

COUNTRY REPORT ABOUT THE IMPLEMENTATION OF SUSTAINABLE LAND USE IN DRINKING WATER RECHARGE AREAS

"Croatia"

Final
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1. Introduction

Water management in Croatia is comprised of a number of activities ranging from legislation activities to organisation of immediate management and monitoring of the water system status. The authorized and responsible leaders of such activities are Croatian Parliament, National Water Council, Croatian Government, Ministry of Regional Development, Forestry and Water Management, as well as other state administration organisations, local and regional self-government units and Hrvatske vode (Croatian waters) as the company in charge of water management.

Despite the fact that the legal framework and regulations pertaining to water management are quite good, they are still unsatisfactory implemented in practice. Future activities should primarily deal with the control of the measures and education to raise awareness of the need to preserve water resources quantity and quality, which is, due to poor industrial development, still to a large extent satisfying.

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

2.1. Water management

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

Based on available data, in year 2012 about 953 million m³ of water for different purposes (without hydropower) was extracted. It is average of 222.5 m³ of water per capita. Water resources used for extraction are groundwater, springs, accumulations, lakes and rivers. Groundwater makes about 41%, springs 17% and the remaining 42% are abstraction of surface water. Almost half of the extracted water (460.8 million m³/year) is used for public water supply, of which groundwater makes 49% and springs additional 35% (total 84%) of the water volumes. The remaining 492.5 million m³/year of abstracted water is for technological and similar purposes.

- For which purpose is this water used?

Water is used for public water supply, for agriculture (irrigation, livestock), for technological and similar purposes, for the purposes of freshwater aquaculture, for other use like recreation, health and also to produce electricity.

- Who controls and manages water policy? The legal and administrative organization of water policy?



Water policy is the responsibility of the Ministry responsible for water management (Water Management Administration) that proposes laws and regulation, and adopts by-laws in the field of water management, performs administration and inspection, establishes international cooperation. Ministry of Environment and Energy propose River Basin Management Plan for adoption to the Croatian Government after completion the strategic assessment has been done. River Basin Management Plan has to harmonized with other relevant bodies and with neighbouring countries.

Croatian waters is an executive body responsible for water management and the implementation and coordination of the implementation of state policy in the field of water, including the development of River Basin Management Plan in the draft in all its elements: preparing documents, analysis of the situation and problems, defining a program of measures, the implementation of the planned measures (independently or in collaboration with other stakeholders), monitoring and the assessment of effects of implemented measures, public information and consultation and reporting to the European Commission.

■ Who controls and manages drinking water policy?

Croatian waters are competent for all activities related to the use of water, they give permission for the use of water, determine the conditions and limits for its use. The approval is needed for any water usage that exceeds the scope of a general or free use, and shall be issued in the form of a concession contract or water permit for water use. Concessions are granted for the economic use of water. For the abstraction of water intended for human consumption, in order to provide services of public water supply or sold in the markets of other countries, water rights are issued. The water service which has water permit and concession for water distribution performs control of drinking water in accredited laboratory

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

Croatian waters coordinate the implementation in scope of water.

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

Water legislation in the Republic of Croatia functions within a legal framework comprised of several regulations. Those are:

Water Act (Official gazette of Republic of Croatia No. 153/09, 130/11, 56/13, 14/14, orig. Zakon o vodama) and The Water Management Financing Act (Official gazette of Republic of Croatia No. 153/09, 90/11, 056/13 orig. Zakon o financiranju vodnoga gospodarstva)

Act on water intended for human consumption (Official gazette of Republic of Croatia No. 056/2013, orig. Zakon o vodi za ljudsku potrošnju)



Regulations on parameters compliance and analysis methods for water intended for human consumption (Official gazette of Republic of Croatia No. 125/2013, orig. Pravilnik o parametrima sukladnosti i metodama analize vode za ljudsku potrošnju)

Decree on water quality standard (Official gazette of Republic of Croatia No. 073/2013, orig. Uredba o standardu kakvoće voda)

Regulations on protection measures and conditions for determination of sanitary protection zones of the drinking water source (Official gazette of Republic of Croatia No. 066/2011, orig. Pravilnik o uvjetima za utvrđivanje zona sanitarne zaštite izvorišta)

Monitoring drinking water quality in ADRIATIC region is regulated by following national legislation:

Act on water intended for human consumption (Official gazette of Republic of Croatia No. 056/2013, orig. Zakon o vodi za ljudsku potrošnju)

Regulations on parameters compliance and analysis methods for water intended for human consumption (Official gazette of Republic of Croatia No. 125/2013, orig. Pravilnik o parametrima sukladnosti i metodama analize vode za ljudsku potrošnju)

Monitoring of quality of water for human consumption in Croatia is in accordance with Drinking water directive. Monitoring of bottled water or water in containers is not analysed in this report.

2.2. Drinking water protection zones (DWPZ)

➤ Which are the criteria for determining water protection zones?

Determination of drinking water protection zones differ depending on aquifer porosity. 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. The boundary between I and II zone is 10 m distance from spring or extraction well. The boundary between II and III zone is defined by 50 day isochrone. Outer boundary of III zone depends on the groundwater travel time and drinking water resource (DWR) maximum capacity. If the capacity of DWR is less than 20 l/s border is defined by the isochrone of 5 years, if the capacity is in the interval between 20 and 100 l/s isochrone is defined by 15 years and if the capacity is higher than 100 l/s isochrone is defined by 25 years.

In aquifers with fracture and fracture-cavernous porosity four drinking water protection zones are implemented. The boundary between I and II zone is the same like in intergranular aquifers, 10 m distance from spring or extraction well. The boundary between II and III zone is defined by lower than 1 day isochrone or groundwater flow velocity higher than 3 cm/s. In the second zone, also within regions in the zone III and IV, ponors and sinking zones must be included in zone II where direct infiltration (ponors and sinking zones) into the aquifer is present. Direct infiltration zones must be fenced. The boundary between



III and IV zone is defined by 1 - 10 day isochrone or groundwater flow velocity 1 - 3 cm/s. Outer boundary of IV zone depends on the groundwater travel time and drinking water resource (DWR) maximum capacity. If the capacity of DWR is less than 20 l/s border is defined by the isochrone of 10 - 20 days, if the capacity is in the interval between 20 and 100 l/s isochrone is defined by 20 - 40 days and if the capacity is higher than 100 l/s isochrone is defined 40-50 days. Exceptionally, outer boundary of IV zone can be defined to include recharge area outside III zone, which are determined by the apparent groundwater flow velocity of less than 1 cm/s, and also the entire catchment area.

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.

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

According to Croatian regulations for DWPZ there are number of limitations and restrictions in the particular sanitary protection zones (Official Gazette 66/2011, 47/2013). In aquifers with fracture and fracture-cavernous porosity, restrictions are more rigorous than in intergranular aquifers. According to the level of limitations and restrictions DWPZ are divided into:

IV zone - zone of limitations

Prohibitions within the IV. zone are:

- 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 - zone of limitations and surveillance

Prohibitions within the III. zone are:

- 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 - zone of strict limitations and surveillance



Prohibitions within the II. zone are:

- 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 cementeries and expansion of existing,
- construction of all industrial facilities that pose threat to water environment,
- forest clear cuts except sanitary cuts.

I zone - zone of strict protection and surveillance

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, transfer of water in the supply system are prohibited.

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

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

DWPZ are designed based on the field investigations and desk studies.

- How DPWZ are transferred to the space and how are DWPZ considered in the spatial planning procedures?
 - Who are parties with whom DPWZ are discussed (e.g. local communities, water managers, land owners, any other party)?

Protecting water sources and surface water intake by DWPZ is carried out in accordance with the Decision on source protection. The Decision prescribes, on the basis of the water research works, the size and borders of DPWZ, sanitary and other conditions of maintenance, protection measures, sources and methods of financing the implementation of protection measures, restrictions or prohibitions to engage in agriculture and other activities, restrictions or construction bans or performing other actions that may affect the quality or quantity of water sources and surface water intake and penalty provisions.

The Decision on source protection, with the prior approval of the Croatian Waters, is adopted by the representative body of the local government if the zone is in the area of the local self-government unit, the



representative body of the regional self-government, at the proposal of the local government, if the zone covers an area of more local self-government units within the same regional unit, or by agreement of the representative bodies of regional governments, on the proposal of the local government, if they are located in the territory of several regional-government units.

The process of drafting the Decision shall be carried out in such a way that the President of the Region, Mayor or Head of Municipality sets up a Commission to prepare a draft decision on source protection. The Commission consists of several representatives of decision makers, members of the ministry responsible for water management, the county administrative body responsible for regional planning and environmental protection, the county administrative body responsible for the economy, the county administrative body in charge of agriculture, Croatian waters and water suppliers by proposal of the body or legal person which they represent.

When Croatian waters order water research works, they establish a commission to prepare a draft decision on the protection of water sources. The commission is then, in addition to the representatives of Croatian Waters, composed of members from the aforementioned public authorities and local governments and water suppliers, everyone by the proposal of the bodies or legal persons which they represent.

- Are borders of DWPZ negotiated and agreed?

Yes, but only in the procedure of drafting the Decision through the work of the Expert Commission, and subsequently during the deliberation of the representative body which ultimately adopts the Decision. So, there is no prescribed procedure of consulting and informing the general public.

The size and borders of DWPZ are defined by the Decision on source protection adopted by the representative body of the local or regional governments with the prior consent of the Croatian waters. It is important to emphasize that the draft Decision and the process of creating and defining all mandatory elements of the Decision are made in a multidisciplinary and multi-sectoral partnership approach, i.e. through the work of the appointed Expert Commission composed of appointed representatives of a large number of public authorities. When the final draft Decision is prepared, the executive body proposes the Decision to the representative body which considers and ultimately adopts the Decision.

In accordance with the Croatian legislation, when creating the Strategy of Water Management and the Water Area Management Plan a procedure of consulting and informing the general public must be carried out. On the other hand, the Decision on DWPZ does not have to be adopted with a prior involvement of the general public.

- Are interdictions, limitations and measures negotiated?

Yes. Interdictions, limitations and measures are an integral part of the Decision on sanitary protection zones which is created in a multi-disciplinary and multi-sectoral partnership approach, i.e. through the work of the appointed Expert Commission.



- Is there any coordination during this process?

Coordinating and monitoring the development and adoption of the Decision is done by the secretariat of the Expert Commission, which usually means a person from the body of decision-makers (county, city or Croatian waters).

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

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 sanitary protection zones (The Decision on source protection). 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 among their employees appoint a body for evaluating the received request and adopt a decision within 30 days. Within the described process, special requests may be accepted. Such requests have to be endorsed by expert studies or submitted by the relevant institutions (e.g. a water supply company managing the area). 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.

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

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

Not necessarily for every DWPZ. The basic graphical representations with all necessary data for the IV. and III. sanitary protection zone are at a scale of 1:25.000, for the II. sanitary protection zone in the scale of 1:5.000, and for the first zone of sanitary protection in the scale of 1:1.000. The borders of the first DWPZ for all sources, according to the Regulation on the conditions for the establishment of sanitary protection zones (Official Gazette 66/2011, 47/2013) must be aligned with the cadastral plot and in accordance with the actual situation on the field (particle property or possessory, i.e. fencing the water intake). The borders of the second zone are aligned with the cadastral parcels only if that's done / proposed by the executed water research works. All the other borders are not aligned with the cadastral parcels. Within the DRINKADRIA project the Region of Istria created a proposal of all currently valid DWPZ harmonized with the cadastral plot. However, given that for the most part of DWPZ necessary water research works were not carried out, these borders will not be proposed as part of an official request for updating the borders.

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



Yes. The ownership of individual parcels or objects is not taken into account. The borders always need to be proposed through water research works and after that, through a study of DWPZ submitted to Croatian waters.

However, the overall impact of human activities is taken into account, although other features are more significant and are considered as basic criteria: geologic features and hydrogeological relations between inflow areas, hydrological features of the inflow area, size, borders and yield of the aquifer, type of aquifer due to the porosity (intergranular, cracking and fracture - cavernous), thickness and permeability of covering layers of the aquifer, the aquifer feed mode, the way water flows into the reservoir or lake, the rate of groundwater flow to the source, purification capacity of covering sediments and aquifers, water quality and analysis of natural systems.

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

No. 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.

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

DWPZ are embedded into the physical planning documents as implementation provisions (interdictions and protection measures for each established zone), as well as the graphical representation of the Plan. All operations and activities in the area should be harmonized with the physical planning documents that are checked and confirmed by competent administrative authorities under the applicable legal regulations at national, regional or local level. On the other hand, the situation in the field is verified by the relevant water inspection.

- How are the breaches of the requirements defined for DWPZ penalized?

The relevant water inspection establishes the breaches, while the penalties and inspection responsibilities are laid down in the penalty provisions of applicable laws.

According the Regulation on the conditions for the establishment of sanitary protection zones (Official Gazette no. 66/11, 47/13), within 12 months from adopting the Decision on DWPZ it is necessary to draw up a Program of rehabilitation measures within the sanitary protection zones for existing buildings and existing activities which becomes an integral part of the Decision on source protection. The Program of rehabilitation measures contains a list of all pollutants in the area of sanitary protection zones, priority



rehabilitation interventions, implementation deadlines for remedial interventions, remediation costs, institutions in charge of financing the implementation of the Program.

The Region of Istria developed the proposal of the above mentioned Program within the DRINKADRIA project.

2.3. Floods/droughts management

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

The objectives of flood risk management are determined by the Water Management Strategy and the Water law (Implemented provisions of the Directive on the assessment and management of flood risks). According to the Water Management Strategy main goal of management and 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.

One of the strategic goals and objectives to be achieved in the context of water management is reaching the required functionality of flood waters at first and second order:

- To a level of around 87% by the end of 2023, and
- To the level of 100% by the end of 2038. year.

The establishment of the flood protection 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 the gradual realization of a number of activities and measures for the implementation. The goal of flood risk management for all areas with a potentially significant risk is equal to the entire Croatian territory, regardless of local or regional circumstances and is primarily aimed at reducing the adverse impact of flood events on human health and safety, on valuable goods and property, and the aquatic and terrestrial environment. Croatian waters implement any measures to manage the risks from flooding predicted by The Water Act and the National Plan of flood protection and in accordance with their obligations, responsibilities and financial capacities (dedicated funds raised from water fees and fees for water regulation).

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

Yes we have flood/drought risk assessment done on national level. (Chapter D in Water management plan 2016-2021).

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



Yes, we have areas for which significant risk of flooding is estimated.

- Is there a map of floods/droughts risk?

Yes, there is a map of floods risk.

- Has been done an estimation of potential flood damage?

Yes, we have estimation of potential flood damage on areas where significant risk of flooding is present.

2.4. Water quality state, trends and monitoring

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

Monitoring of water quality for public water supply (drinking water) is supervised by the Croatian Institute for Public Health. They produce an annual report on drinking water. 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 physico-chemical and chemical parameters: aluminum, ammonia, color, conductivity, hydrogen ion concentration (pH value), odor, 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 22°C and 37°C number of colonies, 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 little chance of finding discrepancies, further sampling can be excluded in the annual monitoring. Analysis 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.

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



Croatian waters are institution competent to provide water monitoring. They determine the frequency of sampling and monitoring sites for physico-chemical analysis of water. 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, sulfates, orthophosphates, trichloroethene and tetrachloroethene sum, conductivity.

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

Systematic monitoring of quality standards for surface water and groundwater is done on national level. Croatian waters are doing annual reports, and reports of trends. Monitoring of drinking water is performed by Croatian Institute for Public Health, while Croatian waters perform monitoring of groundwater quality and quantity.

- Who is the user of this data?

User of quality standards of drinking water is Ministry of Health and Ministry responsible for water management. Users of quality and quantity status data are mainly Croatian waters. This data is public.

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

Ministry of Health and Croatian waters establish the measures in case of negative quality trend.

3. Actual land use activities

3.1. Land use map

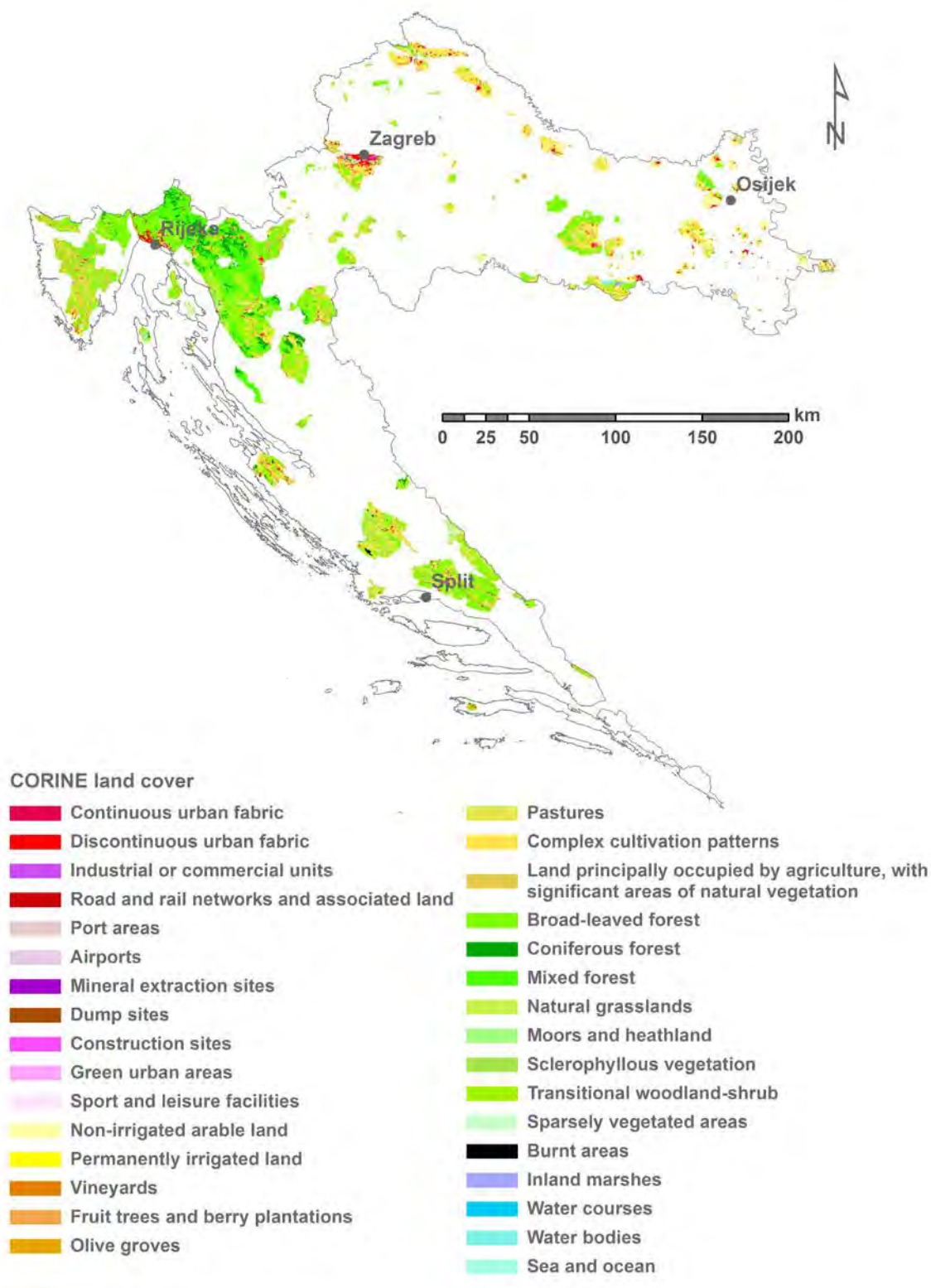


Figure 1 Land cover in all DWPZ in Croatia based on CORINE 2012



Table 1 Percentage ratios of particular land use areas and its surface area in km² for entire country (Corine land cover 2012)

CLC code	LABEL 3		Surface area (%)	Surface area (km ²)
111	Continuous fabric	urban	0,010	5,50
112	Discontinuous fabric	urban	2,649	1499,02
121	Industrial commercial units	or	0,239	135,41
122	Road and networks associated land	and rail and	0,182	102,93
123	Port areas		0,015	8,56
124	Airports		0,047	26,37
131	Mineral sites	extraction	0,091	51,55
132	Dump sites		0,008	4,25
133	Construction sites		0,030	16,83
141	Green urban areas		0,032	17,90
142	Sport and leisure facilities		0,129	73,01
211	Non-irrigated land	arable	6,805	3850,63
212	Permanently irrigated land		0,186	105,11
221	Vineyards		0,494	279,34
222	Fruit trees and berry plantations		0,141	79,72
223	Olive groves		0,391	221,35
231	Pastures		5,018	2839,25
241	Annual associated permanent crops	crops with	0,001	0,79
242	Complex cultivation patterns		17,778	10059,66
243	Land occupied by agriculture, with significant areas of natural vegetation	principally by	9,582	5421,73
311	Broad-leaved forest		29,221	16534,98
312	Coniferous forest		1,805	1021,27
313	Mixed forest		4,842	2739,65
321	Natural grasslands		4,501	2546,54



322	Moors and heathland	0,045	25,73
323	Sclerophyllous vegetation	1,895	1072,40
324	Transitional woodland-shrub	11,518	6517,40
331	Beaches, dunes, sands	0,004	2,09
332	Bare rocks	0,076	43,27
333	Sparsely vegetated areas	0,901	509,60
334	Burnt areas	0,045	25,27
411	Inland marshes	0,344	194,63
421	Salt marshes	0,010	5,46
422	Salines	0,010	5,49
423	Intertidal flats	0,001	0,48
511	Water courses	0,434	245,40
512	Water bodies	0,518	293,04
521	Coastal lagoons	0,001	0,45
523	Sea and ocean		31545,70
Total:			88127,77
Total land:		100	56582,07

Table 2 Percentage ratios of particular land use areas and its surface area in km² for DWPZ (Corine land cover 2012)

CLC code	LABEL 3	Surface area (%)	Surface area (km ²)
111	Continuous urban fabric	0,027691	3,168071
112	Discontinuous urban fabric	2,8381	324,705866
121	Industrial or commercial units	0,431557	49,374285
122	Road and rail networks and associated land	0,344742	39,441773
123	Port areas	0,000207	0,023675
124	Airports	0,050082	5,729886
131	Mineral extraction	0,104083	11,908058



132	Dump sites	0,016673	1,907495
133	Construction sites	0,061866	7,078116
141	Green urban areas	0,01514	1,732105
142	Sport and leisure facilities	0,085994	9,838497
211	Non-irrigated arable land	4,457788	510,013723
212	Permanently irrigated land	0,053523	6,123499
221	Vineyards	0,223826	25,60785
222	Fruit trees and berry plantations	0,044827	5,128664
223	Olive groves	0,1209	13,832084
231	Pastures	3,150476	360,44467
242	Complex cultivation patterns	14,912748	1706,161604
243	Land principally occupied by agriculture, with significant areas of natural vegetation	9,648837	1103,919555
311	Broad-leaved forest	30,102934	3444,064675
312	Coniferous forest	4,112852	470,549716
313	Mixed forest	11,192066	1280,479799
321	Natural grasslands	5,022824	574,659287
322	Moors and heathland	0,044382	5,077732
323	Sclerophyllous vegetation	1,253035	143,359199
324	Transitional woodland-shrub	10,115335	1157,291435
333	Sparsely vegetated areas	0,765477	87,577892
334	Burnt areas	0,081515	9,326144
411	Inland marshes	0,136847	15,656561
511	Water courses	0,198329	22,690746
512	Water bodies	0,379793	43,451941
523	Sea and ocean	0,005556	0,635621
Total:		100,00	11440,96

3.2. Overview of the particular land use activities

3.2.1. Urban areas

According to the documentation of Croatian waters, 245 public sewage systems are recorded, 118 in the water area of the Danube River and 127 in the Adriatic sea catchment area. The 46% of the total population is connected on sewage system. Wastewater treatment has about 80% of sewage system facilities, 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). Only recently a database of dumps has been established. 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. In Croatia cities and counties organise the collection and landfilling of waste in a way which cannot be called an integrated waste management system. In the past few years activities on setting up the system have been carried out (in Zagreb, Šibenik, Rijeka, Sisak, Osijek and other cities) which have been intensified by the adoption of the Strategy. The composition of municipal waste changes depending on the environment in which it is generated and depends on a great number of factors such as: living standard of the population, type of inhabited area, the existing level of utility infrastructure and the like. In Croatia monitoring of the municipal waste system has not been systematically carried out. Results obtained from individual testing exist for some areas. Technical and technological capacities for collecting, storing and treating hazardous waste are being developed in accordance with market principles. Certain economic entities have been issued permits for collecting, transporting and temporary storage of hazardous waste. In addition, there are several smaller specialised facilities in Croatia built for the purpose of recovery/treatment of hazardous waste and there are available capacities within individual industrial installations which are used for recovery/treatment of some type of hazardous waste. For carrying out activities of collection and temporary storage of hazardous waste it is necessary to obtain a permit in accordance with Article 41 of the Waste Act. Currently in Croatia there are 47 companies in possession of the permit for the activities of collection and temporary storage of hazardous waste in accordance with the new Waste Act and its Amendments and the old Waste Act (OG 151/03).

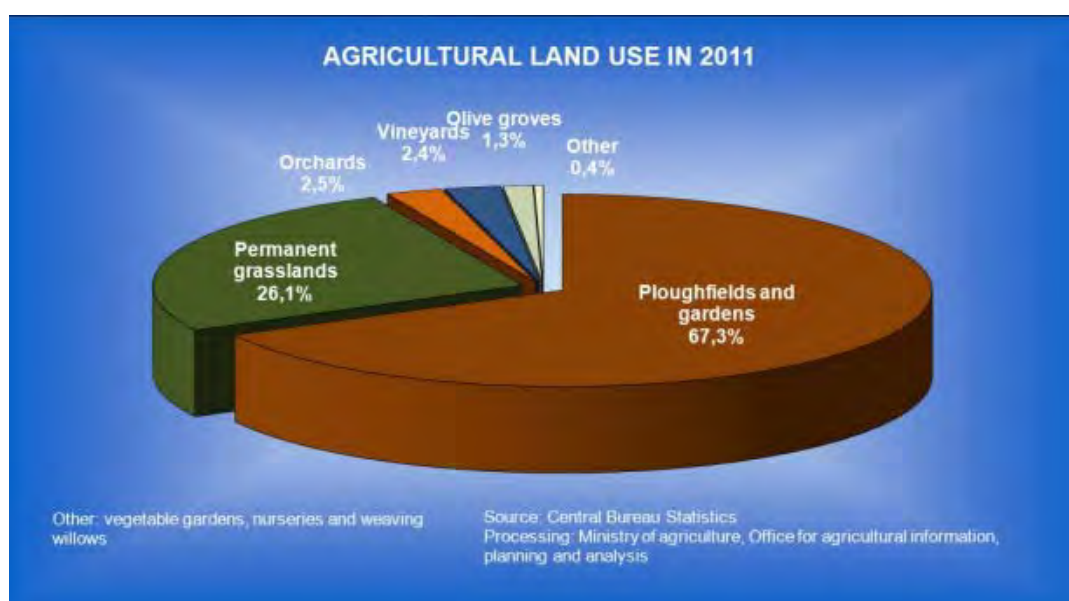
3.2.2. Industrial areas

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. Above mentioned, mainly refers to 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 waste water treatment plant. 20% of industrial waste water 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. Among wastewater treatment devices 61.6% are devices for mechanical purification, 4.8% are devices for chemical treatment, while biological devices are installed on 5% technical units. Devices for heat exchange are installed just on 0.05% technical units.

3.2.3. Agricultural land

In 2011, utilized agricultural area was 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 category in 2011 was the arable land and permanent grassland.



Picture 2 Agricultural lands in use in 2011

(https://ec.europa.eu/food/sites/food/files/plant/docs/pesticides_sup_nap_croatia_en.pdf)



The use of pesticides has in agriculture 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. 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.

3.2.4. Forest

Total forest and forest land area in the Republic of Croatia amounted 2,688,687 ha in 2006, which as regarding total inland area of the Republic of Croatia represents forest cover of 47.5%. Out of total forest area, productive forest land with tree cover amounts 89.4% and the rest is productive forest land without tree cover (productive, non-productive and unfertile land). In total forest area, 75% of forests are owned by the state, managed by the company Hrvatske šume (Croatian forests Ltd.), while the rest is privately owned. The Forest Management Plan in force determines growing stock of about 398 millions of m³ while its yearly increment amounts about 10.5 millions of m³. Species abundance in the total growing stock is as follows: Common beech 36%, Pedunculate oak 13%, Sessile oak 10%, Common hornbeam 9%, Silver fir 9%, Narrow-leaved ash 3%, Spruce 2%, Black alder 2%, Black locust 1%, Turkey oak 1% and other 14%.

3.2.5. Pastures

Although natural pastures occupy a large part of total agricultural area (especially in the Adriatic region where natural pastures comprise about 775,000 ha, ie. 70% of the of the Adriatic part of the Croatian) it is estimated that their utilization is very low (around 10%).

3.2.6. Transport units

The total length of roads in 2011 was amounted to 29,410 km. Number of road vehicles in 2011 was amounted to 1,818,983. In the period 2008-2011 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 2011, a total of 984 km of railway lines were electrified, which amounts to 36% of the total railway length. The network of inland waterways of the Republic of Croatia is 804 km, of which 539 km are international waterways. 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 2011 length of the pipeline amounted to 610 km and has not changed since 2005. The length of the pipeline in 2011 was



amounted to 2.410 km and is steadily increasing. 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) makes 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.

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

Impact on water resources quality and quantity				
URBAN AREAS				
Driving forces	Pressures	State (ECOSYSTEM SERVICES)	Impacts	Responses (MEASURES)
Lack of sewage systems in some areas	potential contamination, discharge of contaminant compounds during floods	high pollutant compounds in the water bodies	lower quality of surface and groundwater	investment and constructions efforts towards better sewage systems must continue KTM 16
Areas without waste water treatment facilities	concentration of hazardous substances above allowed standards	values of nutrients, pathogens and other contaminants above the maximum allowable	deterioration of water quality	effluent treatment needs to be increased, construction of additional treatment



		concentration for drinkable water		facilities KTM16
Concrete and artificial surfaces	discharge of surface pollutants (e.g. from traffic, construction sector)	increased amount of pollutants contained in water	deterioration of water quality (both surface and ground water)	more efficient control of wastewater discharge KTM21 increase the amount of green surfaces KTM21
AGRICULTURE				
Driving forces	Pressures	State	Impacts	Responses
Use of fertilizers (mostly N-based)	discharge of Nitrates into soil, surface and ground waters	values of nitrates above legally permitted limit values in some areas	deterioration of groundwater quality, impact on human health	organic and ecological farming KTM2
Innappropriate use of manure	soil and groundwater pollution caused by nitrates and pathogens	values of nitrates and pathogens above legally permitted limit values in some areas	deterioration of groundwater quality, impact on human health	training of farmers, investments into manure storage KTM21
Use of pesticides	discharge of pesticides into soil, surface and ground waters	values of pesticides above legally permitted limit values in some areas	deterioration of groundwater quality, impact on human health	measures from “National Action Plan To Achieve Sustainable Use of Pesticides for the period 2013-2023” KTM3
Water abstraction for irrigation and livestock farming	decrease in water quantity and quality as abstraction is not monitored for many farms	decreased water quantity and quality	negative trends are on the rise, and in combination with climate changes, present serious threat for the future (especially in the Adriatic river basin)	investments for improving the state of irrigation infrastructures or irrigation techniques water pricing policies water sources differentiation desalinization treatments KTM8, KTM12, KTM15, KTM24, KTM25
FORESTS				
Driving forces	Pressures	State	Impacts	Responses



Clear cutting and deforestation	high degree of soil erosion, increased surface flow, nutrient leaching	low level of forest ecosystem services, reduced water purification	decreased infiltration capacity and water recharge, decreased water availability	implementation of a resource-friendly exploitation system, improved management, improved protection areas KTM17, KTM23
Forest fires	alteration of physical, biological and chemical characteristics of the soil, deterioration of water quality	decomposed soil structure, decreased groundwater recharge	decreased water availability and provision for supplying purposes	improved preventive measures, improved management KTM 17, KTM22, KTM23
TRANSPORT UNITS				
Driving forces	Pressures	State	Impacts	Responses
Road accidental spills	emission of fuel, oil and other dangerous substances	contaminated soil, possible infiltration of fuel, oil or other dangerous substances into groundwater	deterioration of soil and water quality	effective action plan in case of spills, low reaction time and fast intervention
Roaf traffic	waste waters from roads and highways	heavy metal pollution in soils, ground and surface waters	deterioration of water quality, impact on human health	implementation of National environment protection strategy and action plan (NN 46/02) KTM21
INDUSTRIAL AREAS				
Driving forces	Pressures	State	Impacts	Responses
Insufficient dimensioning of sewage systems	discharge of contaminants during flood events	high pollutant compounds in the water bodies	deterioration of surface and groundwater quality, impact on human health	reassessment of sewage systems, fostering implementation of seperated sewers KTM16, KTM21
Industrial waste waters	emissions of pollutants to ground and surface waters	pollutants in ground and surface waters (e.g. heavy metals, organic pollutants)	deterioration of ground and surface water quality, impact on human health	implementation of appropriate measures, better monitoring KTM 15, KTM21
Old industrial locations	soils contaminated with industrial sector-specific	contamination of groundwater	deterioration of groundwater quality, impact on human	more stringent persecution of contaminated site



	pollutants		health	remediation KTM4
Impact on floods/droughts				
URBAN AREAS				
Driving forces	Pressures	State	Impacts	Responses
Insufficient dimensioning of sewer systems	limited drainage capacity	decreased water retention	increased flood risk	investment efforts and constructions of additional sewage systems KTM1, KTM16
Urban development in flood prone areas	increased discharge and runoff	decreased retention	increased flood risk, decreased population safety	investment efforts and constructions of additional sewage systems, development of improved retention capacity KTM23, KTM6, KTM7
Inefficiency of river banks	bank collapse/breach during flood events	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)	increased flood risk, decreased population safety	investments into construction of proper banks, better monitoring, better preparation for flood events KTM6, KTM7, KTM23, KTM24
Closed karst field in mountain areas	increased rainfall/snowfall in mountain areas (e.g. Velebit and Jadranska magistrala)	high threat and flood risk in case of high rainfall/snowfall, inadequate flood protection structures do not exist in many areas	increased flood risk, decreased population safety	proper drainage of karst terrains has to be devised (e.g. hydrotechnical melioration) KTM6, KTM7, KTM23, KTM24
AGRICULTURE				
Driving forces	Pressures	State	Impacts	Responses
Land use change	reduction of green areas and increase in barren soil areas	reduction of infiltration and evapotranspiration	higher flood risk during autumn/winter/spring periods	increase of green areas, construction of protection systems, prevention of land use change



				KTM4
Conventional soil tillage	soil compaction	decreased infiltration capacity and water retention	enhanced overland flow contribution to direct runoff	fostering conservation tillage, non-turning techniques KTM8
Insufficient dimensioning of defensive embankments in rural areas	bank collapse/breach during floods	high risk during high waters which are more common due to climate changes	increased flood risk, decreased population safety, high impact on crops and cultures	further investments into flood protection infrastructure KTM23, KTM24
FORESTS				
Driving forces	Pressures	State	Impacts	Responses
Deforestation and clear cutting	lower evapotranspiration and infiltration (roots)	reduced protection due to lower water retention	enhanced overlandflow contribution to direct runoff	implementation of legal restrictions to avoid clear-cuttings also beyond the borders of DWPZ KTM22
Extreme meteorological events in forests (sleed, strong winds)	destruction of large wood areas near water courses	trees falling in the watercourses with clogging potential	Increased flood levels and potential for debris flow development	adequate forest practice and active response in the case of large scale events KTM23, KTM17, KTM8
Forest fires	alteration of physical, biological and chemical characteristics of soil	water repellency of soil and loose of soil structure	increased runoff and erosion processed that favor overland transport and deposition of sediments within hillospe channels and increase flood risk	improved forest management KTM17, KTM22
TRANSPORT UNITS				
Driving forces	Pressures	State	Impacts	Responses
Development of transport infrastructure	sealed surfaces relate to transport infrastructure	developed transport infrastructure without retention measures	increasing runoff	development of retention capacity KTM21, KTM15, KTM13



ENERGY PRODUCTION				
Driving forces	Pressures	State	Impacts	Responses
Maximizing the benefits of the hydropower production	operational procedures of hydropower systems aimed at power production with limited focus on flood retention mechanisms	power production focused management	flooding	development of agreed operational protocols increasing retention potential (where feasible) KTM7, KTM8, KTM23
Hydropower production	reduction of the sediment transport (suspended and bedload) in reservoirs	reduced amount of sediments in watercourses downstream, sediment accumulation in reservoirs reducing their capacity	erosion processes in watercourses down streams lacking the sediments	adequate monitoring, Erosion control works downstream, KTM23, KTM17

SWOT analysis and evaluation of gaps

■ STRENGTHS

- Croatia has recently put in place new legislation to support water management, including the transposition of EU legislation. The new legislation includes government regulations on water quality and on minimum fees for water service utilities (though implementation of some key legislation was only starting at the time that the RBMP was published).
- Croatia has issued a new River Basin Management Plan (2016-2021) which provides a key step forward in river basin management.
- Protected areas have been identified

■ WEAKNESSES

- Desired ecological state (atleast “good” status, followed by “very good” and “excellent”) has not been achieved for:
 - 58% of rivers
 - 54% of lakes
 - 55% of transitional waters
 - 12% coastal waters
- Croatia is at EU bottom concerning waste management
- Waste water treatment plants purify only around 35% of the waste waters used by population.
- Groundwater monitoring sites (281 sites across Croatia) been developed,



across the country, including drinking water protected areas and bathing water areas.

- Croatia is engaged in international cooperation for water management with neighbouring countries in multilateral forums and through bilateral agreements (Art. 13 of the WFD).
- Land Parcel Identification System (cro. Arkod) has been developed. Arkod data base keeps track of actual land use in agriculture: hydrological data (water protection zones - 3M, 10M, 20M), crop cultures and parcel slopes.
- Monitoring has been carried out for chemical status based on almost all priority substances. Information is well developed for transitional and coastal waters.
- Good chemical status is achieved for > 90% of surface water bodies and > 80% of groundwater bodies.
- Good quantitative status is achieved for 95% of groundwater bodies in Danube river basin district, and 66% in Adriatic river basin district.
- Relatively low percentage of land use change (from agricultural to artificial).
- Low to moderate soil loss rate (2-5 tonnes per ha per year).

although only surveillance monitoring has been used (minimum once a year, as issued by the law), while development of operational monitoring (monthly monitoring) network remains a task for the future. Furthermore, current groundwater monitoring results are not completely reliable due to lack of monitoring stations in some areas.

- In terms of the supporting hydromorphological quality elements, only the hydrological regime is reported to be monitored in rivers and not the morphological conditions. Hydromorphology is not monitored in lakes, transitional and coastal waters
- Large number of rivers are strongly degraded (mostly in Pannonian part - Danube river basin district) due to high hydromorphological stress caused by construction (hydro power plants, flood protection, river traffic)
- Low share of forested drinking water protection zones
- Only 47% of the population is connected to the public sewage system nation-wide
- High percentage of loss during water abstraction and distribution - 46 % average nation-wide
- Pollution of groundwater with nitrates and pesticides related to excessive use in agriculture (eg. Varaždin groundwaters)
- Furthermore, inadequate landfills are also source of nitrate pollution (eg. Zagreb aquifer is polluted with



	<p>nitrates from Jakuševac landfill, trichloroethylene and tetrachloroethylene).</p> <ul style="list-style-type: none"> ○ Inefficient control system of measures for water protection. ○ Insufficient education of local population and farmers in some regions. ○ Poor forest management.
<p>■ OPPORTUNITIES</p> <ul style="list-style-type: none"> ○ A set of 269 measures have been designated for implemented in period 2016-2021 with purpose of achieving atleast “good” water status. ○ Action plan for water protection against nitrate pollution from agricultural sources has been developed. Action plan sets out clear guidelines with the purpose of reducing nitrate pollution, but degree of implementation remains unknown. ○ 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 agriculture. ○ Due to Croatia’s recent admittance in the EU, substantial amount of funds is available for investments in public water supply network, waste water treatment facilities and flood mitigation (about 4,4 billion Euros) . ○ During the period 2010-2015 an increase of 376% in organic farming has been reported. 	<p>■ THREATS</p> <ul style="list-style-type: none"> ○ The current Programme of Measures only includes basic measures and not supplementary measures (e.g. hydromorphological measures), though these appear to be needed as not all water bodies will achieve good status by 2015. The costs for some measures are provided, including those requiring major investments such as wastewater treatment plants. While potential sources of finance are indicated, further detail is not provided. ○ The 1st RBMP notes that the assessment of the status of rivers and lakes (general physicochemical and hydromorphological status and general chemical status) is affected by uncertainties stemming from the current system of monitoring and assessment. ○ Pollution from household sources, agriculture and industry (point and diffuse) remains a water management task and efforts in terms of installation of urban wastewater treatment plants have to continue. ○ Coastal agglomerations discharge



	<p>large amount of wastewater into sea (lack of sewage systems).</p> <ul style="list-style-type: none"> ○ Rising flood risk due to climate changes and inadequate flood protection infrastructure (flood risk maps have been created). ○ Saline intrusion in many coastal areas (eg. Bokanjac-Poličnik water body), caused by higher water abstraction and reduced precipitation during summer months. ○ High degree of arable soil erosion, especially in the karst region (Dalmacija, Istra). ○ Severe fire hazards pose a great threat towards water and land resources, especially in the karst region (Dalmacija). ○ Although the quality of water in Croatia is still very good, long-term monitoring of individual pollutant
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Huge percent of the area is under protection, resulting in land use conflicts

According to the River Basin Management Plan (2016-2021), 269 measures are planned for implementation with purpose of achieving at least “good” status of waters. These measures can be divided into:

144 basic measures

116 additional measures related to protection of protected areas (special water protection areas, habitat and wildlife protection areas)

9 supplementary measures for water bodies that will not achieve at least “good” status after basic measures have been implemented

Additionally, measures that are under way or have already finished (from RBMP 2013-2015) are also taken into consideration.

In respect of relevant and partly relevant measures for PROLINE-CE, the identified key type measures in Croatia are:



KTM2 (Reduce nutrient pollution in agriculture beyond the requirements of the Nitrate directive): 22 measures to be implemented, 2 are on-going

KTM3 (Reduce pesticides pollution in agriculture): 16 measures, 2 are on-going

KTM4 (Remediation of contaminated sites - historical pollution including sediments, groundwater, soil): 2 measures

KTM6 (Improving hydromorphological condition of water bodies other than longitudinal continuity): 108 measures to be implemented, 3 are on-going

KTM7 (Improvement of flow regime and/or establishment of ecological flows): 92 measures to be implemented, 3 are on going

KTM12 (Advisory services for agriculture): 16 measures

KTM13 (Drinking water protection measures - e.g. establishment of safeguard zones, buffer zones): 36 measures to be implemented, 10 are on-going

KTM14 (Research, improvement of knowledge base reducing uncertainty):

96 measures to be implemented, 3 are on-going

KTM15 (Measures for the phasing-out of emissions, discharges and losses of priority hazardous substances or for the reduction of emissions, discharges and losses of priority substances): 40 measures, 6 are on-going

KTM17 (Measures to reduce sediment from soil erosion and surface run-off):

12 measures

KTM21 (Measures to prevent or control the input of pollution from urban areas, transport and built infrastructure): 80 measures

KTM24 (Adaptation to climate change): 52 measures

370 Other key type measure reported under PoM (Programme of Measures)



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