



# PROLINE-CE

## WORKPACKAGE T1, ACTIVITY T1.2

### REVIEW OF BEST MANAGEMENT PRACTICES FOR DRINKING WATER SUPPLY ISSUES

#### D.T1.2.1 Country-specific best management practice reports

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**CROATIA**

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March, 2017





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Date of last release	07/03/2017



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## 1. Introduction

The purpose of this report is to provide the review of existing best practices and measures regarding water protection, flood mitigation and land use. As a relatively new EU member state, Croatia has not yet developed full scope of best practices, mainly due to lack of projects and studies. Hence, best practices and measures listed in this report mostly originate from existing national strategies, action plans, policies, regulations and decrees, which are harmonized with EU legislation. However, the degree of implementation of some practices/measures remains unknown, due to lack of funds (for some measures the source of funding is unspecified), low political commitment (many measures are non-binding) and tempo of implementation. Therefore, this report has left out the attribute table for best practice (functionality, cost, duration of implementation, sustainability time interval), as well as advantages and disadvantages, since it would be purely speculative and subjective considering no past projects or studies dealt with best management practices in Croatia regarding drinking water protection, flood mitigation and land use.



## 2. Plain and mountain sites

### 2.1 Forests

#### 2.1.1. BP MF1 Sustainable forest management and establishment of protective forests

##### Description of the measure

Forests cover around 48% of land territory in Croatia. Current trends suggest that forest growth (artificial and natural) surpasses cutting activities, resulting in steady increase of forest area year by year. Protective forests cover around 3% of total forest area (data from 2012). Protective forests are forests that mitigate or prevent the impact of a natural hazard, including a rockfall, avalanche, erosion, landslide, debris flow or flooding on people and their assets. One of the most effective protective functions of forests is reducing soil erosion by water, which degrades water quality. The product of erosion is sediment, which has adverse impacts during transport in running water and as a deposit in stream channels or stagnant water bodies. Thus the protective role of forests in reducing erosion on-site has a far-reaching, off-site effect through reduced sedimentation. The influence of forests and forest alteration on water yield and timing is complex. Where forests were the original land cover, the protective effect consists in maintaining as far as possible the 'natural' flow regime, which inevitably consisted of both flooding and low flows to which stream channels and associated biota were adjusted. With human intervention and occupancy, there is a need for better understanding of the forest/water interaction. With regard to floods, it is now quite clear that forests reduce stormflow peaks and delay them better than other land cover. Protecting stream and river banks from undue horizontal erosion is function of a buffer zone of trees along both sides of a watercourse. The buffer area also acts as a filter and depository for sediment, pesticides and fertilizers from upslope land use (FAO, 2005).

## 2.1.2. BP MF2 Investments in forest area development and improvement of the viability of forests

### Description of the measure

The measure is based on the Republic of Croatia's Forest Management Area Plan 2006-2015. The value of forest ecosystem services, especially in the karst area of Croatia, greatly exceeds the value of wood. The specific objectives of the measure are:

- conversion of degraded forest stands, structurally degraded forest stands per tree species, and forest cultures into mixed high forest stands of indigenous tree species;
- improving forest ecosystem services;
- modernisation of the existent and the introduction of innovative and environmentally friendly technologies, machines and equipment, as well as increasing the safety of work processes in wood harvesting, silvicultural works and pre-industrial wood processing;
- promotion of timber and non-timber forest products;
- increase of competitiveness of the forestry sector;
- job creation in the forestry sector.

### Submeasures within BP MF2:

**Climate change mitigation and adaptations** - The activities within the framework of this measure are aimed at the adaptation of forest ecosystems to climate change. The restoration of the degraded forms of forest stands improves forest ecosystem services, which helps mitigate climate changes. Moreover, activities within the framework of this measure foster the use of more efficient and environmentally friendly machines, tools and equipment for works in wood harvesting and pre-industrial wood processing. Once all the activities within the framework of this measure have are implemented, there will be a long-term increase of the availability and use of renewable sources of energy, which will help reduce greenhouse gas emissions.

**Environmental protection** - The activities within the framework of this measure are aimed at soil protection (erosion), water and air protection (forest ecosystems as water and air purifiers), biodiversity preservation and improvement, preservation and restoration of special habitats and natural landscapes including NATURA 2000 areas. Furthermore, the use of environmentally friendly technologies and machinery reduces soil damage, water pollution and exhaust gas emissions, while the modernisation of the existent and the introduction of new technologies in pre-industrial wood processing reduces the adverse impact on the environment through increased efficiency and more rational use of resources.

**Innovation** - Activities within the framework of this measure foster the transfer of advanced technologies and innovative approaches in wood harvesting, pre-industrial wood processing and marketing of forest products, which have numerous effects on business, the most relevant being: increased productivity and employment rate with reduced production costs, improved quality of products and business processes, increased production flexibility and shorter delivery times.



### 2.1.3. BP MF3 Prevention of forest fires

Prevention of forest fires presents one of the most important measures for protection of forests and forest ecosystems in Croatia. Due to climate changes (drought, low humidity and low rainfall during summer season) and human factor (negligence, accidents) forest fires in Croatia present an everlasting and widespread issue. Similar to all Mediterranean countries, forest fires in Croatia are on the rise (around 80% of all fires are connected to Adriatic karst region). As of 2014, Croatia has issued “Ordinance on protection against forest fires” (OG 33/14) which is comprised of 3 components:

- Technical measures - maps (1:25000) with IV degrees of danger and related coloration; video surveillance and detection system; observation and reporting system; intervention system
- Silvicultural and preventive measures - forest stands care, timely thinning of the stands, removal of dry wood, construction and maintenance of fire paths, keeping the water springs clean,
- Other measures - restriction, prohibitions and other regulations related to camping, tourism, burning (grass, shrubs, weeds)

## 2.2 Agriculture

### 2.2.1. BP PA1 Protection of water from pollution caused by nitrates originating from agriculture

#### Description of the measure

General principles on the use of fertilizers, prohibitions and general recommendations are contained within 1<sup>st</sup> Action Programme - Protection of water from pollution caused by nitrates originating from agriculture (2013).

During the period of one calendar year, for fertilizing purposes farmers can use maximum 170 kg/ha of nitrogen. In case of flood events, fertilizing must be done after the floods have ended. In order to decrease the loss of nitrogen by evaporation and leeching, it is prohibited to perform the first fertilization with slurry on agricultural land in the period from 15<sup>th</sup> of November to 15<sup>th</sup> of February. Additionally, it is prohibited to perform the second fertilization with slurry in the period from 1<sup>st</sup> of May to 1<sup>st</sup> of September.

Furthermore, fertilizer application is forbidden: on the ground covered with snow blankets; on the frozen ground; on the flooded soil; on non-agricultural land; at 20 meters distance from the outer edge of the lakebed or other standing water; at 3 meters distance from the outer edge of the river beds with width of bed of 5 meters or more; on slopes near rivers - with a slope of more than 10% within a distance of 10 meters from the outer edge of the river bed; mixed with sewage sludge.





## 2.2.2. BP PA2 Sustainable use of pesticides

### Description of the measure

Based on The National Action Plan to achieve the sustainable use of pesticides (NAP, 2013), the objectives of sustainable use of pesticides are reducing risks to human and animal health and to the environment associated with pesticide use, and stimulating integrated and alternative measures to controlling pests, in such a way that it:

- develops a better understanding of the methods of pesticide use,
- ensures the application of scientific and other evidence to recognise pesticides and procedures requiring attention, aimed at developing and promoting measures and procedures that will reduce the detrimental impacts of the use of these chemicals, and enable the user to economically control pests, diseases and weeds,
- ensures the recognition of the roles of all stakeholders and interest groups in achieving the common goal to achieve the sustainable use of pesticides.

Sub-measures for achieving the objectives laid out in NAP are:

#### 1. Authorization of plant protection products (PPP):

- The PPP authorization system in Croatia was aligned with EU standards and requirements in the period from 2005 to 2007. Since then, the legislation has continually been aligned with new EU legislation. New requests for the authorization of PPPs were conducted pursuant to the requirements set out in Directive 91/414/EEC as were the measures being undertaken. The measures undertaken significantly contributed to reducing risk and achieving a greater level of protection of human health, animals and the environment. The key measures were: Establishing a single competent body for the authorization of PPPs pursuant to the requirements of Council Directive 91/414/EEC,
- Revoking the authorization of PPPs that contain active substances for which a decision has been adopted at the EU level to not include these active substances in the list of approved active substances in PPPs. As a consequence of these measures, the placement on the market and application of 162 PPPs and 75 active substances that lack documentation pursuant to EU standards or are not supported has been prohibited,
- Revoking the authorization of PPPs from re-registration groups I to VI for which the the authorization holders did not submit additional documentation for their re-assessment. The placement on the market and application of 113 PPPs was prohibited,
- 57 PPPs were re-assessed and 37 new PPPs were registered pursuant to the new authorization system,
- A review and change of authorization was conducted with the aim of harmonising approved uses with stipulated MRLs (maximum residue levels) for pesticides in food and risk mitigation measures for bees and other pollinators,



- Performance of a detailed risk assessment pursuant to EU requirements and standards for every PPP prior to authorization,
- The introduction of elaborated risk mitigation measures for the environment and non-target organisms,
- Much more information for the safe application of PPPs is placed on the approved label for individual PPPs, thereby providing conditions for the safe application of PPPs,
- Through the recognition procedure of EU authorization of PPPs are approved more applications per PPP, which puts our agricultural producers in a more equal position in relation to agricultural producers in the EU, and provides them with the ability to more effectively protect plants from harmful organisms.

2. Post-authorization control of plant protection products - The goal of the PPP post-authorization control programme (formulation monitoring) is to verify the compliance of registered PPPs based on the selected active substances on the market and to verify if their physico-chemical properties are consistent to their authorization. Every change to a PPP may lead to the change in the effectiveness of a PPP or to threats to humans, animals or the environment. The post-authorization control programme seeks to cover the greatest possible number of samples from the most represented (dominant) PPP batches present on the market, in order to create a clearer picture of the compliance of specific plant protection products.

3. Pesticide residues monitoring in food - The National programme for the monitoring of pesticide residues in and on products of plant origin was established pursuant to the Plant Protection Products Act and has been in force since 2007. The objective of monitoring is to determine the quantity of pesticide residues in food and to verify compliance with stipulated MRLs. This provides insight into the extent to which pesticide residues exceeding MRLs pose a risk to people who consume foods containing this level of pesticide residues. Products are also selected based on their importance in the diet of the population of Croatia, pesticide residues found in previous monitoring programmes, products that have not been covered by the programme and products that, because of their lower accessibility on the market, were not sampled in the planned number. The Ministry of Health samples products in accordance with the Guidance for the monitoring implementation prepared every year by the Ministry of Agriculture. Sample collection and control procedure is conducted in large shopping centres—central distribution warehouses, wholesale markets and refrigeration plants where complete batches are more readily accessible, in shops and markets. In the frame of pesticide residue monitoring in Croatia, products of plant origin are analyzed for residues of 110 pesticide active substances (multi-residue method).

4. Training of professional pesticide users, distributors and advisors - The new training system consists of initial and additional training and will cover all professional users of pesticides, distributors and advisors taking into account their respective roles and responsibilities. The initial training module includes at least 15 school hours. Training for all those for whom it is compulsory must regularly update their knowledge with additional training within five years of acquiring initial or additional training. The additional module consists of at least five school hours. The training



system covers all areas listed in Annex I of Directive 2009/128/EC, in particular the principles of integrated pest management, the use of pesticide application equipment, the calibration of this equipment, their maintenance, special application techniques and work with the least possible risk to the health of professional users, agricultural workers, other persons, non-target animals and plants, birds, mammals, bees and the environment—including surface and groundwaters, the aquatic environment and the health of humans through food containing pesticide residues.

5. Regular inspections of pesticide application equipment - New equipment sold after 1 January 2013 is subject to regular inspection at least once in the period five years following purchase, and later subject to regular inspection at least once every three years. Pesticide application equipment in use is subject to regular inspection at least once every three years after the last inspection. Regular inspections of devices will be carried out by authorised testing stations that must meet the stipulated requirements on equipment and employees. The inspection verifies whether the devices satisfy the requirements set out in Annex II of Directive 2009/128/EC and relevant standards in order to achieve a high level of safety, human health protection and environmental protection.

6. Trade and sale of plant protection products - Record keeping on sold quantities of PPPs and report to the Ministry of Agriculture on total annual sales of PPPs to end consumers has been established. Training for all distributors and advisors in sales with the aim of raising the level of knowledge and improving the quality of advice provided to end professional users of pesticides is being conducted. Furthermore, the sale, provision of advice and purchase of PPPs targeted to professional users is prohibited to persons who have not acquired initial training . The ban shall be in force as of 26 November 2015. Upon acquiring initial training, those for whom training is compulsory shall be required to undertake additional training at least once every five years.

### 2.2.3. BP PA3 Encouraging organic farming

#### Description of the measure

According to EUROSTAT, in 2010 there was 15 913 ha of organic farming area in Croatia, while in 2015 75 883 ha were reported, resulting in increase of 367% in organic farming area, with tendency to rise even more. In 2011 Ministry of Agriculture issued Action Plan for Development of Organic Farming in Croatia for period 2011-2016, which harmonized the Croatian legal framework for organic agriculture with the EU acquis, established monitoring of authorized and accredited control and certification bodies for organic agriculture, insured a financial support scheme for agriculture holdings and individuals, established advisory services as well as training and education, and finally, assistance with marketing and distribution.

### 2.2.4. BP PA4 Advisory services, farm management and farm relief services

#### Description of the measure

In conditions of increasing specialization and strict environmental requirements in agriculture, food production and food processing industry and forestry, tailored and qualified individual advice on the use of new technologies, as well as approaches and techniques for mitigation and adaptation to



climate change is needed to improve the sustainable management of natural resources and the economic and environmental performance of farms and forest holdings. New requirements lie before farmers and forest owners in Croatia thereby widening the role of Advisory Services such as the reduction in pesticide use in accordance with the National Action Plan, the protection of soil and water, animal health and welfare, the implementation of agri-environmental measures, reducing air pollution, management of Natura 2000 areas, etc. Currently, the Advisory Service is providing assistance and services to rural stakeholders with reference to IPARD measures through its well-distributed network of county offices. However, given the significant widening of the scope of support in the RDP (Rural Development Programme of the Republic of Croatia for the Period 2014-2020), including to new sectors such as the forestry sector, and the need to provide RDP beneficiaries with tailored advice on the use of new technologies, responsible management of natural resources as well as mitigation and adaptation to climate change, the provision of advisory services faces constant need to be increased. This includes tailored advice to the agricultural sector on the reduction of GHG (greenhouse gas) and ammonia emissions. Furthermore, specific training for those providing advisory services given the new requirements and wider scope of activities listed above is necessary.

Indicative, non exhaustive topics on which advice may be offered are:

- Cross-compliance obligations (Regulation (EU) No 1306/2013), the relevant criteria and minimum activities (Regulation (EU) No 1307/2013), relevant minimum requirements for fertilisers and plant protection products use, and relevant mandatory requirements established by national law;
- The sustainable use of pesticides (such as the minimum requirements for plant protection products use, general principles for integrated pest management introduced under Directive 2009/128/EC, requirements to have a licence to use the products and meet training obligations, requirements on safe storage, the checking of application machinery and rules on pesticide use close to water and other sensitive sites as established by national legislation: Act on sustainable use of pesticides (OG 14/14);
- The Codes of Good Practice introduced under Directive 91/676/EEC for farms outside Nitrate Vulnerable Zones, and requirements concerning phosphorous pollution;
- Agri-Environmental practices;
- Organic farming;
- Natura 2000 areas and areas of high natural value introduced under Regulation on the Ecological network (OG 124/2013);
- Biodiversity preservation and protection;
- Mitigation and adaptation to climate change; Kyoto protocol basic, farm management activities contributing to climate change mitigation and/or adaptation;
- Water protection in accordance with Water Framework Directive (Directive 2000/60/EC).



Through the RDP (networks and operational groups), cooperation in INTERREG Europe (thematic platforms) and other Cooperation programmes and thematic networks foreseen under Horizon 2020, knowledge exchange can better orientate R&D activities and improve innovation transfer which could affect not only technological and productive areas but also the organisational sphere (Rural Development Programme of the Republic of Croatia for the Period 2014-2020).

#### 2.2.5. BP PA5 Increasing the efficient use of water in agriculture and adapting to climate change

##### Description of the measure

Croatia is increasingly exposed to extreme weather conditions causing floods and droughts, attributed to climate change. Drought in Croatia occurs on average every three to five years and depending on intensity and duration can reduce crop yields by 20-70 % and cause billion damages in agricultural production. Considering Croatian natural resources, which are favourable temperate climate, good soil and rich water resources irrigation is not carried to the extent offered by the real opportunities, as indicated by the fact that in 2011 in Croatia only 1,1 % of agricultural land was irrigated. National strategy adopted in 2004 (National Project of Irrigation and Management of Agricultural Land and Water in the Republic of Croatia) has set a target that by 2020 on 65.000 ha of agricultural land irrigation will be provided, giving priority to agricultural land that has a high and very high suitability for irrigation (484.026 ha). Construction of irrigation infrastructure and the introduction of sustainable irrigation techniques on farm allows improving economic performance of agricultural holdings and facilitate process of restructuring and modernization and provide an effective mechanism at farm level for climate-change adaptation and mitigation of the damage caused by drought. The modernization and reconstruction of existing on farm irrigation systems lead to an increase in water efficiency. The development of irrigation infrastructure is only undertaken where it does not conflict with the Water Framework Directive (Directive 2000/60/EC) and does not cause any deterioration in water status. Furthermore, all actions include the appropriate prevention and mitigation measures to offset potential environmental impact.

#### 2.2.6. BP PA6 Soil erosion prevention and increasing of soil fertility and soil organic matter

##### Description of the measure

Loss of soil and soil fertility due to erosion in Croatia is significantly higher than the EU average, and 23 % of agricultural land is at high risk of soil erosion. A particularly negative effect of soil erosion occurs on cultivated soils without vegetation cover for a certain period during the year. The removal of topsoil means the disappearance of the organic matter essential for soil fertility. Forming ridges and gullies makes mechanisation harder and reduces the net surface suitable for usage. Long-term use of synthetic and mineral fertilizers and pesticides has had negative impact on organic components, ultimately impoverishing the soil and reducing the quality of other segments. To reduce the negative effects of erosion or prevent it entirely, it is necessary to provide vegetation cover throughout the year, especially on slopes. A rich root system of permanent pastures and meadows retains humus, reducing the impact of intense rainfall, thus imposing the need to maintain such





surfaces. Increasing the land permanently covered with vegetation increases organic matter in the soil, which has an irreplaceable role in the formation of granular structure. This increases aeration, drainage and the water capacity of the soil making humus rich soils less exposed to erosion. The biggest erosion damage caused by rainfall is visible on arable land; sowing inter row crops and proper soil management will reduce this. For perennial crops on slopes, negative erosion impact is reduced by maintaining vegetation cover between rows as well as the construction and maintenance of terraces. About 10 % (110.000 ha) of utilised agricultural land benefits from implementation of measures programmed for the protection of soil.

### 2.2.7. BP PA7 Maintenance of water, soil and air quality in agriculture

#### Description of the measure

Lack of education and awareness among farmers of the importance and benefits of sustainable management of ecosystems in agriculture has resulted in intensive agricultural practices and over-usage of fertilizers and pesticides with a consequent significant environmental impact. Inappropriate levels of fertilization and improper manure storage are the main ground water nitrate polluters. 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. Inappropriate manure disposal additionally contaminates the soil, water and air so it must be stored properly thereby reducing emissions of greenhouse gases in the atmosphere. This contributes to achieving the overall objectives of the Water Framework Directive. In addition to training on the use and disposal of fertilizers, farmers must receive essential information about the responsible use of pesticides and waste disposal, in order to raise the level of knowledge about agricultural practices and methods that reduce the negative environmental impact of agriculture (organic farming, the introduction of a wide crop rotation, mulching) which ultimately reduce the impact of agriculture on climate change. Sustainable agricultural production includes reduced energy consumption; thus there is a need to modernize farms through the construction and reconstruction of facilities, purchasing machinery and the application of technology, especially in the livestock sector, which best reduces the emission of greenhouse gases and air pollutants into the atmosphere. Livestock farms can be a source of air pollutants such as dust particulates, microorganisms and gases, including ammonia and carbon dioxide, potentially harmful to the welfare of farm workers, livestock and surrounding areas, which could be addressed by innovative approaches to air cooling, air circulation and air purification. Strengthening cooperation with the scientific community to address these challenges through the take-up of innovation by farmers is also needed.



## 3. General Best practices

In this section we will describe best practices which are divided into two main groups: drinking water protection measures and flood measures.

### 3.1 Drinking water protection measures

#### 3.1.1. BP DWPM1 Establishment of sanitary protection zones

##### Description of the measure

Sanitary protection zones are protected areas, or areas of special water protection, where additional protection measures need to be implemented in order to protect waters and the aquatic environment. In line with the Waters Act, areas or springs or other water deposits that are used or are reserved for the public water supply, as well as areas where water is captured from rivers, lakes, reservoirs or the like for the same purpose, must be protected from intentional or accidental pollution and from other impacts that could negatively affect the health suitability of the water or its abundance.

In Croatian case, particular interest is put on springs that capture groundwater (84 % of drinking water is abstracted from GW). Sanitary protection zones in this case are divided according to type of aquifer:

1a) Sanitary protection zones for springs that capture groundwater from aquifers with intergrain porosity are:

- restriction and control zone - zone III,
- strict restriction and control zone - zone II, and
- strict protection and control regime zone - zone I.

1b) Sanitary protection zones for springs that capture groundwater from aquifers with fracture and fracture-cavern porosity are:

- restriction zones - zone IV,
- restriction and control zones - zone III,
- strict restriction and control zones - zone II, and
- strict protection and control regime zones - zone I.



Table 1. Restrictions and prohibitions within the individual sanitary protection zone

zone		Aquifer with intergrain porosity
III		wastewater discharge without previous treatment
		temporary or permanent waste disposal
		construction of facilities for recovery, treatment and disposal of hazardous waste
		construction of chemical industrial facilities
		mining excluding geothermal and mineral waters
		exploration and exploitation wells, except for water research
II		all prohibitions from zone III and
		agricultural production, except ecological (organic)
		cattle production (maximum 20 livestock units)
		recycling or waste transfer stations
		the formation of new cementeries and expansion of existing
		discharge of treated and untreated wastewaters from roads
I		all activities except those related to abstraction, conditioning, transfer of water in the supply system.
		Aquifer with fracture and fracture-cavern porosity
IV		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		all prohibitions from zone IV and
		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		all prohibitions from zone III and
		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		all activities except those related to abstraction, conditioning, transfer of water in the supply system.
		all activities except those related to abstraction, conditioning, transfer of water in the supply system.





In sanitary protection zones active or passive protective measures are undertaken. Passive measures include restrictions and prohibitions (as seen in Table 1.), while active measures, which are proposed by an expert (eg. hydrogeologist) and approved by competent authority, include:

- monitoring of water quality on entire catchment area
- construction of public water supply infrastructure
- construction of waste water infrastructure (sewage)
- encouraging clean industry and organic farming
- construction of proper manure storage areas

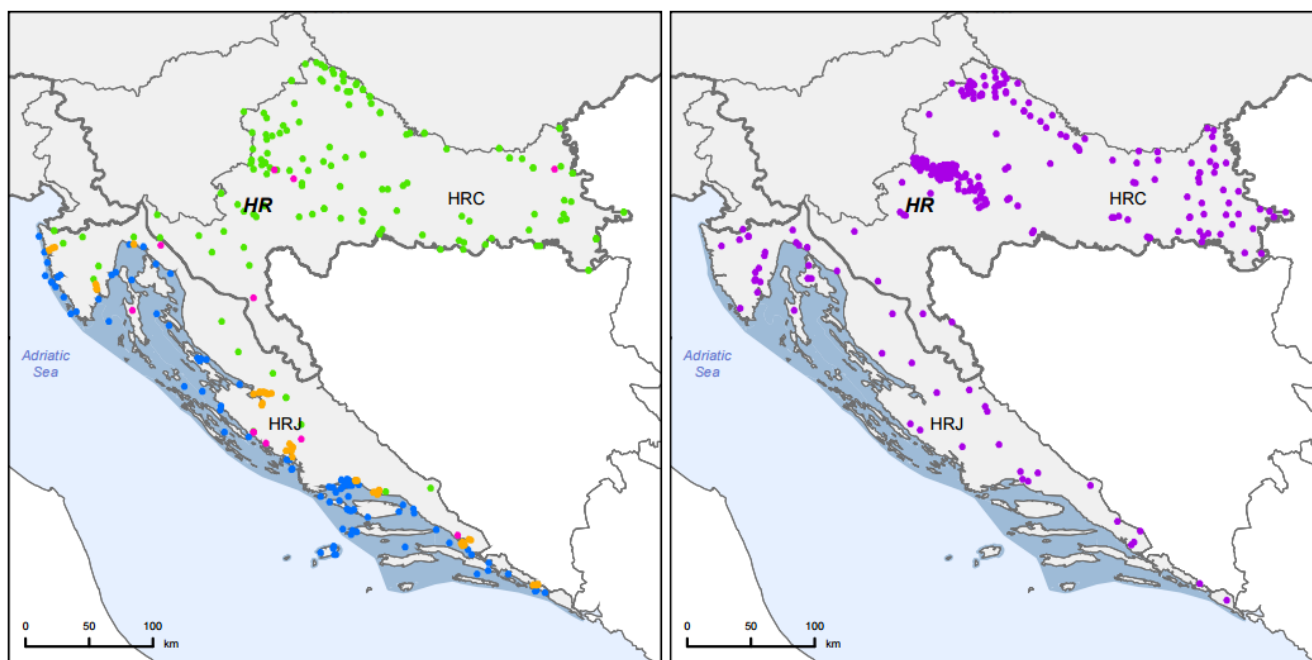
### 3.1.2. BP DWPM2 Monitoring of ground and surface waters

#### Description of the measure

Monitoring of water quality is performed by the Head Water Management laboratory of Croatian Waters, and laboratories authorised by the Ministry of Agriculture. Indicators that are being monitored:

- volume, level, flow, speed, hydromorphological characteristics, ecological and chemical status, and ecological potential for surface waters,
- ecological and chemical status and ecological potential for coastal waters,
- chemical status for waters of the territorial sea, and
- quantity and chemical status of groundwater.

In Croatia there are 281 surface water monitoring sites and 371 groundwater monitoring sites. Three types of monitoring is being carried out: surveillance monitoring, operational monitoring and quantitative monitoring.



**Figure 1:** Maps of surface water (left) and groundwater (right) monitoring stations

- River monitoring stations
- Lake monitoring stations
- Transitional water monitoring stations
- Coastal water monitoring stations
- Unclassified surface water monitoring stations
- Groundwater monitoring stations
- River Basin Districts
- Countries outside EU

**Source:** WISE, Eurostat (country borders)

Water quality for public water supply (drinking water) is supervised by the Croatian Institute for Public Health. Samples for water quality control are taken minimum four times a year.

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 tested 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,  $\text{KMnO}_4$  consumption, residues of disinfectants (sip, chlorite, chlorate, ozone, ...), temperature, and microbiological parameters: escherichia coli, total coliforms, enterococci, the number of colonies  $22^\circ\text{C}$ ,  $37^\circ\text{C}$  number of colonies, clostridium perfringens (including spores), pseudomonas aeruginosa. Those parameters for which it was established that the period of two years have not reached the limit, and that the risk assessment determines that there is little chance of finding discrepancies further sampling can be excluded in the annual monitoring.

### 3.1.3. BP DWPM3 Establishment of protected areas

#### Description of the measure

In Croatia, over 2700 protected areas have been designated: over 900 areas are designated for drinking water abstraction under Art. 7 of the WFD and a similar number are designated as bathing protected areas. According to WISE there are 649 protected areas in HRC (continental) river basin district and 254 in HRJ (adriatic) river basin district. Electronic register (Water Information System) operated by Croatian Waters has been established, and it is comprised of:

- register of protected areas for drinking water
- cadaster of water, water resources and water buildings
- cadaster of water protection and water usage
- cadaster of extreme hydrological phenomena
- cadaster of erosion conditions and measures against erosion
- database of measuring stations and laboratories performing water analysis

Water Information System keeps track of issued water permits and concessions for economic use of water (including amounts of abstracted water). Through the issuance of water permits, control is being performed, and if necessary, utilization of water resources is limited.

Furthermore, hydrological information system has been set up (HIS 2000). HIS 2000 is under the authority of Croatian Meteorological and Hydrological Services and available to public via <http://hidro.dhz.hr/>.

### 3.1.4. BP DWPM4 Measures for mitigating accidental and sudden pollution of waters

#### Description of the measure

In the reporting period 2009-2012 there have been 258 cases of water pollution (35 accidental and 223 sudden). Most common pollutants are: industrial wastewater discharge, traffic (including traffic accidents), municipal wastewaters, disasters related to oil/gas (transport accident, spills), pollution from oil industry, pollution from farms and pollution from unknown sources. In 2011 Croatia has issued „State plan - measures for mitigating accidental and sudden pollution“ (OG 5/11) which contains detailed guidelines, activities and plans which need to be undertaken in case of pollution event of any scale.

### 3.1.5. BP DWPM5 Proclamation of sensitive areas

#### Description of the measure

In compliance with the obligations resulting from the activities and decisions of the Danube River Protection Convention and Decision on determination of sensitive areas (OG 23/10), Croatia proclaimed the area of the Danube river basin a sensitive area due to eutrofication of the Danube



Delta and applied more advanced treatment with nitrogen and phosphorus removal in all agglomerations larger than 10.000 PE (population equivalent).

Croatia proclaimed the mainland part of the Adriatic Sea basin a single sensitive area for protection of protected areas designated for abstraction of water for human consumption and shall applied more advanced treatment with nitrogen and phosphorus removal if necessary in all agglomerations larger than 10.000 PE for all discharges into inland waters. In order to protect the areas designated for the abstraction of water for human consumption, the mainland part of the Adriatic Sea basin is given the highest level of protection. This is an area of significant strategic water reserves, whose protection is a national priority of utmost importance. This area is a karst area which, in comparison with other areas, has specific characteristics in view of groundwater flow and pollution transfer, which makes the implementation of groundwater and groundwater ecosystem protection measures additionally complex.

### 3.1.6. BP DWPM6 Emission into groundwaters

#### Description of the measure

Regulations strictly prohibit direct discharge of treated waste waters into groundwaters. Only indirect discharge is allowed, in following cases where:

- recharge area is at such distance from the discharge area that the costs of drainage would be irrationally high
- or
- it is proven that such discharge has no negative effect on status of groundwater and environment

### 3.1.7. BP DWPM7 Monitoring of production, import and use of chemical products

#### Description of the measure

As a way of reducing chemical pollution of waters, Croatia has put in power the new legislation concerning better monitoring of production, import, use and management of chemical products (eg. agriculture, industry). The Law on chemicals (OG 18/13) orders that records must be kept on all chemical products entering Croatia, which is being controlled by Croatian Institute for Toxicology and Antidoping.

Concerning use of chemicals in agriculture, regular monitoring of pollution state is being performed by Croatian Agricultural Agency.





Figure 2. Ploče harbour and Neretva estuary

## 3.2 Flood measures

Generally speaking, flood measures in Croatia can be divided broadly into 2 categories:

- Structural flood defence measures
- Non-structural flood defence measures

Existing prevention, protection and preparedness measures are in accordance with:

- Water Act
- National Flood Defence Plan
- Annual Maintenance Programme of Regulation and Flood Protection Systems

Croatian Waters has the main responsibility for the Flood Defence.

### 3.2.1. Structural flood defence measures

#### 3.2.1.1. BP FM1 Construction and regulation

##### Description of the measure

Croatian Waters have initiated large-scale structural activities in order to address the hot spots, e.g. reconstruct and extend particular parts of the flood defence system, as well as in order to construct new water regulation and protection structures for the purpose of further development of the flood defence system.

Structural measures defined in 2015 were:

- 3,935 km of watercourses of first order
- 17,000 km of watercourses of second order
- 4,100 km of dikes
- 60 multipurpose reservoirs with a total volume of 1.0 billion m<sup>3</sup>
- 44 upland retarding basins
- 5 large natural retarding basins with a total volume exceeding 2.0 billion m<sup>3</sup> (Odransko polje, Lonjsko polje, Mokro polje, Zelenik, and Kopački rit)
- 3 large flood relief canals (Sava-Odra, Lonja-Strug, Kupa-Kupa)
- 2 connecting canals (Zelina-Lonja-Glogovnica-Česma, Ilova-Pakra)
- 900 km of lateral canals
- 9 drainage tunnels in the total length of app. 17.3 km
- Plenty minor water regulation and protection structures

### 3.2.2. Non-structural flood defence measures

#### 3.2.2.1. BP FM2 Flood hazard and flood risk maps

##### Description of the measure

During 2013 and 2014 Croatia participated in EU IPA 2010 TWINNING PROJECT "Development of Flood Hazard Maps and Flood Risk Maps" with purpose of implementing EU Floods Directive (with final aim of developing flood hazard maps and flood risk maps).

Developed flood hazard and flood risk maps are in 1:25000 scale and contain 3 scenarios:

- High probability  $T \approx 25$  years
- Medium probability  $T=100$  years
- Low probability  $T \approx 1000$  years - large dam and dike breach




Flood risk maps include following content: number of population in danger; land use data from CORINE Land Cover 2006; infrastructure (school, airport, hospital, ...); environment protection data from Register of protected areas (DWPZ, Natura 2000, national parks, ...) and cultural heritage data.

Maps are published in WebGIS format and are available to public via <http://voda.giscloud.com/> .



Figure 3. Flood hazard map

<http://voda.giscloud.com/map/321490/karta-opasnosti-od-poplava-po-vjerojatnosti-poplavljivanja>

-  High probability of flood hazard
-  Medium probability of flood hazard
-  Low probability of flood hazard



### 3.2.2.2. BP FM3 Operational flood control

#### Description of the measure

Operational flood control is being implemented according to National Flood Defence Plan (Official Gazette No. 84/10). Flood defence is spatially organized into river basin districts, sectors, areas and sections. Responsible body for the implementation of operational flood control is Croatian Waters. Status of operational flood control is generally regarded as good, with numerous successful actions to support that claim. National Flood Defence Plan sets out the following sets of measures:

#### Monitoring, planning and study measures:

- planning and implementation of the water monitoring system of water regime and announcements of flood waters
- planning and development of mathematical simulations and forecast systems of hydrological models
- planning and management of flood risks by monitoring the development of spatial planning documents and by the issuance of water rights acts
- creation and updating of implementation plans of flood
- update of hydrological forecasting models
- maintenance and upgrading of information and communication system

#### Water regulation measures:

- planning and implementation of construction, reconstruction and extension of the protective buildings and structures for basic amelioration drainage that can accept and evacuate high waters
- planning and implementation of maintenance of natural and artificial watercourses and other waters, regulation and protection of buildings and structures for basic amelioration drainage in flood control system

#### Preventive preliminary work:

- regular checks on the state (condition) of structures
- regular checks on the state of river beds
- ensuring adequate retention area for reception of high waters
- ensuring adequate equipment and materials for flood defence and its storage

#### Direct measures of regular and extraordinary flood protection:

- forecast time and size of encountering water wave
- frequent checks on the condition of protective building and structures



- further work on protective building, structures and melioration drainage that can accept or evacuate high waters
- removal of causes that impede the flow of water in waterbeds
- functional provision of the facilities built for the relief of high waters (drainage canals, accumulations with retention area, overflows, dams...)
- construction of second defence line in case there is risk of breach, demolition and overflow of protective buildings
- in case of flooding caused by ice accumulation in streams or when ice barriers (caps) which interfere with the flow of the water are present, breaking the ice surface and preventing and stopping the accumulation of ice masses in waterbeds

#### Actions after the end of regular flood protection:

- urgent overhaul of regulative and protective structures in case new water waves may arise
- removal of waste, sediment or any other flotsam caused by water wave
- geodetic survey of the flood line
- data acquisition (e.g. actions, material costs, expenses) followed by reimbursement of expenses
- preparation of a comprehensive report on the conducted flood control with proper analysis and assessment of implemented measures

#### 3.2.2.3. BP FM4 Monitoring and forecasting of hydrometeorological phenomena

##### Description of the measure

For more efficient implementation of the operational flood protection, Croatian Waters and Croatian Meteorological and Hydrological Services have automated the majority of water level meters, making data on water levels available in real-time. Data is available to centers for flood control, teletext of Croatian National Television, website of Croatian Waters as well as all mobile phone users.

Hydrological forecasting is insufficiently developed. Croatian Waters and Croatian Meteorological and Hydrological Services are putting effort into improvement.

Meteorological data from automated stations are available in real-time to flood control centers and Croatian Waters, via special web-portal.

#### 3.2.2.4. BP FM5 Water resources

##### Description of the measure

To prevent inappropriate use of land which plays important role in maintaining of water regime, the Law on Waters (Official Gazette. No. 153/09, 63/11, 130/11, 56/13) defines particular land particles (water-bearing and abandoned river beds of inland surface waters, regulated and unregulated inundation zones and islands in the water-bearing beds) as water resources. If a land particle is declared as a water resource, it is enter into land registers and spatial plans, and the law perscribes measures and limitations for such zones. Main issue - disorderly registers.

#### 3.2.2.5. BP FM6 Financial property insurance from uncovered flood risks

##### Description of the measure

Poorly developed so far, but by increase of market economy, insurance measures are expected to rise in the near future.

#### 3.2.2.6. BP FM7 Mitigation of risks due to sudden collapse or overflow of dams

##### Description of the measure

Prepared documentation about possible consequences of sudden collapse or dam overflow. Possible flood zones have been designated and systems for population alarming have been developed.



Figure 4. Vrgorac field during flood



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Workshop on Flood Risk Management measures & links to EU WFD



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