazing activities	Ploughing up of grassland	Insufficient dimensioning of sewer systems	Urban development in flood prone areas	Sealed surfaces
KTM 23	**KTM 23**	**KTM 23**	**KTM 1, 16**	**KTM 6, 7, 23, 24**	**KTM 23, 24**
Industrial areas			**Transport**		
Expansion of industrial areas	Expansion of industrial areas	Expansion of industrial areas	Expansion of industrial areas	Transport infrastructure crossing watercourses	
KTM 1, 21	**KTM 4**	**KTM 15, 21**	**KTM 21**	**KTM 21**	**KTM 21**

Table 9. Most common driving forces – Impacts of floods and droughts on water quality and quantity

Floods			Droughts		
Higher flood risk, endangered population/industry and agriculture	Flash floods, river floods	River training for the purpose of floood safety	Over-abstraction during low hydrological conditions	Drought during low hydrological conditions	Low water discharge
Maintenance of hydraulic structures and river canals	Pollution sources on flood areas (e.g. pesticide and chemicals leaching from agricultural areas during floods)	Changed river hydromorphology – bedload and sediment transport	No (or low) precipitation during main recharge periods	Drying out of irrigation ditches	Climate change
Urban drainage flooding – sewerage (incl. Combined Sewer Overflows)	Floating debris and waste releases (activation) during the flood events	Slope instability and erosion process effects induced by floods (also other phenomena i.e. debris flow)	Unequal spatial and temporal distribution of natural water resources	Agricultural pressures (increased water demand)	Human activity (illegal water exploitation)

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