4.4. Joint report on proposal of measures for crossborder water resources protection and management for Adriatic area

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DRINK ADRIA

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CONTENT

1. Introduction

In the Adriatic region water resources are facing different human and natural pressures, causing alterations in water quantity and quality. In last decades increase in temperature and increased frequency of droughts and heavy precipitation events have been observed [1]. At the same time in this region there are areas with common problems regarding drinking water quantity and quality like increase in drinking water demand especially during summer touristic season, intensification of agricultural production, problems with salinization of groundwater, etc. [2]

In this region there are many transboundary (cross-border) water resources that are used for drinking purpose (resources that are used for water supply in one country with a part of aquifer / catchment in another country). The protection and management of cross-border water resources used for drinking purpose is very complex. The EU Water Framework Directive (EU 2000/60) defines the need for a common definition and protection of water resources that are used for supplying population with drinking water. This is implemented by water management plans. But the drinking water protection areas are still defined for each country separately, with no consensus with the neighboring country [3]. So the improvement in protection and management of cross-border drinking water resources is necessary.

To be able to plan long term water supply it is necessary to analyse the availability and quality of drinking water (re)sources in the future. These analyses must take into account the impact of climate change and the socio-economic characteristics of the region. This is also important in planning cross-border water supply and should be addressed in the contract between two water utilities and also included in Water safety plans [4,5].

It must be stressed that within DRINKADRIA project the cross-border aspect of water supply and water resources is analysed between two countries but also between two or more regions within one country.

To encompass all previously addressed problems the following activities regarding the management of cross-border water resources used for drinking in the Adriatic region were carried out within Work Package 4 (WP4) Cross-border water resources management (Figure 1.1.):
- Analyses of regional climate characteristics and climate change (activity 4.1.),
- Analyses of present and future risks on water (re)sources availability (activity 4.2.),
- Analyses of present and future water safety and risk imposed to water (re)sources (activity 4.3.),
- Improvement of cross-border water (re)sources protection and management (activity 4.4.).

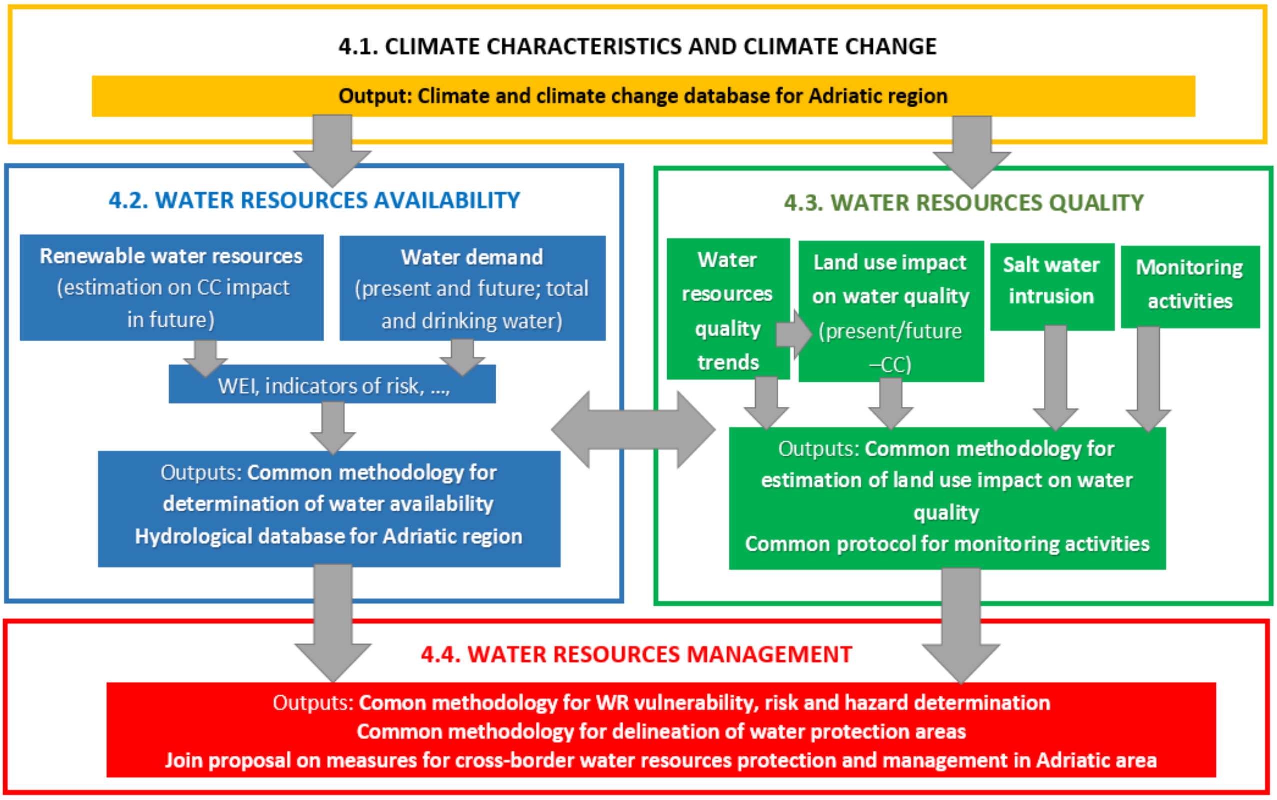

Figure 1.1. WP4 – Cross-border water resources management activities and outputs

In each activity one or more outputs and results were expected. In these outputs the results of all activities carried out by FBs in WP4 are collected and analysed so that joint conclusions, recommendations, guidelines and measures could be prepared.

Partners involved in WP4 activities are:

- LB: AcegasApsAmga jointly with DMG – UNITS, Italy
- FB2: Optimal Territorial Area Authority N. 3 Marche Centro – Macerata, Italy
- FB3: CNR-IRSA, Italy
- FB5: Faculty of Natural Sciences and Engineering, University of Ljubljana, Slovenia
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- FB14: Public Utility "Vodovod i kanalizacija" Niksic, Montenegro
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List of outputs for WP4 from Application Form (AF) are:

- Climate and climate change data base for Adriatic area
- Hydrological data base for Adriatic area
- Common methodology for determination of water availability, incl. development of common indicators of risks (water pollution, scarcity) and determination of present/future water demand
- Water quality trends for pilot areas (water resources)
- Report on common methodology for estimation of climate change-induced land use changes
- Common protocol for water sources monitoring activities in the Adriatic Region
- Common methodology for water resources vulnerability, risk and hazard determination
- Common methodology for delineation of water protection areas (incl. measures)
- Joint report on proposal of measures for cross-border water resources protection and management for Adriatic area

List of results for WP4 (form AF) and in brackets the number of stakeholders and end-users that were involved in the project through workshops, conferences, lectures etc.:

- Stakeholders and end users better informed about future climate data (more than 1080)
- End users with improved knowledge about uncertainties influencing climate change adaptation measures (more than 590)
- Experts and stakeholders with improved knowledge about water availability determination methodology (more than 496)
- Stakeholders and end users with improved information about future water availability (more than 557)
- Experts and stakeholders with improved knowledge about impact of land uses on drinking water quality (more than 1460)
- Stakeholders and end users with improved knowledge about future water safety (more than 538)

In the following chapters WP4 activities will be presented with core results, conclusions and at the end with proposed recommendations, guidelines and measures to improve the cross-border water resources protection and management in the Adriatic area. These recommendations, guidelines and measures can be applied in other similar areas.

In Annex I is added a more detailed report on Cross border resources management - Water Safety Plans, since Water Safety Plan is the most effective means of consistently ensuring the safety (quality and quantity) of drinking water supply through the use of a comprehensive risk assessment).

2. Activities in WP4 – Cross-border water resources management

2.1. Regional characteristics of climate and climate change

According to international and national studies the Mediterranean region is expected to undergo particularly negative climate change impacts over the next decades, which, combined with the effects of anthropogenic stress of natural resources, make this region one of the most vulnerable areas in Europe. The anticipated negative impacts are mainly related to possible extraordinary heat spells (especially in summer), increased frequency of extreme weather events (heat waves, droughts and severe rainfalls) and reduced annual precipitation [6].

In order to analyze the availability of water resources in Adriatic area within DRINKADRIA project it was important to prepare the database of climate and climate change including observed characteristics and simulated climate change for the future within the *Activity 4.1. Regional characteristics of climate and climate change*. Climate analyses were made on national, regional and test areas level [7]. Test areas analysed in work package 4 are marked on Figure 2.1.1.

Figure 2.1.1. Test areas in WP4

Reports on national level for most countries are based on National Communications under the United Nations Framework Convention on Climate Change (UNFCCC) with additional information from other national studies and documents.

For future climate simulations SRES (Special Report on Emissions Scenarios) scenarios were used for most countries involved in the project. The IPCC (Intergovernmental Panel on Climate Change) published a new set of SRES scenarios in 2000 for use in the Third Assessment Report [8]. The SRES scenarios were constructed to explore future developments in the global environment with special reference to the production of greenhouse gases (GHGs) and aerosol precursor emissions. A detailed description of A1 (including A1FI, A1T and A1B), A2, B1 and B2 storyline and scenario family is available on IPCC website [9].

Based on data about climate and climate change simulations for future on national and regional level, it is concluded that the increase of temperature is predicted in all DRINKADRIA countries. The predicted temperature rise varies by country, depending on the analyzed period, SRES scenario, season of the year, part of the country, etc. Regarding the precipitation, changes vary in the sign depending on the season and part of the country. Changes in precipitation also depend on the analyzed period. However, predictions about precipitation are less reliable [7].

Climate change simulations for future on national level are given in Table 2.1.1. Reference period is 1961-1990 for all countries, except for Albania where reference period is 1980-2004, and for Italy where is not specified.

For climate change analysis on test areas the following methodology was used. The period 1961-1990 was selected as the baseline period for the present climate conditions (as recommended by the World Meteorological Organization). Climate change simulations for future are shown on most test areas for the period 1951-2050 [7].

Present and future climate is assessed based on the results from numerical simulations of the three regional climate models (RCMs) - Aladin, Promes and RegCM3. Those models and methodologies were developed and used in the CC-WaterS project (SEE) [10] and in the ENSEMBLES project (FP6) [11]. The initial and boundary data for each RCM were provided from different global climate models (GCMs) [12]. The mentioned RCMs were not used for test areas in Albania and Greece. The following abbreviations were used in the analyses: *RCMcorr* (the RCMs' output was bias corrected by EOBS data) and *RCMcorr_adj* (further adjusted model time series due to the differences between EOBS data and local observations). In case of test area Isonzo Plain, a different definition of *RCMcorr* is given (*RCMcorr* is further adjusted model time series due to the differences between the CC models data and local observations) [7].

These are some of the limitations of the methodology [12]:

- When using the IPCC scenarios it should be taken into account that the higher GHGs emission scenarios are usually associated with the higher temperature increase.
- In the analysed RCM simulations of the reference climate, the RCMs are not reproducing the actual variability observed in the real climate system. Specific values indicated in the time series do not signify a specific prediction for a specific year.

Table 2.1.1. Climate change simulations for the future in Adriatic region - national level [13]

Country	Period	Model and SRES scenario	Temperature	Precipitation
Italy			Possible extraordinary heat spells (especially in summer) and increased frequency of extreme weather events (heat waves, droughts).	The anticipated negative impacts are mainly related to increased frequency of extreme weather events (severe rainfalls) and reduced annual precipitation and river flow.
Slovenia	2001-2090	Simulation results with 4 MSC methods; six scenarios A1T, A1FI, A1B, A2, B1, B2	Temperature is expected to rise by 0.5 °C to 2.5 °C (2001 - 2030), from 1 °C to 3.5 °C (2031 - 2060), for 1.5 °C to 6.5 °C (2061 - 2090) (for Ljubljana).	The predictions of changes in annual precipitation are less reliable. The projected changes in annual precipitation in the future range from +10% to -30% (for Ljubljana).
	Aladin and RegCM: 2021-2050, 2071-2100. Promes: 2021-2050	RCMs: Aladin, Promes and RegCM A1B	The future simulations showed the increase on average more than 3°C.	Precipitation data manifests a high degree of ambiguity. General trend pointing to less precipitation in the summer. All models predict an increase of precipitation in autumn (at location Ljubljana).
Croatia	2011-2040 2041-2070	RegCM A2	Period 2011-2040: winter: temperature increase of 0.6°C; summer: 1°C. Period 2041-2070: winter: increase up to 2°C (continental part) and up to 1.6°C (south); summer: up to 2.4°C (continental Croatia), and up to 3°C (coastal zone).	Period 2011-2040: Small changes limited to smaller areas. They vary in the sign depending of the season. The biggest change can be expected in the Adriatic in autumn when RegCM indicates a decrease of precipitation with a maximum of approximately 45-50 mm in the southern Adriatic (not statistically significant). Period 2041-2070: During summer in the mountainous Croatia and in the coastal area a decrease in precipitation is expected. Reductions reach value of 45-50 mm (statistically significant). During winter an increase in precipitation in north-western Croatia and on the Adriatic can be expected (not statistically significant).
Bosnia and Herzegovina	2001-2030	EBU-POM A1B	The mean seasonal temperature change is expected to range from +0,6 to +1,4°C, depending on the region of BiH.	Model showed positive and negative variations. During spring from +5% and during summer even up to +15% (in the north-east part of BiH); up to -20% (in the other parts of BiH, especially south).
Montenegro	2001-2030	EBU-POM A1B	Seasonal changes in mean temperature in the range of +0.6°C to +1.3°C, depending on the season and the area of Montenegro.	Model results show negative and positive changes in precipitation, depending on the part of Montenegro and the season. Positive changes up to 5% (season JJA for the central area of Montenegro, and for the MAM season in parts bordering BiH). Decrease from -10% to 0% (in other areas of Montenegro during the seasons DJF and MAM). Deficient rainfall and the highest values of -20% (MAM season, almost over the whole territory).
Serbia	2001-2030	A1B	The average temperature change on the annual basis is around +1°C.	Change in precipitation is between -5% to +5%.
Albania	2025-2049 2050-2074	GFDL-ESM2M	Period 2025-2049: during winter increase of 3°C is expected, and 4°C during summer. Period 2050-2074: the expected increase during winter is up to 4°C, and during summer up to 4.5°C.	Significant decrease of precipitation. Although total precipitation is expected to decrease, the number of days with heavy precipitation is likely to increase.
Greece	2021-2050	RACMO2 A1B	Mean minimum winter temperatures will be ~1.5ºC higher in 2021-2050. The increase in mean maximum summer temperatures will exceed 1.5ºC and in some cases reach 2.5ºC.	Maximum consecutive 3-day precipitation during 2021-2050 will remain essentially unchanged in regions like Western Greece, Eastern Macedonia-Thrace and Crete, but will increase significantly in others.

Models simulations of the future climate should be interpreted as projections of possible states of the climate system which is sensitive to applied initial and boundary conditions, GHGs scenarios and the model internal configuration [12].

In test area ATO 3, test area Ostuni and Croatian test areas, the RCMs were forced by the observed concentrations of the GHGs from 1951 to 2000; from 2001 onwards the IPCC A1B scenario of the GHGs emissions is applied [7].

On all test areas an increase of temperature is predicted in the future period. Precipitation trends on test areas are diverse, they vary depending on the selected station, model (Aladin, Promes, RegCM3 or other) and time series (RCMcorr or RCMcorr_adj) [7]. It is interesting to note that for example in Albanian test area precipitation is expected to decrease, but the number of rainy days with hazardous rainfalls is expected to increase [14]. Climate and climate change simulations for future on test area level are given in Table 2.1.2.

Temperature and precipitation trends for six selected meteorological stations are presented on Figure 2.1.2., as results of the climate change simulation using model Promes (since in general this model estimated possible highest changes) [15].

Figure 2.1.1. Test areas in WP4 with marked meteorological stations relevant for Figure 2.1.2.

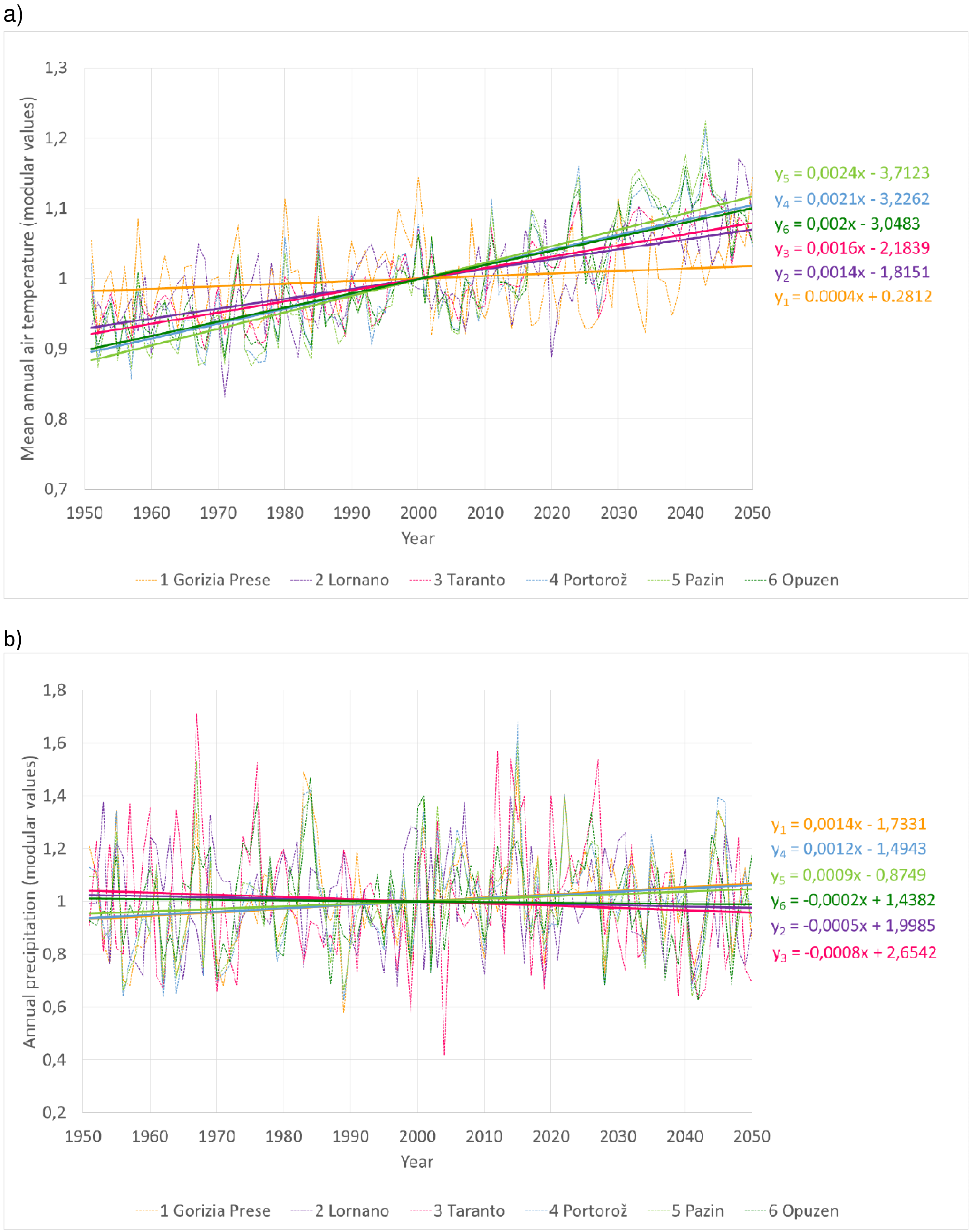


Figure 2.1.2. Mean annual air temperature (a) and annual precipitation amount (b) in modular values for model Promes for several selected meteorological stations

Temperature and precipitation scenarios from three Regional Climate Models (RegCM3, Promes and Aladin) have been developed through downscaling to observed land data by FBs in activity 4.1 (except for Albanian and Greek test areas).

In general, results from this activity show an increase of temperature in the Adriatic region and on test areas (that is statistical significant). The trends in precipitation are less reliable, showing changes in annual precipitations that decrease on some areas and increase in other. Precipitation trends are not statistically significant.

The most significant decreases in precipitation are observed in the southern areas of the Adriatic region, resulting in a stronger reduction in terms of water availability [15].

Table 2.1.2. Climate change simulations for future in Adriatic region - test area level [13]

Test area	Station	Model	Time period	Temperature	Precipitation
ITALY: Friuli Venezia Giulia Region - Isonzo Plain	Gorizia CBPI	Regional climate models (RCMs): Aladin, Promes, RegCM3. The ECHAM5 GCM data were used to force RegCM3, Aladin was forced by the Arpege GCM and Promes was forced by the HadCM3Q GCM.	2001-2100	Annual mean temperature (corrected models): 0.34°C/10y (ARPEGE), 0.38°C/10y (ECHAM5), 0.17°C/10y (PROMES).	Annual precipitation amount corrected (RCMs corr): -28 mm/10y (ARPEGE), 26 mm/10y (PROMES), 12 mm/10y (ECHAM5).
	Torviscosa		2001-2100	RCMs corr: 0.3°C/10y (ARPEGE), 0.5°C/10y (PROMES), 0.4°C/10y (ECHAM5).	RCMs corr: -22 mm/10y (ARPEGE), -30 mm/10y (PROMES), -11 mm/10y (ECHAM5).
	Alberoni		2001-2100	RCMs corr: 0.3°C/10y (ARPEGE), 0.5°C/10y (PROMES), 0.4°C/10y (ECHAM5).	RCMs corr: -19 mm/10y (ARPEGE), -13 mm/10y (PROMES), -6 mm/10y (ECHAM5).
ITALY: Marche Region - ATO 3	Lornano	RCMs: Aladin, Promes, RegCM3. The ECHAM5 GCM data were used to force RegCM3, Aladin was forced by the Arpege GCM and Promes was forced by the HadCM3Q GCM.	1951-2050	RCMcorr: All models simulate statistically significant increasing trends in the mean annual temperature from 0.16 °C/10yr (RegCM3) to 0.30 °C/10yr (Promes).	RCMcorr: RegCM3 and Aladin simulate decreasing trend in the annual precipitation amount, while Promes simulates increasing trend. These trends are not statistically significant.
	Montemonaco		1951-2050	RCMcorr: All models simulate statistically significant increasing trends in the mean annual temperature from 0.17 °C/10yr (RegCM3) to 0.32 °C/10yr (Promes).	RCMcorr: All models simulate decreasing trend in the annual precipitation amount, but these trends are not statistically significant.
ITALY: Apulia Region - Ostuni	data for station Ostuni is extracted (10 stations are shown in the report)	RCMs: Aladin, Promes, RegCM3. The ECHAM5 GCM data were used to force RegCM3, Aladin was forced by the Arpege GCM and Promes was forced by the HadCM3Q GCM. (RCM model output downscaled to the observed time series through a q-q plot procedure).	1951-2050	Annual mean temperature trend (°C/10yr): RCMcorr: RegCM3 (0.19), Aladin (0.28), Promes (0.29). RCMcorr_adj: RegCM3 (0.16), Aladin (0.24), Promes (0.24).	Annual precipitation amount trend (mm/10yr): RCMcorr: RegCM3 (2.8), Aladin (0.69), Promes (-2.63). RCMcorr_adj:RegCM3 (-0.3), Aladin (-4.84), Promes (-5.57).
	comparison among all 10 stations		1955-2050	Increasing temperature forecast by all RCMs.	The signs of trends are not equal for all the stations. Promes indicates a uniform in space decrease of precipitation, in the order of 2.5 mm/10yrs (corr), and in the order of 8 mm/10yrs (corr_adj). Aladin also forecasts a tendency to reduction of precipitation, but less significant than Promes and not uniform in space.
SLOVENIA: Kobariški stol, Mia, Matajur and Mirna River catchments	Bilje	RCMs: Aladin, Promes, RegCM3. Analyses with RCM corrected and RCM corrected & adjusted data.	1951-2050	Decadal temperature trend: RCM bias corrected models (RCMcorr): Aladin (0.25), RegCM3 (0.17), Promes (0.32). RCM bias corrected and adjusted models (RCMcorr_adj): Aladin (0.25), RegCM3 (0.17), Promes (0.32). Trends for all three models have statistically significant regression at 5% significance level.	Decadal precipitation amount trend: RCMcorr: Aladin (1.17), RegCM3 (0.04), Promes (1.38). RCMcorr_adj: Aladin (1.17), RegCM3 (0.05), Promes (1.38). Aladin and RegCM3 have statistically non-significant trend at 5% significance level, and for Promes the trend is statistically significant.

	Portorož		1951-2050	Decadal temperature trend: RCMcorr: Aladin (0.25), RegCM3 (0.17), Promes (0.30). RCMcorr_adj: Aladin (0.25), RegCM3 (0.17), Promes (0.30). Trends for all three models have statistically significant regression at 5% significance level.	Decadal precipitation amount trend: RCMcorr: Aladin (0.85), RegCM3 (0.56), Promes (1.13). RCMcorr_adj: Aladin (0.85), RegCM3 (0.56), Promes (1.13). All three trends have statistically non-significant regression at 5% significance level.
CROATIA: Northern Istria – springs Gradole, Sv. Ivan, Bulaž	Pazin	RCMs: Aladin, Promes, RegCM3. The ECHAM5 GCM data were used to force RegCM3, Aladin was forced by the Arpege GCM and Promes was forced by the HadCM3Q GCM.	1951-2050	RCMcorr: All models simulate statistically significant increasing trends in the mean annual temperature from 0.17 °C/10yr (RegCM) to 0.31 °C/10yr (Promes).	RCMcorr: All models simulate increasing trend in the annual precipitation amount, but not statistically significant.
CROATIA: Southern Dalmatia – spring Prud and Blatsko polje	Opuzen		1951-2050	RCMcorr: All models simulate statistically significant increasing trends in the mean annual temperature amounting to 0.19 °C/10yrs (RegCM), 0.27 °C/10yrs (Aladin) and 0.31 °C/10yr (Promes).	RCMcorr: Increasing trend for annual precipitation (RegCM3 and Aladin), decreasing trend (Promes). These trends are not statistically significant.
MONTENEGRO Nikšić	Nikšić	RCMs: Aladin, Promes, RegCM3.	1951-2050	RCM corrected models: Mean annual temperature trend equation - Aladin (y= 0.0312x - 50.939), Promes (y= 0.0323x - 52.976), RegCM3 (y= 0.0201x - 28.912). The reliability of T trends is relatively high.	RCM corrected models: Sum annual precipitation trend equation - Aladin (y= -0.2899x + 2558.6), Promes (y= -1.7665x + 5499.1), RegCM3 (y= -0.4401x + 2882.6).
	Lukovo		1951-2050	/	RCM corrected models: Sum annual precipitation trend equation - Aladin (y= -0.1897x + 2225.2), Promes (y= -1.6554x + 5143.6), RegCM3 (y= -0.4914x + 2844). The reliability of P trends is lower.
ALBANIA: Drini Basin	Theth, Shkoder A, Shishtavec, Peshkopi, Shupenze	A1BAIM scenario (Average values), A2ASF scenario (Min values), A1FIMI scenario (High values).	Years: 2030, 2050, 2080, 2100	The annual temperature is likely to increase (related to 1990) up to 1.8°C (1.3 - 2.4°C) by 2050; 2.8°C (2.1 - 4.1°C) by 2080 and 3.2°C (2.3 - 5.0°C) by 2100.	Annual precipitation changes related to 1990: -8.1% (-5.5 to -11%) by 2050, -12.9% (-8.4 to -21%) by 2080, -15.5% (-9 to -26.1%) by 2100.
GREECE: Corfu island	Gouvia	Ensemble (scenario A1B); Prudence (scenario A2); Prudence (scenario B2); REGCM (scenario A1B).	2021-2050	Temperature is expected to increase during all the seasons and annually. The average annual mean temperature is expected to increase from 1.23°C to 4.27°C depending on the model.	Total annual precipitation is expected to decrease from 3.93% to 25.4% depending on the model. Total precipitation decrease especially in the summer months. In the winter months two models predict a slight increase.

2.2. Present and future risks on water (re)sources availability with emphasis on drinking water supply

Changes in many extreme weather and climate events (heat waves, heavy precipitations, cold spells, etc.) have been observed since about 1950 and have especially affected water resources in terms of quantity and quality [1]. The pressure on water resources is also increasing due to the increase in water demand caused by development of human society and increased human activities. Partly the increase of water demand is also a result of climate change impact [16,17].

The Adriatic region as part of the Mediterranean basin is a very sensitive region from the climate change and anthropogenic impact aspect [18,19,20].

Surface runoff and recharge constitute basic hydrological information for determining the renewable water resources. In order to understand the impact of climate on renewable water resources it is worth analysing the changes together with alterations in the hydrological basis (long-term averages of the total runoff, spring rate or the recharge).

Results about climate change (temperature and precipitation) analyses performed in activity 4.1. (explained in 2.1.) were input data for calculation of change in water availability in test areas for the future period 2021-2050.

The common methodology to quantify the climate change impact on water availability was focusing mainly on the harmonised results, so uniform modelling tool was not proposed. The partners could use existing well known models or their own models to quantify CC impact on water availability.

In order to be able to compare the climate change impact on water resources in test areas it was agreed to calculate long-term average water resources conditions (average conditions water resources – ACWR) in m^3/s for the period 1961-1990 and if data were available it was agreed to calculate also characteristic renewable water resources (CRWR) in m^3/s for the same period.

Based on results from climate models and change in precipitation and temperature for the period 2021-2050 using available models it was agreed to calculate long-term average conditions (m^3/s) for the future period 2021-2050 and if data were available also characteristic renewable water resources (m^3/s) for the same period.

Both for long-term average conditions and characteristic renewable water resources the change (in %) between results for the period 2021-2050 and the baseline period 1961-1990 had to be calculated [15].

It was important to use adequate models that were also calibrated and validated. Following the classification defined in the previous project CC-WaterS, resources are characterized according to estimated changes [10]:

- low changes ≤ 10% (green),
- medium changes 11-25% (yellow),
- high changes 26-50% (orange) and

- extreme changes >50% (red).

Tables 2.2.1. and 2.2.2. give core results of these analyses [15]. In Table 2.2.1. the representative values for test areas as the basis for the evaluation, providing basic information for the assessment of possible water shortages considering different scenarios of future water demands are presented for average conditions.

For Corfu (Greece) test areas changes in water resources availability are given by expert evaluation while in Marche region (Italy) only a qualitative assessment of water resources availability was done (Table 2.2-3). For test area in Slovenia only the present available water resources quantity was analysed. For all other test areas climate data (temperature and precipitation) from the climate models RegCM3, Aladin and Promes were used as input data for water resources modelling. Analyses carried in Croatian test areas covered also the mean annual discharge and lowest mean monthly discharge, so extreme conditions were analysed as characteristic renewable water resources (Table 2.2.2.).

Table 2.2.1. Basic hydrological information for the evaluation of the climate change on water resources for AVERAGE CONDITIONS [15]

Country	Test area	WR (m^3/s)				Changes in future (2021-2050) compared to baseline (1961-1990) in %		
		1961-1990	2021-2050					
			RegCM3	Aladin	Promes	**RegCM3**	**Aladin**	**Promes**
Italy	Isonzo plain - Gorizia Prese	41.6	41.6	40.8	42.7	**3.3**	**19**	**-11.2**
	Isonzo plain - Torviscosa	41.6	41.7	40.1	42.5	**5.9**	**18.8**	**-14.3**
	Isonzo plain - Alberoni	41.6	42.2	40.5	42.5	**9.1**	**16.7**	**-8.1**
	Ostuni- Adriatic	6.23	5.81	4.84	4.61	**-6.7**	**-22.3**	**-26.0**
	Ostuni - Ionic	5.24	4.86	4.80	3.46	**-7.3**	**-8.4**	**-34.0**
Croatia	N. Istria – Gradole	2.17	2.13	2.08	2.00	**-1.9**	**-4.1**	**-7.8**
	N. Istria –Sv. Ivan	0.92	0.92	0.86	0.60	**-0.3**	**-6.5**	**-34.9**
	N. Istria – Bulaž	1.70	1.56	1.55	2.22	**-6.3**	**-8.8**	**30.8**
	S. Dalmatia - Prud	6.16	5.60	5.39	5.01	**-9.1**	**-12.5**	**-18.7**
	S. Dalmatia - Blatsko polje	0.287	0.259	0.235	0.222	**-9.8**	**-18.1**	**-22.6**
Montenegro	Nikšić	1.26	0.88	0.89	0.86	**-30.2**	**-29.4**	**-31.75**
Albania	Drini basin – Drini river	(1951-1985) 360	340	310	290	**-5.6**	**-13.9**	**-19.4**
	Drini basin – Buna	(1951-1985) 320	305	290	275	**-4.7**	**-9.4**	**-14.1**
	Drini basin – Drini+Buna	(1951-1985) 680	645	600	565	**-5.1**	**-11.7**	**-16.8**
	Drini basin – Drini of Lezha	(1951-1985) 30	27	25	22	**-10**	**-16.7**	**-26.7**
Greece	Corfu - GR0500010	2.38	1.78-2-97			-25 to +25		
	Corfu -GR0500020	1.27	0.95-1.59			-25 to +25		
	Corfu -GR0500030	1.27	0.95-1.59			-25 to +25		

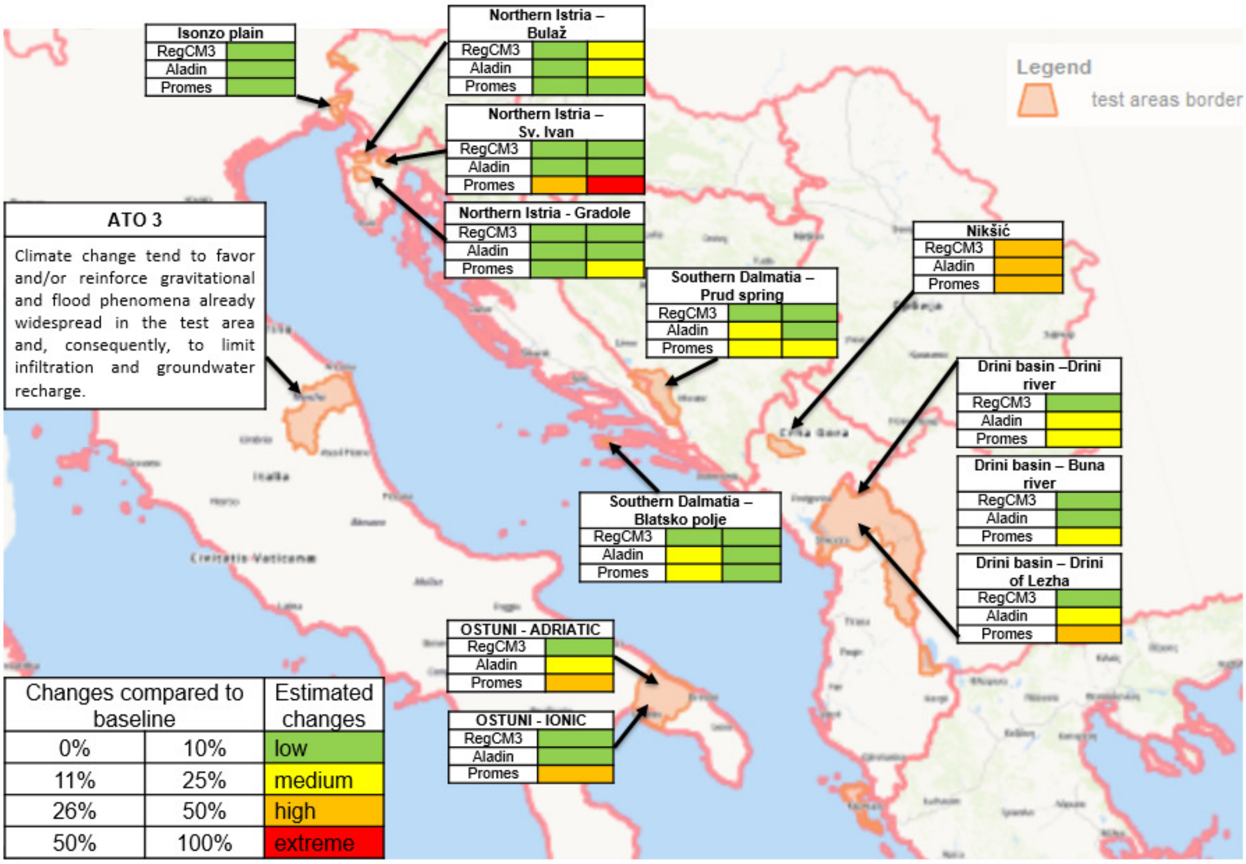
On Figure 2.2.1. climate change impact on water resources in Adriatic region on selected test areas are presented for average conditions and for characteristic renewable water resources (the second column for test areas in Croatia).

Table 2.2.2. Basic hydrological information for the evaluation of the climate change on water resources for CHARACTERISTIC RENEWABLE WATER RESOURCES [15]

Country	Test area	WR (m^3/s)				Changes in future (2021-2050) compared to baseline (1961-1990) in %		
		1961-1990	2021-2050					
			RegCM3	Aladin	Promes	**RegCM3**	**Aladin**	**Promes**
Croatia	N. Istria – Gradole	0.86	0.80	0.81	0.75	**-7.2**	**-5.6**	**-13.1**
	N. Istria –Sv. Ivan	0.42	0.42	0.39	0.17	**-0.5**	**-8.4**	**-60.3**
	N. Istria – Bulaž	0.32	0.28	0.28	0.45	**-11.4**	**-11.2**	**41.2**
	S. Dalmatia - Prud	3.36	3.13	3.05	2.92	**-6.8**	**-9.2**	**-13.1**
	S. Dalmatia - Blatsko polje	0.043	0.042	0.040	0.039	**-2.3**	**-7.0**	**-9.3**

Table 2.2.3. Qualitative assessment of CC impact on water resources availability [15]

Country	Test area	Qualitative assessment CC impact on WR	
Italy	Marche	Climate change tend to favour and/or reinforce gravitational and flood phenomena already widespread in the test area and, consequently, to limit infiltration and groundwater recharge.	Mountain aquifers: effective recharge 400 – 1000 mm/year



Isonzo plain	
RegCM3	🟩
Aladin	🟩
Promes	🟩

Northern Istria – Bulaž		
RegCM3	🟩	🟨
Aladin	🟩	🟨
Promes	🟩	🟩

Northern Istria – Sv. Ivan		
RegCM3	🟩	🟩
Aladin	🟩	🟩
Promes	🟧	🟥

Northern Istria - Gradole		
RegCM3	🟩	🟩
Aladin	🟩	🟩
Promes	🟩	🟨

Southern Dalmatia – Prud spring		
RegCM3	🟩	🟩
Aladin	🟨	🟩
Promes	🟨	🟨

Southern Dalmatia – Blatsko polje		
RegCM3	🟩	🟩
Aladin	🟨	🟩
Promes	🟨	🟩

Nikšić	
RegCM3	🟧
Aladin	🟧
Promes	🟧

Drini basin –Drini river	
RegCM3	🟩
Aladin	🟨
Promes	🟨

Drini basin – Buna river	
RegCM3	🟩
Aladin	🟩
Promes	🟨

Drini basin – Drini of Lezha	
RegCM3	🟩
Aladin	🟨
Promes	🟧

OSTUNI - ADRIATIC	
RegCM3	🟩
Aladin	🟨
Promes	🟧

OSTUNI - IONIC	
RegCM3	🟩
Aladin	🟩
Promes	🟧

ATO 3

Climate change tend to favor and/or reinforce gravitational and flood phenomena already widespread in the test area and, consequently, to limit infiltration and groundwater recharge.

Changes compared to baseline		Estimated changes
0%	10%	low
11%	25%	medium
26%	50%	high
50%	100%	extreme

Figure 2.2.1. Climate change impact on water resources in test areas for average conditions and characteristic renewable water resources (the second column for test areas in Croatia) [15]

From water resources availability analyses conducted in activity 4.2 [15] and results presented in Table 2.2.1. and 2.2.2. and Figure 2.2.1. it can be concluded that the climate change will have an impact on the water resources availability in the future period 2021-2050 causing the decrease in available water resources quantities. Such a decrease is mainly due to an increase in temperature. This can be concluded from both long-term average water resources conditions and is even more emphasised on characteristic renewable water resources conditions (e.g. critical period) as on Croatian test areas. (The only exceptions are Bulaž spring in Croatia, for input data from Promes climate model, and Isonzo plain, for input data from RegCM3 and Aladin, where the increase in renewable water resources quantity was calculated.)

From comparison of water resources availability for baseline period (1961-1990) and the future period (2021-2050) the estimated decrease on test areas varies from 0.3 to 60.3%. Test areas in the Northern part of the Adriatic region (e.g. Northern Istria) show lower changes than those in the Southern part of the Adriatic region (Southern Dalmatia, Ostuni, Drini Basin). The highest changes in water availability (decrease from 7.8 to 60.3%) can be noticed if results from the Promes climate model are used, following by Aladin (decrease from 4.1 to 29.4%). The lowest changes (decrease from 0.3 to 30.2%) are noticed if the RegCM3 climate model is used.

Vulnerability of water supply depends on the water exploitation level and available water resources. To analyse the risk in test areas the water exploitation index (WEI) was selected [21].

WEI is the ratio of the water demand (WD) and available water resources (WR):

$$WEI = WD / WR.$$

Total water demand consists of drinking water, water for irrigation, industry and ecological water demand. Although, the common practice is to determine water exploitation index using the total water use, in this case, WEI for drinking water was also calculated in some test areas. For Ostuni test area the ecological water demand was included in total water demand while in other test areas not.

The total demand had to be calculated and, if possible, separately the drinking water demand in test areas. It was agreed that water demand should be calculated for three scenarios [15]:

- scenario 0 (WD_0): present water demand,
- scenario 1 (WD_1): future water demand 1 (present water demand increased by 25%),
- scenario 2 (WD_2): future water demand 2 (present water demand decreased by 25%).

The WEI is usually calculated as percentage of average annual total demand with respect to long-term average annual water resources conditions [21] and this was done for all test areas in Table 2.2.4. On test areas in Croatia the WEI was also calculated for characteristic renewable water resources to assess the vulnerability of water resources considering a strong seasonal variability. The water demand for Croatian test areas and Montenegrian test area was also calculated as long-term mean of August monthly averages of abstracted quantities and max. values of abstracted quantities during the summer, respectively.

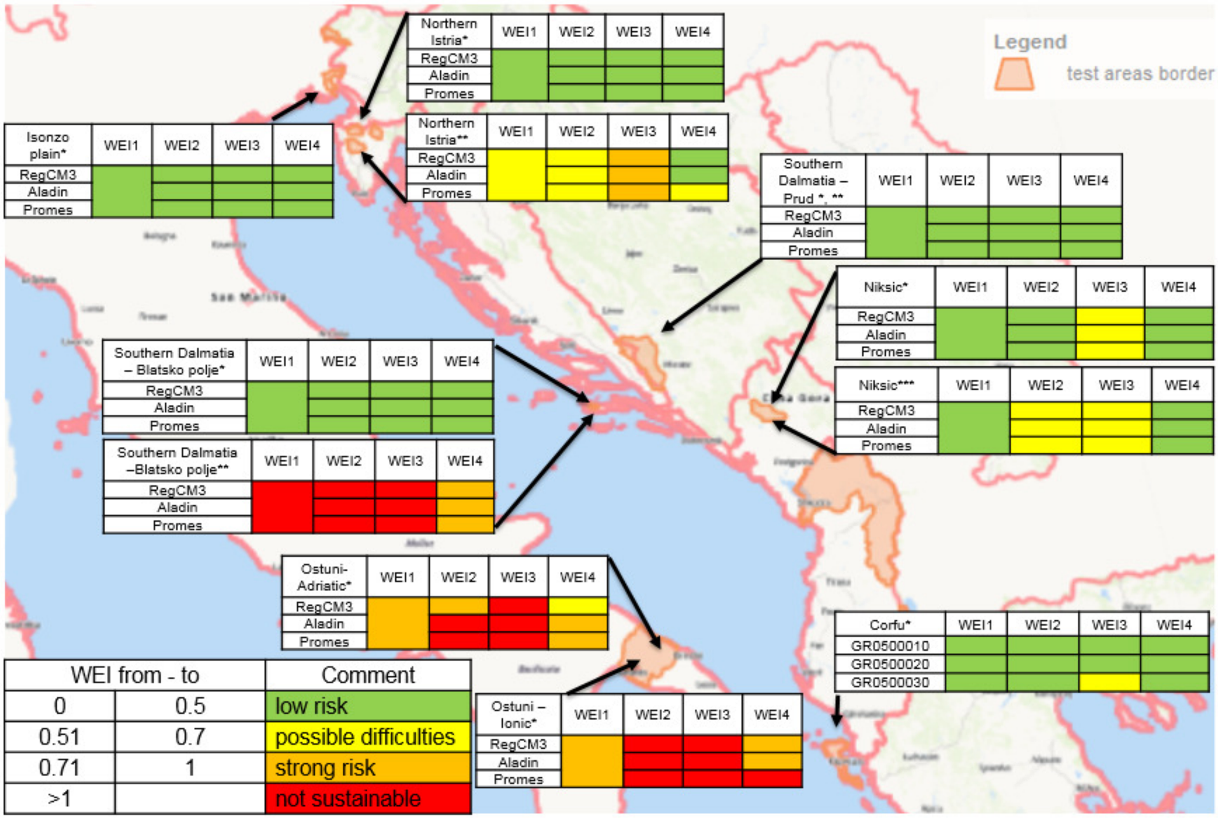
Four different combinations of water demand scenarios and renewable water resources (ACWR and CRWR from tables 2.2.1. and 2.2.2.) were considered [15]:

- $WEI_1 = WD_0 / WR_{1961-1990}$
- $WEI_2 = WD_0 / WR_{2021-2050}$
- $WEI_3 = WD_1 / WR_{2021-2050}$
- $WEI_4 = WD_2 / WR_{2021-2050}$

This assessment should have some threshold values to define different stages of vulnerability or risk. Following the classification defined in the previous project CC-waterS [10], 70 % exploitation rate has been selected for indicating strong risk (instead of the usual 90 % a lower threshold is applied, considering a 20 % decrease because of the uncertainty related to water dependent ecosystems) and 50 % for indicating possible difficulties, so thresholds for defining risk based on the WEI that are applied are:

- low risk ≤0.50 (green),
- possible difficulties 0.51-0.70 (yellow),
- strong risk 0.71-1.00 (orange),
- not sustainable >1.00 (red).

Results are shown in Table 2.2.4. and on Figure 2.2.2. The evaluation of water demand and calculation of water exploitation indexes according to agreed common methodology that includes different scenarios for water demand (present and future) and take into account the decrease (and in some cases increase) in available water resources quantity, caused by the climate change impact, have shown different risks on test areas [15].



Isonzo plain*	WEI1	WEI2	WEI3	WEI4
RegCM3	🟩	🟩	🟩	🟩
Aladin		🟩	🟩	🟩
Promes		🟩	🟩	🟩

Northern Istria*	WEI1	WEI2	WEI3	WEI4
RegCM3	🟩	🟩	🟩	🟩
Aladin		🟩	🟩	🟩
Promes		🟩	🟩	🟩

Northern Istria**	WEI1	WEI2	WEI3	WEI4
RegCM3	🟨	🟨	🟧	🟩
Aladin		🟨	🟧	🟩
Promes		🟨	🟧	🟨

Southern Dalmatia – Prud *, **	WEI1	WEI2	WEI3	WEI4
RegCM3	🟩	🟩	🟩	🟩
Aladin		🟩	🟩	🟩
Promes		🟩	🟩	🟩

Niksic*	WEI1	WEI2	WEI3	WEI4
RegCM3	🟩	🟩	🟨	🟩
Aladin		🟩	🟨	🟩
Promes		🟩	🟨	🟩

Southern Dalmatia – Blatsko polje*	WEI1	WEI2	WEI3	WEI4
RegCM3	🟩	🟩	🟩	🟩
Aladin		🟩	🟩	🟩
Promes		🟩	🟩	🟩

Niksic***	WEI1	WEI2	WEI3	WEI4
RegCM3	🟩	🟨	🟨	🟩
Aladin		🟨	🟨	🟩
Promes		🟨	🟨	🟩

Southern Dalmatia –Blatsko polje**	WEI1	WEI2	WEI3	WEI4
RegCM3	🟥	🟥	🟥	🟧
Aladin		🟥	🟥	🟧
Promes		🟥	🟥	🟧

Ostuni-Adriatic*	WEI1	WEI2	WEI3	WEI4
RegCM3	🟧	🟧	🟥	🟨
Aladin		🟥	🟥	🟧
Promes		🟥	🟥	🟧

Corfu*	WEI1	WEI2	WEI3	WEI4
GR0500010	🟩	🟩	🟩	🟩
GR0500020	🟩	🟩	🟩	🟩
GR0500030	🟩	🟩	🟨	🟩

WEI from - to		Comment
0	0.5	🟩 low risk
0.51	0.7	🟨 possible difficulties
0.71	1	🟧 strong risk
>1		🟥 not sustainable

Ostuni – Ionic*	WEI1	WEI2	WEI3	WEI4
RegCM3	🟧	🟥	🟥	🟧
Aladin		🟥	🟥	🟧
Promes		🟥	🟥	🟥

* AAAQ / ACWR
** LTMAMAAQ / CRWR
*** AMS / ACWR

Figure 2.2.2. Water exploitation index for total use at present (WEI1) and in the future for different scenarios (WEI2, WEI3 and WEI4) [15]

The selected common methodology applied on test areas has given better understanding of the impact of climate change on water resources in the Adriatic region, as well as possible risks of deterioration of water supply possibility from those resources. By analysing different scenarios for water demand in future possible problems were pointed out and analysed in order to timely implement appropriate measures.

Table 2.2.4. Exploitation index at present (WEI1) and in the future for different scenarios (WEI2, WEI3 and WEI4) [15]

Country	Test area		WEI_1		Climate models	WEI_2		WEI_3		WEI_4	
			Total use	Drinking water		Total use	Drinking water	Total use	Drinking water	Total use	Drinking water
Italy	Isonzo/Soča plain	AAAQ / ACWR	0.45	0.06	RegCM3	0.45	0.06	0.46	0.05	0.43	0.08
					Aladin	0.45	0.06	0.46	0.04	0.43	0.08
					Promes	0.44	0.05	0.45	0.04	0.42	0.08
	Ostuni – Adriatic*	AAAQ / ACWR	0.85		RegCM3	0.90		1.13		0.68	
					Aladin	1.08		1.35		0.81	
					Promes	1.13		1.42		0.85	
	Ostuni – Ionic*	AAAQ / ACWR	0.98		RegCM3	1.04		1.30		0.78	
					Aladin	1.05		1.31		0.79	
					Promes	1.45		1.82		1.09	
Croatia	Northern Istria - springs Sv. Ivan, Bulaž and Gradole	AAAQ / ACWR	0.13	0.11	RegCM3	0.13	0.11	0.17	0.14	0.10	0.08
					Aladin	0.14	0.12	0.17	0.15	0.10	0.09
					Promes	0.13	0.11	0.16	0.14	0.10	0.08
		LTMA MAAQ / CRWR	0.59	0.50	RegCM3	0.63	0.54	0.79	0.67	0.49	0.41
					Aladin	0.64	0.54	0.80	0.68	0.49	0.42
					Promes	0.69	0.59	0.86	0.73	0.53	0.45
	Southern Dalmatia – Prud spring	AAAQ / ACWR	0.02		RegCM3	0.02		0.03		0.02	
					Aladin	0.02		0.03		0.01	
					Promes	0.02		0.03		0.02	
		LTMA MAAQ / CRWR	0.05		RegCM3	0.06		0.07		0.04	
					Aladin	0.06		0.07		0.04	
					Promes	0.08		0.08		0.05	
	Southern Dalmatia – Blatsko polje	AAAQ / ACWR	0.12		RegCM3	0.13		0.17		0.10	
					Aladin	0.15		0.18		0.11	
					Promes	0.15		0.19		0.18	
		LTMA MAAQ / CRWR	1.07		RegCM3	1.10		1.38		0.83	
					Aladin	1.15		1.45		0.88	
					Promes	1.18		1.49		0.90	
Montenegro	Nikšić	AAAQ / ACWR	0.32		RegCM3	0.45		0.57		0.34	
					Aladin	0.45		0.56		0.34	
					Promes	0.47		0.58		0.35	
		AMS / ACWR	0.36		RegCM3	0.51		0.64		0.38	
					Aladin	0.51		0.63		0.38	
					Promes	0.52		0.65		0.39	
Greece**	Corfu - GR0500010	AAAQ / ACWR	0.09	0.09	Expert evaluation	0.12	0.11	0.15	0.14	0.09	0.09
	Corfu - GR0500020	AAAQ / ACWR	0.18	0.10	Expert evaluation	0.23	0.13	0.29	0.17	0.18	0.10
	Corfu - GR0500030	AAAQ / ACWR	0.36	0.11	Expert evaluation	0.48	0.15	0.60	0.19	0.36	0.11

ACWR – average conditions water resource
CRWR - characteristic renewable water resource
AAAQ – average annual abstracted quantities
LTMAMAAQ – long-term mean of August monthly averages of abstracted quantities
AMS- abstraction that incorporate max values during the summer
* In Ostuni test area the ecological demand was calculated within the total demand.
** For Greece (scenarios from FB16 report that were used are):
WEI (2) - scenario 56 (present WD; CWR-25%)
WEI (3) - scenario 110 (future WD (present WD+25%); CWR-25%)
WEI (4) - scenario 1 (future WD (present WD-25%); CWR-25%)

2.3. Present and future water safety and risk imposed to water (re)sources used for drinking water supply

2.3.1. Water (re)sources quality trends on test areas

DRINKADRIA project partners have prepared reports about water resources quality analysis and trends on test areas. Six project partners (LP, FB2, FB3, FB5, FB9, FB16) have prepared the trends for groundwater quality, five partners (FB2, FB5, FB10, FB11, FB12) have prepared the trends for quality of surface waters (lakes, rivers) and four partners (FB2, FB8, FB9, FB14) have prepared the trends for quality of spring waters [22].

The most common problems with water quality and their causes on analyzed test areas are following. An increase of nitrates was observed in some test areas, due to intensive agriculture like in case of ATO 3 test area (Italy), anthropogenic activities (Corfu island, Greece), or contribution of unused nitrates from the soil zone in the wet season (Blatsko polje, Croatia). On Corfu Island (Greece) the reason for increased sulfates and conductivity is natural geological background. Increased chlorides are caused by the exploitation of the aquifer and the natural causes (Corfu, Greece), or a fossil marine aquifer in case of Isonzo Plain (Italy). There is a problem with seawater intrusion and groundwater salinization, due to groundwater over-abstraction on four test areas - ATO 3 and Ostuni in Italy, Blatsko polje in Croatia and Corfu in Greece. In some cases there are problems with microbiological contamination which occur due to the following reasons: hydrological conditions (Northern Istria in Croatia, Trebižat river in BiH and Nikšić in Montenegro), untreated urban waste waters from settlements (Northern Istria and Trebižat river), wild animals or livestock in the watershed areas of springs (Northern Istria) and small water sources which are in many cases obsolete and not well maintained (ATO 3 test area in Italy). In some test areas there is an increasing trend of total suspended solids (TSS). TSS content depends probably on the amount of rainfall (test area in Slovenia and Northern Istria in Croatia), so this should not be considered as an indicator of pollution. High values can also occur due to the interventions in the river bed (test area in Slovenia). There can be also increased turbidity during high intensity rainfalls like on water sources Gornji Vidrovan and Donji Vidrovan in Nikšić (Montenegro). In Trebižat river (BiH) oxygen saturation is maintaining high values, and that can be a sign of eutrophication (increased activity of algae, where oxygen comes mostly from photosynthesis). DRINKADRIA project includes various test areas, consequently problems regarding water quality are also diverse [22].

In the joint report about water quality trends on test areas, a description of each test area is given with specific water quality problems and a table showing trends for various parameters [22].

Table 2.3.1. shows basic water quality characteristics and trends on test areas.

Table 2.3.1. Basic water quality characteristics and trends in DRINKADRIA test areas [13]

Country and test area	Basic water quality characteristics and trends
ITALY: Friuli Venezia Giulia Region - Isonzo plain	In general, the groundwater quality related to the phreatic and the confined aquifers present in the test area is considered very good. For some of the major ions there has been the possibility to realize the trends. Chlorides, sulphates, chromium and tetracloroethylene always had values definitely lower than the legal limit. Only for the nitrates, in only one well (well n.16) a peak of 21 mg/l (in 2006) has been recorded, but this value is lower than the legal limit defined as 50 mg/l, and now that the company started to withdraw waters, the concentration of the ion dramatically dropped reaching and maintaining a constant value in the range of 10 mg/l.
ITALY: Marche Region – ATO3	Very rich mountainous area in terms of aquifers, potentially providing large volumes of good quality water. Progressive worsening in the valleys (medium-high hilly area and flat-coastal zone) of water quality features: electric conductivity between 600 and 1400 µS/cm, dry residue between 0.3 and 0.8 g/l; significant increase in nitrates concentration.
ITALY: Apulia Region - Ostuni	The Apulia region has been exposed to a sequence of prolonged droughts in the past decades. Natural recharge does not refill the aquifers sufficiently. The main problem at the Salento peninsula is related to the increase of groundwater salinization due to groundwater over-abstraction and subsequent seawater intrusion. At several places along Salento's coast, groundwater salinity already exceeds 7 g/l.
SLOVENIA: Kobariški stol, Mia and Matajur aquifers	The physical and chemical parameters of surface and groundwater show the characteristics of natural conditions. Possible human impacts practically absent within the test area. All measured parameters (pH, EC, oxygen regime, TOC, nutrients, microbiology and metals) indicate that surface water and groundwater in test areas are not polluted and have a good chemical status. Groundwater hydrogeochemical type is Ca - HCO_3. Good surface and groundwater quality status on test areas in NW Slovenia (Kobariški stol, Mia and Matajur aquifers).
CROATIA: Northern Istria-springs Gradole, Sv.Ivan and Bulaž	There is an increasing trend of total suspended solids on all springs. However, the content of TSS depends primarily on hydrological conditions, so this should not be considered as an indicator of pollution. During 2003-2013 there was a decreasing trend of nitrates (bellow MAC). Microbiological contamination is present and is associated to the hydrological conditions. Higher concentrations of total number of microorganisms and microorganisms of fecal origin were occasionally observed, mostly from untreated urban waste waters. For all springs phosphates and total phosphorus are very low. The values of nearly all indicators are decreasing, and the water quality on springs improves.
CROATIA: Southern Dalmatia - spring Prud and Blatsko polje	Different hydrochemical facies of the two test areas in Southern Dalmatia. Sampled waters from island test area (Blatsko polje) range from calcium - hydrogencarbonate to sodium-chloride hydrochemical facies which indicates strong influence of the sea water intrusions. Waters from continental test area (Prud) range from calcium-hydrogencarbonate to calcium-sulfate hydrochemical facies, suggesting recharge from deposits rich in sulphate minerals. Trends of indicators of water quality are negative, showing decrease in the concentration of water quality indicators.
BOSNIA AND HERZEGOVINA: Trebižat river*	High saturation with oxygen in Trebižat River, mostly due to fitobentos activities. For the Trebižat River concentrations of phosphates and total phosphorus are very low. Microbiological contamination is present, and a large range is between minimum and maximum values which is associated to the hydrological conditions. Increased concentrations of copper and total chromium which were above the Maximum Allowable Concentration (MAC) for surface water (2010-2014). Concentrations of lead in the range of limit values. For Trebižat River there is absence of fresh pollution indicators in the basin (but could be potentially eutrophicated and have impact on biological status).
MONTENEGRO: Nikšić	Good quality of water used for water supply in the test area in Nikšić. Deviations of quality parameters (turbidity and mild microbiological contamination) from maximum allowable concentration only during heavy precipitation. Only chlorination is applied in springs.
SERBIA: Veli Rzav and tributaries**	Veliki Rzav is very vulnerable to the impacts of weather. There are areas exposed to erosion, as well as arable land. The conditions of heavy rainfall or rapid snowmelt bring on drastic deterioration in water quality. In Veliki Rzav and its tributaries there is an increasing trend in consumption of potassium permanganate ($KMnO_4$) and nitrates (except in the case of Mali Rzav), a trend close to zero in most of the rivers with regard to five-day biological oxygen demand (BOD_5), while the mineralisation mainly shows a declining trend (1997-2014). Sources of water pollution classified into two categories: scattered and concentrated ones.
ALBANIA: Drini basin	Pollution from diffuse (e.g. agriculture) or point sources (e.g. industrial and urban wastewaters etc.) is a matter of concern throughout the extended Drini river basin. Wastes are dumped in a large number of uncontrolled disposal sites or even in the vicinity of watercourses. A long and uncontrolled discharge of municipal sewage water, agriculture and industrial waste in Drini i Bardhë River, inflicted the change of water quality. With the polluted water in the bank of Drini i Bardhë River also the organic and inorganic substances are being discharged. It is possible to reduce or to stop this negative trend.

Country and test area	Basic water quality characteristics and trends
GREECE: Corfu Island	Water quality of the surface water systems of Corfu is good. No heavy pressures identified. The three groundwater systems identified are assessed to be in a good chemical quality status. High concentrations of sulphates because of the natural geological background. Locally increased values of nitrates and ammonium are due to the diffuse and point pollution sources of human activities. In the coastal areas some increased values of chlorides due to the sea intrusion because of the exploitation and of natural causes.

* Related to test area Prud in Croatia.

** Not a test area.

2.3.2. Climate change and anthropogenic impact on water (re)sources in test areas

Analysis of impact of land use changes (caused by climate change and development of the area) on water quality in test areas was made. It was agreed that for determining the present land use and land use changes in the past Corine Land Cover (digital database on types of land cover/use) will be used. For assessment of land use change in the future the climate change impact and development impact in the area was analysed. Climate change data from activity 4.1 and also data about development in the test area in the future from spatial or other plans were used. Based on DPSIR (Figure 2.3.1.) the common methodology (Figure 2.3.2.) was prepared and used for the analyses on test areas [23].

The European Environmental Agency (EEA) assesses the State (S) of the environment using the DPSIR methodology. Namely, the State (S) is the result of specific Drivers (D) and Pressures (P), positive or negative, which Impact (I) the environment. The Responses (R) represent the solutions (e.g. policies, investments) that should then be done to improve or maintain that state. The EEA report also looks at Outlooks (O) for the state of the environment-namely, what will happen to that state over time based on various scenarios. The DPSIR framework is in some way a conceptual model (Figure 2.3.1.) representing direct interactions through a loop in the way that human being interacts with the environment [24].

Aquifer types, land use and impacts on water quality on test areas are presented in Table 2.3.2.

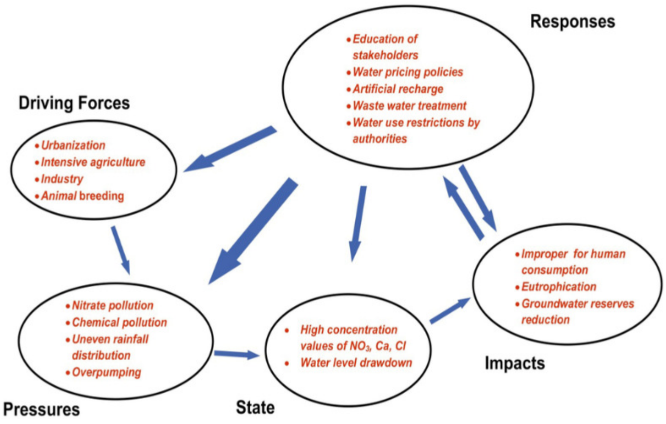


Figure 2.3.1. DPSIR methodology [24]

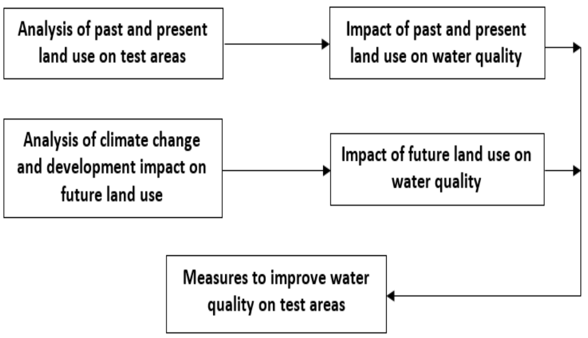


Figure 2.3.2. The common methodology used for test areas [23]

These analyses allowed to estimate the risks related to possible water quality degradation and propose measures to protect and improve the water quality. Some relevant measures that are or will be applied on test areas are: water quality monitoring data collected regularly, farming in a framework of ecological and sustainable development, organic agriculture, storage of surface water at those periods when availability exceeds demand, wastewater treatment, education etc. Within this activity problems of salt water intrusion on some test areas were also analysed [23].

Table 2.3.2. Test areas, type of aquifer, land use and impacts on water quality [23]

Test area	**Aquifer type**	**Present land use**	**Changes of land use (past)**	**Changes of land use in future (CC and development)**	**Impacts on water quality and measures**
ITALY: Friuli Venezia Giulia - Isonzo plain	Porous aquifer. Mainly phreatic in the northern part and confined in the southern, downstream the resurgence belt.	From CLC 2012: Agriculture 58,81%; Natural environment 10,50%; Urbanized area 22,48%; Water surface 3,56%; Industrial area 3,14%; Sport and leisure facility 0,94%; Quarry and landfill 0,57% (for the whole study area)	CLC 1990, 2000, 2006 and 2012: Artificial areas grow at the expense of agricultural areas. Artificial areas 22.3% in 1990 and 25.2% in 2012. Agricultural area 69.2% in 1990 and 66.2% in 2012.	Comparing land cover maps from different years. Use of Spatial Plans.	From the data analyses emerges that the situation is now sustainable, but attention has to be paid to the use of fertilizers, and especially to nitrates, mainly in the northern part of the Soca/Isonzo Plain where there is the phreatic aquifer (more vulnerable). Use of Nitrates Directive and monitoring programs to reduce the impact.
ITALY: Marche Region - ATO3	WR 1: At least three overlapped aquifers: groundwater circulation mainly due to secondary porosity; WR 2: Mainly unconfined sandy-gravelly aquifers: locally perched or leaky confined	From CLC 2006: WR 1: Agriculture 35%, Forestry 63%, Artificial surfaces ~ 1%, Water bodies ~ 1%. WR 2: Agriculture 77%, Forestry 16%, Artificial surfaces 6%, Water bodies <1%.	ATO 3 test area has undergone a significant land use change, related to urbanization and infrastructure construction, resulting in the permanent loss of agricultural land and green belts.	Climate changes will possibly have an impact on changes of land use in the future.	An increase (probably minor) in the use of fertilizers and in the quantities of water abstracted from the facilities will cause an overall increase of the pressure for many water resources.

	aquifers near the coast				
ITALY: Apulia Region - Ostuni	Karstic limestone aquifer	Agriculture 80%, Forestry 13%, Artificial surfaces 7%	No data	No data	Climate change impact on groundwater discharge. Proposed measures to improve water quality; Management of Aquifer Recharge.
SLOVENIA: Kobariški stol and Mia - Matajur aquifers	Karstic	From CLC 2012: Artificial areas 0.28 %, Agricultural areas 14.56 %, Forest and semi natural areas 85.27 %	CLC 1995, 2000, 2006: No significant changes in land use in last 20 years. Minor changes only within separate land cover group, such as different kinds of grassland or forest.	Comparing land cover maps from different years. Use of Spatial Plan of the Municiality of Tolmin	There is no negative impact of land use on water resources
CROATIA: Northern Istria - springs Gradole, Sv.Ivan and Bulaž	Karstic aquifer	From CLC 2012: Sv.Ivan, Bulaž and Gradole: Discontinuous urban fabric 0.49%, Different forests 50.47%, Transitional woodland 12.38%, Pastures 6.44%, Land principally occupied by agriculture 21.06%, Complex cultivation patterns 5.72%, Vineyards 0.82%, Natural grasslands 2.48%, Non-irrigated arable land 0.07%, Mineral extraction sites 0.07%.	CLC 2000, 2006, 2012: In the period 2000-2012 there were no significant changes on the test areas.	Comparing land cover maps from different years. Use of Spatial Plan of the Istria County.	No significant impact in present state. In future negative impact will be decreased through measures like: organic farming, drinking water sources under protected areas, the problem of wastewaters drainage with corresponding WWTP will be solved, and other structural and non-structural measures.
CROATIA: Southern Dalmatia - spring Prud and Blatsko polje	Karstic aquifer	Spring Prud: Forest and semi natural areas 68,88 %, Agricultural areas 29,14 %, Artificial surfaces 1,77 %, Water bodies 0,18 %, Wetlands 0,04 %. Blatsko polje: Agriculture 56,8 %, Forestry 38,7 %, Artificial surfaces 4,5 %.	CLC 2000, 2006, 2012: Minor changes on Prud catchment. Significant changes in Blatsko polje in types of agricultural land use.	Comparing land cover maps from different years. Future spatial plans.	There is no negative impact of land use on water resources.
MONTENEGRO: Nikšić	Karstic aquifer	Agriculture 28.73%, Forestry 65.13%, Artificial surfaces 4.94%, Water bodies 1.20%	CLC 2006, 2012: No significant changes in land use.	No data	No data
ALBANIA: Drini basin	Karstic aquifer	Agriculture 30.26 %, Forestry 21.76%	No data	Climate change will have an impact on changes of land use in the future.	Impact on water resources. Invest in better irrigation systems.
GREECE: Corfu Island	Karstic, granular	From CLC 2000: Area under cultivation and fallow land 73.0%, Forests 10.2%, Areas occupied by settlements 4.9%, Pastures 4.7%, Areas under water 1.1%, Other areas 6.1%	CLC 1990, 2000: In the period 1990-2000 there were no significant changes.	Comparing land cover maps from different years. Future spatial plans.	Climate change is expected to have an impact in the water quality. Land uses are expected to change (small variations).

2.3.3. Common protocol for water (re)sources monitoring activities in the Adriatic region

The national legislative framework for water resources monitoring (for countries involved in the project: Italy, Slovenia, Croatia, Bosnia and Herzegovina, Montenegro, Serbia, Albania and Greece) was analysed and compared. All national regulations regarding water resources monitoring in national languages with short descriptions in English were gathered and are now available on the DRINKADRIA shared platform: http://drinkadria.fgg.uni-lj.si/ (Figure 2.3.3.) [25].

Legislation (water sources monitoring)

Legislation comparison: **ALB vs BIH vs CRO vs GRC vs ITA vs MNE vs SRB vs SVN**

Select to compare:

ALB, BIH, CRO, GRC, ITA, MNE, SRB, SVN ▾ by ● Level

For details: click into any cell of the table.

Country Level	ALB	BIH	CRO	GRC	ITA	MNE	SRB	SVN
	•Law No. 1. 111/2012, date 15.12.2012 "Integrated Management of Water Resources" •DCM No. 1189, dated 18.11.2009 "to the rules and	•Rulebook on Drinking Water Safety	•Water act •Act on water intended for human consumption •Regulation on parameters compliance and analysis	•National Law 3199/2003 for the "Protection and Management of Water" in compliance with the Water Framework Directive 2000/60/EC •Presidential Decree No 51	•Implementation of EU Drinking Water Directive 98/83/EC on the quality of water intended for human consumption •An integration/modification of the Legislative Decree regrading Implementation of EU	•Water Law •Regulation on the hygienic quality of drinking water •Regulations on methods for determining and	•Water Act •Act on Sanitary Observation • Drinking water supply sources management and protection Act •Environmental protection Act and Act on amendments and additions to the	•Waters act •Rule on drinking water •Decree on groundwater status • Rules on groundwater monitoring •Decree on

Figure 2.3.3. Comparison of legislation for water (re)sources monitoring in the Adriatic region [26]

In EU members countries Italy, Slovenia and Greece legislation that address monitoring of the water for human consumption quality is harmonized with EU Drinking water directive - DWD (Directive 98/93/EC on the quality of water intended for human consumption). Croatia has two regulations that cover jointly the DWD. Bosnia and Herzegovina legislation regarding monitoring the quality of water for human consumption is also in accordance with Drinking water directive although Bosnia and Herzegovina is not member of EU. There are minor differences between all these national legislative acts. Montenegro, Serbia and Albania have their own legislation relevant for the monitoring of the water for human consumption quality. The new proposal for the

Regulation on Drinking Water Quality in Albania, which is still in approval process, has integrated the DWD norms and regulation.

Water Framework Directive is not operative in Albania, but the Law on "Integrated Management of Water Resources" and some other DCM updated this year are written in compliance with this Directive. In Serbia WFD requirements are transposed into Water Act and by-laws, existing and those that are still pending to be approved.

From analyses of national legislation for water (re)sources monitoring in DRINKADRIA project partner countries it can be concluded that there are more particularities and differences given the monitoring of water (re)sources quality with respect to the quality of water supplied for human consumption.

It was concluded that a common protocol for monitoring activities on cross-border water resources (used for human consumption) in the Adriatic region that could be applicable on all cross-border water (re)sources and all countries is very difficult to prepare given the differences in national legislation. Thus, the protocols for monitoring activities on cross-border water (re)sources should be prepared bilaterally between two interested countries (e.g. relevant institutions in those countries) [25].

For this reason guideline for preparation of protocol for monitoring activities on cross-border water (re)sources in the Adriatic region is proposed. Based on this guideline and taking into account the particularities of just two countries (instead of 8) the bilateral protocol for monitoring activities on cross-border water (re)sources can be prepared with much more details [25].

The guideline for protocol preparation is given in Chapter 3.

2.4. Cross-border water (re)sources protection and management

2.4.1. Cross-border water (re)sources protection

In the DRINKADRIA project proposal it was estimated that protection of drinking water sources recharging from cross-border catchments suffers from lack of regulatory framework, which results in inadequate technical and institutional tools for the assessment and implementation of the protection measures. This very starting hypothesis was tested by the analysis of drinking water protection zones for all eight participating countries. Collection of data has been based on the two questionnaires prepared in spreadsheet, and on the special reports prepared for each participating country. Results of analysis are also based on the discussion and results obtained by the direct communication between participating partners.

In the Adriatic Ionian region both groundwater and surface water bodies are used for water supply. In all countries supply from surface water is subordinate in comparison to groundwater. The only exception is Montenegro where drinking water supply from surface bodies represents between 60 – 90% of the total supply. In majority of the countries drinking water supply from surface water bodies represents between 10 – 30 %.

In all participating countries drinking water resource recharge area protection is based on the zoning principles and hierarchy of protection measures. In all states the principles are based on the classification of water resources types. For propose of the design of drinking water zones and implementation of protection strategies they are divided into two large groups; first group is represented by groundwater and second by surface water resources. In general two approaches to the natural and technical conditions of water resources are accepted; first one is technical approach where technical characteristics of the capturing facilities are defined first and then natural conditions of the water bodies used for the supply are considered. Such approach to drinking water protection zones is implemented in Greece and Italy. The other is natural conditions approach; here first natural conditions of water body used for the supply are determined than according to the resource type protections and the design criteria for protection zones are defined. In this approach technical characteristics of capturing facilities are not as exposed as in the case before. Such approach is implemented in Bosnia and Herzegovina, Croatia, Montenegro, Serbia, and Slovenia. Albania has very simple approach to water protection; they are defining some rules which are valid for all water resources types.

In all participating countries drinking water protection zones on intergranular aquifers are defined. Criteria for their definition and zoning are mainly based on the groundwater velocity and travel times. In majority countries are defining three different zones; the only exception is Bosnia and Herzegovina where four zones are defined. Zoning principles on intergranular aquifers are illustrated in the Figure 2.4.1.

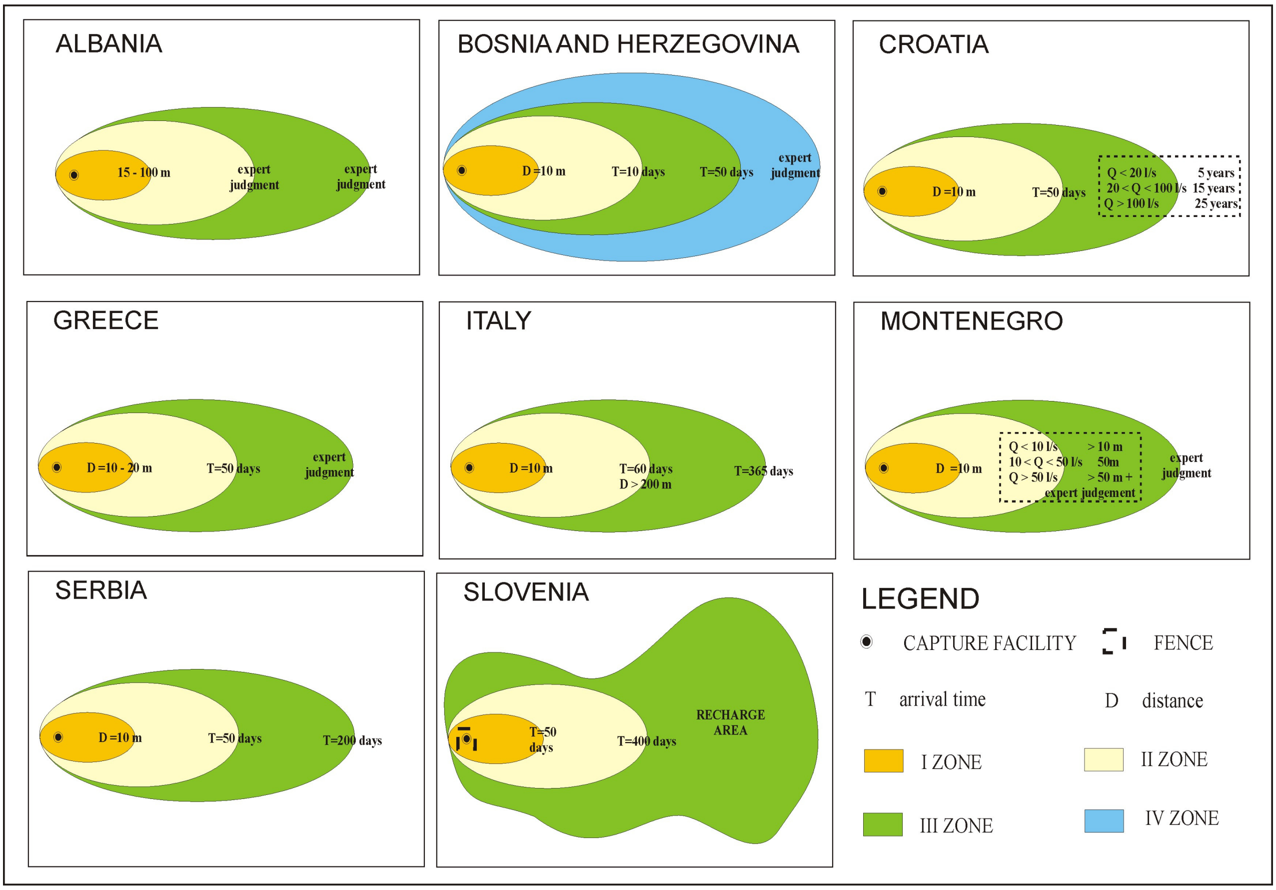


Figure 2.4.1. Graphical representation of drinking water protection in the participating countries on the intergranular aquifers

Important specificity in the region are karstic water resources. Large part of them is belonging to Dinaric karst system extending from Italy on the north-west to the Greece and Albania on the south-east. There are also other parts outside of the Dinaric karst where karstic water resources of more or less extended area are present. Karst is highly heterogeneous and anisotropic system where groundwater flow velocities inside of the same aquifer can have very large range; from very high velocities (up to 2.5 km/day) to very low (e.g. 1 m/year). This requires special approach to the design of drinking water protection zones and protection measures. Protection zones on karstic aquifers are usually irregular and their design contrary to the intergranular aquifers is based mainly on geomorphological, geological, and hydrogeological criteria. In Bosnia and Herzegovina, and Croatia as well as from practical point of view in Slovenia four protection zones are defined. In other countries are using three zones. Zoning principles on karstic aquifers are illustrated in the Figure 2.4.2.

Protection measures on the drinking water protection zones are hierarchically defined. The highest and most stringent requirements are set in the vicinity of the capturing facility and they diminish in the direction toward the borders of hydrological basin of the protected water source. In all countries the same hierarchical principle is applied. The exceptions of such spatial hierarchy are karstic aquifers where in some relative remote parts direct infiltration to the groundwater is possible (e.g. swallow holes) such geomorphological features are protected with more strict measures than surrounding area. Protection measures can be further classified into interdictions, limitations and measures [27]. Interdictions are representing ban of certain activities; they can be further divided into unconditionally allowed activities and conditionally allowed activities which can be performed under some certain and strict measures. Limitations allowed certain activities but limit their extent and magnitude. Measures are usually consisting of activates which have to be performed to sustain present status of water body or even to improve it.

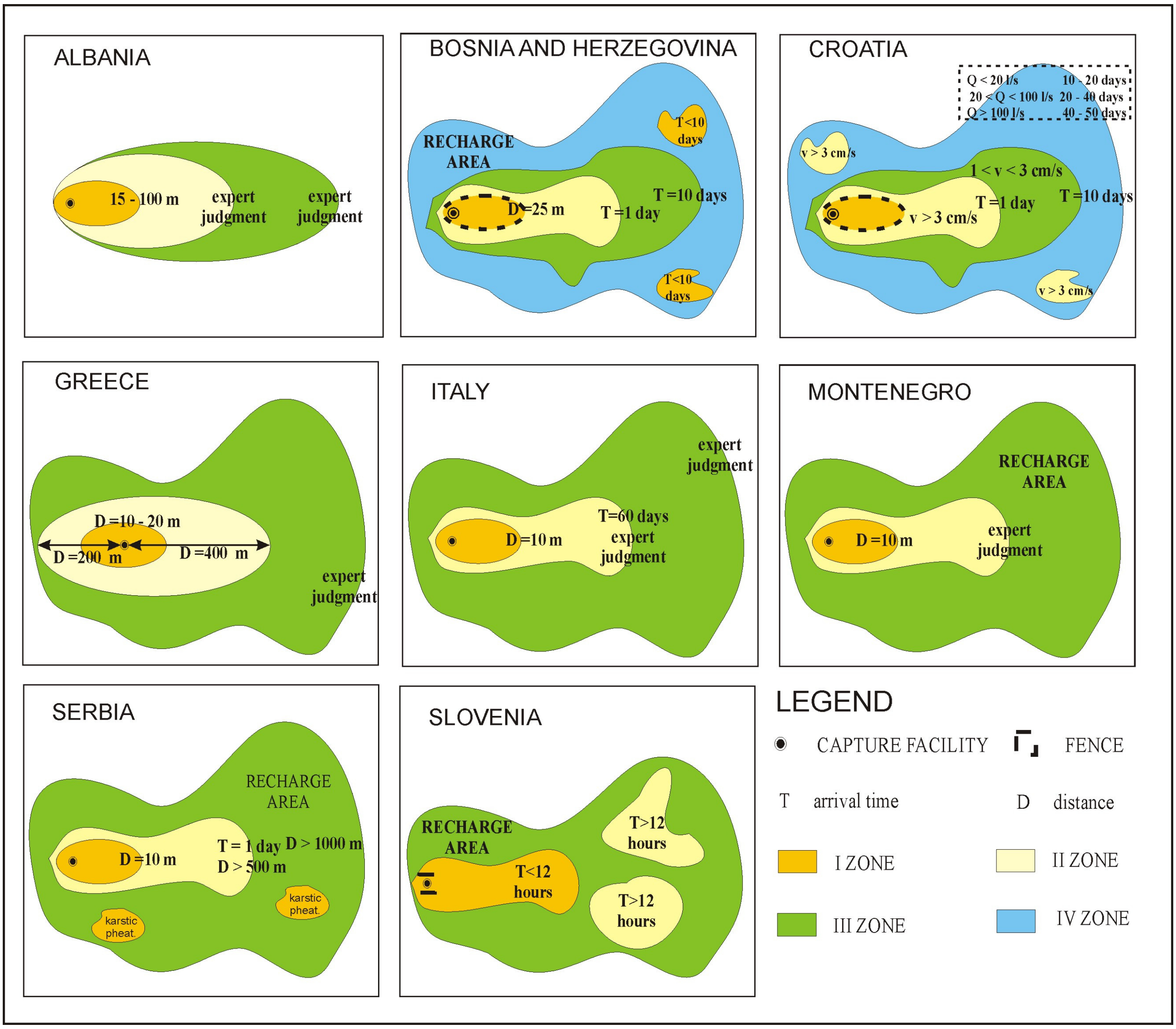


Figure 1.4.2. Graphical representation of drinking water protection in the participating countries on the karstic aquifers

To achieve drinking water protection goals between neighbouring countries the principle of acceptable compatibility must be applied. The phrase as such was coined in the project ISTRA-

HIDRO [28] dealt with the drinking water protection in the region of Istra and Kvarner in the border region of Republics of Croatia and Slovenia. The principle of acceptable compatibility was already implemented in the cross border drinking water resources protection in the border region between Republics of Slovenia and Austria [29].

2.4.2. Cross-border water (re)sources management

DRINKADRIA is dealing with cross-border water supply, therefore a water quality and quality assurance is a major issue, since the countries are many times entitled to different legislation requirements regarding not only water quality but also water quantity risks. The safeguarding of water quality and quantity gets even more uncertain in emergency situations that are highlighted from the climate change pressures, as well as the large number of small scale water supplies in the DRINKADRIA area.

Present and future risk for drinking water quality and quantity has to be determined for cross-border drinking water sources. Many water supply companies in IPA Adriatic area have adopted HACCP (Hazard Analysis and Critical Control Points), which is an internationally recognized process control system for identifying and prioritizing hazards and risks to the quality of drinking water (Figure 2.4.3.) from »source to tap«. These countries are former Yugoslavia countries (Slovenia, Croatia, Serbia and Montenegro), in which drinking water is considered as food, for which HACCP system is obligatory. HACCP is mainly dealing with water quality risks (Figure 2.4.3.). However, water quantity risks should be also considered due to changes in climate and water demand.

In last decades increased frequency of droughts and heavy precipitation events has been observed. Water suppliers have to prepare for such extreme events in order to supply sufficient quantities of safe water to consumers without disruptions. This is a responsibility of water suppliers and a great challenge, above all in Mediterranean region due to high water demand in summer months and decreasing recharge.

World Health Organization (WHO) recommends Water Safety Plans (WSP) as codified safe management. WSP is the most effective means of consistently ensuring the safety (quality and quantity) of drinking water supply through the use of a comprehensive risk assessment (Figure 2.4.3.). According to amended Drinking Water Directive (DWD) [30] from 6 October 2015 (2015/1787) WSP approach in Guidelines for Drinking Water Quality [31], together with standard EN 15975-2 concerning “security of drinking water supply, guidelines for risk and crisis management”, which is based on WHO Guidelines, are internationally recognised principles on which the production, distribution, monitoring and analysis of parameters in drinking water is based. According to DWD risk assessment has to be aligned to the latest updates of those principles.

Only some countries in the IPA Adriatic region have adopted WSP (some in Croatia and Slovenia), none of them include climate change risk assessment with measures.

The WSP approach is easily applied to the different countries legislation, since a lot of step by step guides and guidelines have been published to facilitate the implementation procedure. Taking into account the small scale and the climate change is compulsory for the DRINKADRIA area, since significance percentage of water utilities could be characterized as small, while the climate change effects and emergency situation are of significant frequency in the area.

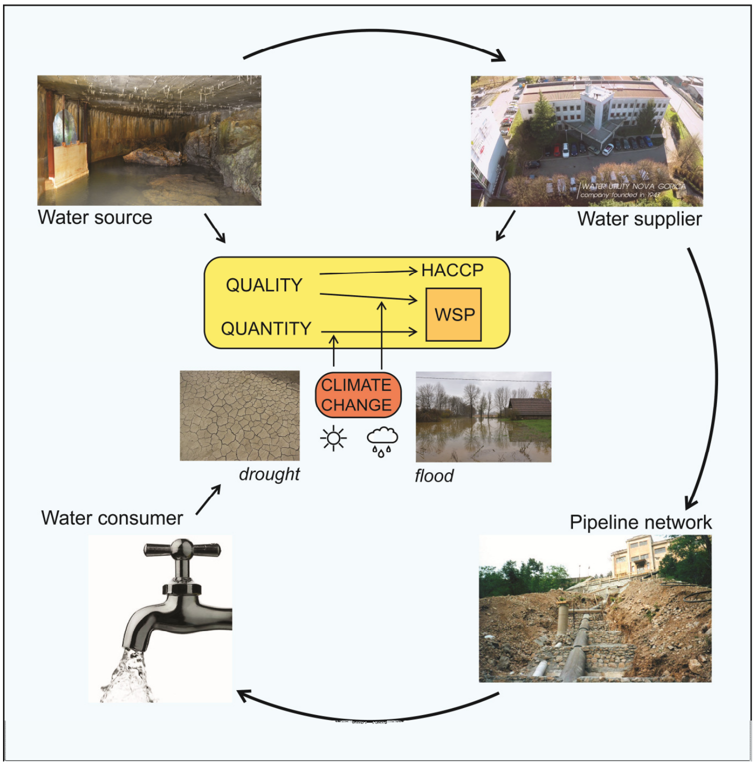


Figure 2.4.3. HACCP and WSP in drinking water supply

3. Recommendations and proposal of guidelines and measures for improvement of cross-border water resources protection and management for Adriatic area

Climate change:

Data about climate characteristics that are to be expected in future are essential input data for estimation of water resources availability in the future.

Based on analyses carried out in the 4.1. activity it can be recommended that the climate change impact should be assessed for future periods up to 2050 and if possible even 2100.

The change of temperature and precipitation for the future on specific areas can be assessed using the methodology that was agreed by DRINKADRIA FBs and that was already developed in the CC-WaterS project with the application of RCMs (Aladin, RegCM3 and Promes or other available model that is applicable on the selected area).

The methodology and result of estimation of climate change characteristics on test areas and also on national and regional level are presented in the Joint report Climate and climate change database for Adriatic area and Annexes [7]. Annexes consist of detailed reports prepared by FBs for each and for each country/region and test area.

Cross-border water (re)sources availability (quantity):

To be able to plan long-term water supply it is necessary to estimate the climate change impact on water resources quantity.

Climate change characteristics temperature and precipitation should be estimated.
The methodology that could be applied is given in the Chapter 2.1.

The second step is to apply appropriate hydrologic models to estimate the availability of water resources in the future period (2021-2050 and if possible also 2051-2100).

To be able to assess the changes in water resources availability in the future (in %) it is necessary to estimate the water resources availability in the future period 2021-2050 (2051-2100) in relation to the water resources availability during the base line period 1960-1991.

The other aspect that has to be included is the future water demand. This should be assessed for every analysed area according spatial plans, expected climate change impact etc. Different scenarios for water demand should be defined.

To estimate the risk of water shortage in future the WEI can be calculated for different water demand scenarios.
By analysing different scenarios for water demand in future possible problems can be pointed out and analysed in order to timely implement appropriate measures.

This should be a part of the resilience strategy.

The methodology applied for estimation of water resources availability on test areas in the Adriatic region is given in Chapter 2.2. and in the Joint report Common methodology for determination of water availability in Adriatic region and Annexes [15].

Cross-border water (re)sources quality:

The quality of water resources on test areas in the Adriatic region and the trends in quality are presented in Chapter 2.3.1. and in detail in the Joint report Water quality trends on test areas (water resources) and Annexes [22].

To estimate the climate change and socio-economic impact on water resources quality in the future it was proposed to apply the DPSIR approach and the methodology described in 2.3. (Figure 2.3.2.).

The methodology and the most important measures to be applied on test areas were pointed out in the Joint report on common methodology on estimation of climate change induced land use changes and changes in water quality on test areas and Annexes [23]:

- Continuous and regular monitoring of water quality trends, with wide monitoring network;
- Increase of organic agriculture without mineral fertilisers, pesticides, hormones and similar products;
- Improvement of wastewater treatment;
- Decreasing pumping rate to solve sea water intrusion problems;
- Contrasting seawater intrusion in coastal aquifers with the Management of Aquifer Recharge (MAR). MAR allows storage of large quantities of surface water (including surface runoff, storm water, reclaimed water and also freshwater from desalination) when availability exceeds demand and to restore them when demand exceeds availability;
- All drinking water sources areas should have established protection areas;
- Maintenance and modernization of the abstraction facilities;
- Public education about importance of achieving and preserving the good quality of water resources.

Cross-border water (re)sources monitoring:

In the Joint report Common protocol for water (re)sources monitoring activities in the Adriatic region [25] it was concluded that a common protocol for monitoring activities on cross-border water resources (used for human consumption) in the Adriatic region that could be applicable on all cross-border water (re)sources and all countries is very difficult to prepare given the differences in national legislation. Thus, the protocols for monitoring activities on cross-border water (re)sources should be prepared bilaterally between two interested countries (e.g. relevant institutions in those countries).

For this reason guideline for preparation of protocol for monitoring activities on cross-border water (re)sources in the Adriatic region is proposed. Based on this guideline and taking into account the particularities of just two countries (instead of 8) the bilateral protocol for monitoring activities on cross-border water (re)sources can be prepared with much more details.

Guideline for preparation of protocol for monitoring activities on cross-border water (re)sources in the Adriatic region:

The bilateral protocol for monitoring activities on cross-border water resources (used for human consumption) should include:

- relevant institutions on both sides;
- the procedure for exchange of results from national level monitoring and other levels of monitoring between relevant institutions of both countries;
- the procedure of exchange of planned monitoring programmes or even the preparation of joint monitoring programmes;
- the procedure to enable the access to monitoring locations in the neighbor country;
- the procedure of sample collection;
- the monitoring methods for both parties that should be standardized and comparable;
- the procedures regarding data and information use and publication;
- the procedure covering of additional monitoring costs;
- human resources and capacities development;
- other that might address cross-border water resources used for human consumption management.

The bilateral protocol for monitoring activities on cross-border water resources (used for human consumption) should be structured as follows (if applicable):

1. **Whereas:**

- EU Water Framework Directive;
- EU Drinking Water Directive, etc.;
- National regulatory framework relevant for Drinking Water Protection Zones;
- Risk assessment and management (Water Safety plans);
- Bilateral commissions;
- Strategies;
- Freedom of movement is a postulate in EU and accession countries also inducing possibility to take samples;
- …

2. **Scope of common procol for water (re)sources monitoning activities:**

- Appropriate drinking water (re)sources management in cross-boundary context is essential.
- Mutual exchage of information is reqired.
- We are drinking same water thus development of mutual trust, confidence, and awareness that same reality is shared by all of as is prerequest.
- Multiplication of monitoring activities should be considered as a tool for increase of mutual confidence instead of mistrust.
- Soft transition of administrative responsabilities in the cross-border context.
- Other than might be significant for particular cross-border drinking water source.

3. **Application/Interested parties**

- This protocol is addressing public institutions in charge for monitoring surface and ground water for human use.
- Interested private stakeholders play an important role in the cross-border monitoring of water resources, but their monitoring results and interpretations should be considered unofficial and therefore not part of this protocol.
- Nevertheless, the private parties should be informed about the existence of the protocol and motivated to respect the procedures and requirements defined by this protocol.
- Other than might be significant for particular cross-border drinking water source.

4. **Glossary of terms**

   Terms to be defined are:

- Cross-border / transboundary water (re)source
- Authority
- Agency
- Bilateral comission
- Monitoring

- Cross-border monitoring
- Regular, investigative, accidental monitoring
- Parallel sampling
- Monitoring programme
- Monitoring stations
- Other of relevance for particular cross-border drinking water source.

5. Protocol

The parties agree:

Acces to monitoring locations/sites

- Access to measurement locations/sites and infrastructure should be enabled to the neighbouring country party even with short advanced notice to institution in charge.
- Access to the zones with any specific restrictions should be enabled as well, balancing the level of restrictions and monitoring requirements.
- …

Sample collection

- Parallel sampling (not necessary analysis) should be enorsed in order to ensure the comparability of monitoring results.
- Presence of the national representative of insititurtion in charge in the cross-border monitoring and sampling is endorsed.
- ...

Monitoring methods

- Monitoring methods of both parties should be standardized and comparable.
- ...

Data and information

- Data and information from the national monitoring system and national reporting and publishing systems should be considered official.
- Parties agree that they will endorse common validation procedures and publication of the agreed data from national and cross-border monitoring.
- Public disclosure of the monitoring results – with interpretation of the results shall be performed as a joint expert statement using the mechanism of bilateral commission.
- …

Monitoring programmes

- Different types of monitoring have different regulations and should be declared.

- Parties endorse the annual exchange of planned monitoring programmes and obtained results of monitoring for previous year (time period should be defined) this is including official national level monitoring as well as other monitoring programmes.
- Development of cross-border monitoring long term action plan is endorsed, ensuring stability of monitoring process and development of adequate time series.
- …

Monitoring costs

- Interested party must cover the cost of all the additional monitoring for which they show interest in the other country (regular additional, investigative additional and accidental additional).
- Costs incurred to the third party, including national public bodies/institutions should be compensated unless agreed otherwise.
- …

Human resources and capacities development

- Involved countries endorse the exchange of professionals recognizing that the human resources are in the focal point of the improvement of the overall cross-border monitoring system.

All before mentioned should be in line with EU and national legislation and policies.

Cross-border water (re)sources protection:

It is recommended that principle of acceptable compatibility should be used for the cross border open questions in relation to drinking water protection in the Adriatic Ionian region. The principle can be relatively easily implemented because indications based on DRINKADRIA screening analysis of drinking water protection zones is showing that mainly more remote cross border recharge must be protected and only small number of cross border inner protection zones are possible to exist. This means that cross border protection is needed mainly for the outer protection zone where protection measures are not so strict and they are based mainly on the surveillance criteria. Therefore, they are not very demanding and it is easier to achieve agreement on the cross border protection measures.

Principle of acceptable compatibility is based on the implementation of valid national legislation for the protection of the recharge zone from where drinking water resource in the neighboring country is recharging (see Figure 3.1.). At the same time principle of acceptable compatibility suppose that national legislations regarding drinking water protection in both states are compatible to the acceptable level that both states can agree that legislation of other state can properly implement protection of recharge area of its drinking water resource.

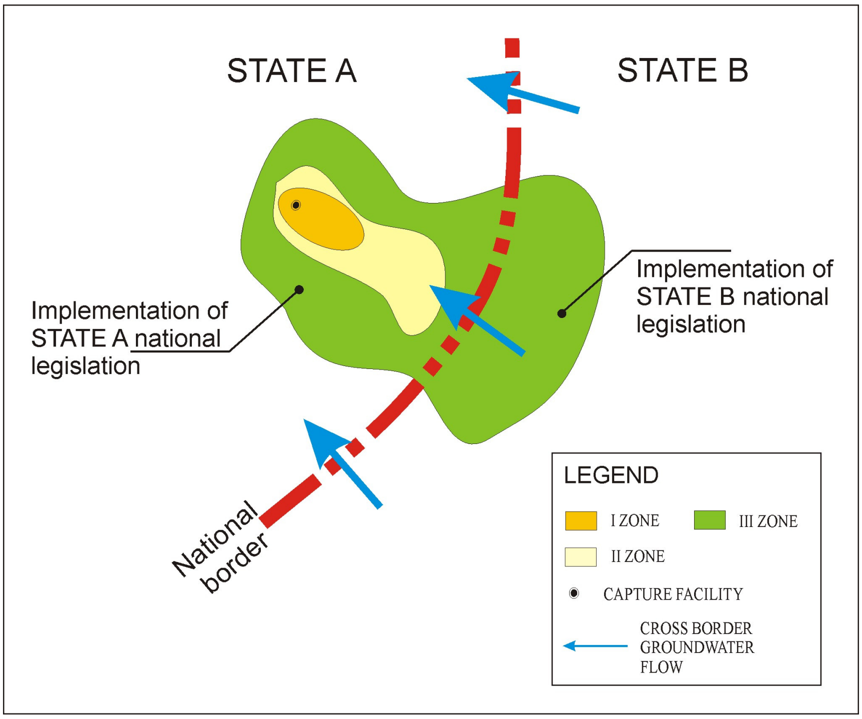


Figure 3.1. Principles of cross-border drinking water protection zones

In the Adriatic Ionian region principle of acceptable compatibility can be easily used for the protection of drinking water captured from groundwater. All the rules are very elaborated an enable proper and effective protection. The same is not valid for surface water drinking resources. Among the states relatively big differences exist in zoning principles. In the case of such water resources involved parties should find another solution. Possible solutions are covered in the Water Framework directive implementation related to common transboundary surface water bodies.

Cross-border water (re)sources management:

Drinking water resource systems are very complex and often do not meet the present demands, especially during the summer. Besides, drinking water has to meet high quality standards which are hard to achieve due to constant pressures that result from different land uses. Furthermore, water resources have to be protected, taking into account the functioning of aquatic ecosystems and the perenniality of the resource, in order to satisfy and reconcile needs for water in human activities [32]. In order to ensure adequate and sustainable drinking water supplies, water quantity and quality for humans and ecosystems, a comprehensive water resources management has to be established to address all complexities given the socio-economic and other factors and changes.

World Health Organization (WHO) recommends Water Safety Plans (WSP) as codified safe management. WSP is the most effective means of consistently ensuring the safety (quality and quantity) of drinking water supply through the use of a comprehensive risk assessment. According to amended Drinking Water Directive (DWD) from 6 October 2015 (2015/1787) WSP approach in Guidelines for Drinking Water Quality, together with standard EN 15975-2 concerning "security of drinking water supply, guidelines for risk and crisis management", which is based on WHO Guidelines, are internationally recognised principles on which the production, distribution, monitoring and analysis of parameters in drinking water is based. According to DWD risk assessment has to be aligned to the latest updates of those principles. Therefore, drinking water suppliers have to prepare WSP for their operation.

A WSP has to comprise, as a minimum, three essential actions, which are the responsibility of the drinking water supplier in order to ensure safe drinking water: (1) a system assessment, (2) effective operational monitoring and (3) management. WSP usually takes the form of a documented plan (or a number of plans) that identifies credible risks from catchment to consumer prioritizing those risks and puts in place and validates controls to mitigate them (Fig. 3.2). It also requires processes to verify the effectiveness of the management control systems and the quality of produced water. WSP approach is flexible and adaptable to national situations, plans are suited to deal with changes in water quantity and quality resulting from climate change and extreme weather events. Key feature for a successful WSP application is the right definitions and evaluation of risks and hazard for all the states of the WSS from catchment to consumer. For this reason, possible hazards, impacts and measures for the avoidance of adverse consequences have to be identified.

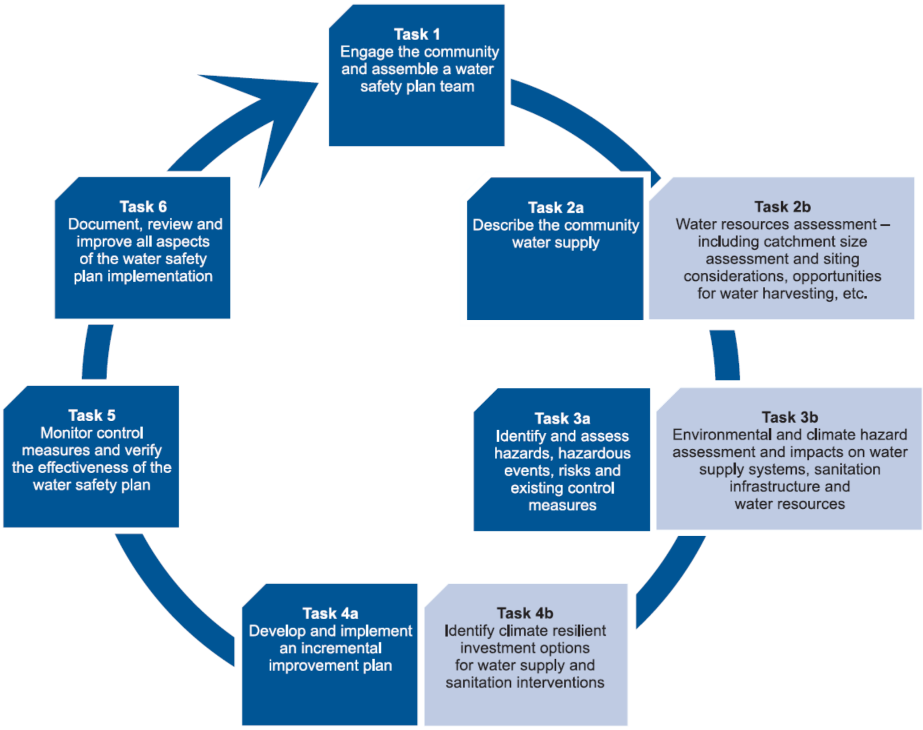


Figure 3.2. The six tasks to develop and implement a water safety plan [33]

4. Conclusion

The Adriatic region is a very sensitive region to climate and other changes on water resources. Moreover, there are numerous cross-border water resources that are used for drinking water supply.

In DRINKADRIA project the impacts of climate change, changes in land use, socio-economic changes and other relevant changes on water (re)sources have been analyzed with emphasis on cross-border (between countries or regions within one country) drinking water resources.

Selected and applied methodologies in estimation of these impacts on water resources in test areas are applicable in other areas and may provide useful data and information for suitable drinking water management.

Special emphasis is given to cross-border water (re)sources monitoring and protection, so the guideline for preparation of protocol for monitoring activities on cross-border water (re)sources in the Adriatic region and the proposal of the cross-border drinking water resources protection zones establishment and suitable protection measures implementation are developed.

It is proposed that the climate change risk and other relevant risks assessment with measures should be implemented in WSP.

In order to improve the water (re)sources management in the Adriatic it is recommended to:

1. Estimate the impact of climate change and other changes on water (re)sources quantity and quality for a future period 2021-2050 (2051-2100)
2. Estimate the risk of water shortage in future period 2021-2050 (2051-2100)
3. Define and implement bilateral protocols for cross-border water (re)sources monitoring through the activities of bilateral commissions and other relevant institutions
4. Establish the cross-border drinking water resources protection zones and implement adequate protection measures that will consider relevant legislation and policies, through the activities of bilateral commissions and other relevant institutions
5. Prepare and implement WSP that include climate change risk and other relevant risks assessment with measures

All these methodologies, guidelines and principles could be applied on other water (re)sources in the Adriatic area but also on wider area.

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Proposal of measures for crossborder water resources protection and management for Adriatic area – Rijeka 2016

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ANNEX 1

to

4.4. Joint report on proposal of measures for crossborder water resources protection and management for Adriatic area

Let's grow up together

DRINK ADRIA

Adriatic IPA
Cross Border Cooperation 2007-2013

The project is co-funded by the European Union,
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Cross border resources management

Water Safety Plans

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DRINK ADRIA

Adriatic IPA
Cross Border Cooperation 2007-2013

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Worckpackage 4

Activity 4.4 Water (re)sources protection and cross border water (re)sources management

Water Safety Plans

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Contents

ANNEXES

Annex 1 WP4 ACT4.4 Questionnaire about HACCP plans and water safety plans for drinking water supply

Annex 2 Analysis of questionnaires

Annex 3 Questionnaires answered by the project partners

List of abbreviations

CB - cross-border

CR - cross-regional

DWD - Drinking Water Directive

EECCA - Eastern European Caucasus and Central Asia

UNICEF - United Nations Children’s Fund

EU - European Union

SEE - South Eastern Europe

HACCP - Hazard Analysis Critical Control Point

WHO - World Health Organization

WSP - Water Safety Plan

WS - water supply

WSS - water supply systems

WU - Water Utility

Summary

In contrast with general public, even scientific community believe, that water safety and thus Water Safety Plans (WSP) are not a tool only for the poor water supply systems of developing countries. Serious outbreaks of waterborne diseases in developed countries in the past years have indicated the need for a continuous vigilance in the management of water supply systems [1].

For DRINKADRIA project, dealing with cross-border water supply systems (CB WSS) and cross-regional water supply systems (CR WSS), a water quality and quality assurance in Adriatic area is a major issue, since the countries are many times entitled to different legislation requirements regarding not only water quality but also water quantity risks. The safeguarding of water quality and quantity gets even more uncertain in emergency situations that are highlighted from the climate change pressures, as well as the large number of small scale water supplies in the DRINKADRIA area. Thus, a WSP is need to be modified where the emergency incidents and the particularities of small scale supplies are taken into account and are the key, that could provide effective management of drinking water systems, critical to ensure the delivery of safe drinking water.

A questionnaire was prepared in order to investigate the implementation of HACCP (Hazard Analysis Critical Control Point) and/or WSP in water utilities and partner countries in the DRINKADRIA area. The questionnaire found in the annexes asked for the following information:

- the existence of a WSP or HACCP in the Water Utility (WU)/partner country,
- if the implementation of WSP or HACCP is a mandatory legal obligation,
- what are the contents of the WSP/HACCP and in which documents they are defined,
- if risks for water quality and water shortage are determined,
- the measures applied to deal with the qualitative and quantitative risks, and
- if alternative drinking water resources are determined.

Interesting outcome of the questionnaire is how different are the approaches of water security, even in restricted areas like in Istria Peninsula in Croatia. Since the legislation does not impose the implementation of WSP or HACCP, it relies on the WU whether it will adopt such a plan or not. Moreover, we can conclude the fact that although some WU adopt HACCP or WSP they do not give emphasis to the quantitative aspect such as water shortage incidents, but rather the qualitative aspect even in the incident situations.

Attention should also be given to the fact that although a lot of countries implement a WSP type approach in the WU (like the case of Greece [2]) to safeguard the supply of water in the emergency situation, they do not refer to it as WSP. As a result it is therefore more difficult to make an overview of the benefits of the WSP.

Generally, for water systems, which have implemented WSPs or their equivalent documents, many have positive effects were observed, such as an increase in regulatory compliance, improvements in microbiological water quality, decreases in the incidence of clinical cases of diarrhea, greater customer satisfaction, and better management asset, leading to potential financial benefits. These benefits suggest that implementation of WSPs could offer added value to existing regulations [3].

1. Introduction

Present and future risk for drinking water quality and quantity has to be determined for cross-border drinking water sources. In last decades increased frequency of droughts and heavy precipitation events has been observed. Water suppliers have to prepare for such extreme events in order to supply sufficient quantities of safe water to consumers without disruptions. This is a responsibility of water suppliers and a great challenge, above all in Mediterranean region due to high water demand in summer months and decreasing recharge.

Most water supply companies in IPA Adriatic area have adopted HACCP (Hazard Analysis and Critical Control Points), which is an internationally recognized process control system for identifying and prioritizing hazards and risks to the quality of drinking water from »source to tap«. However, water quantity risks should be also considered due to changes in climate and water demand.

WHO (World Health Organization) recommends Water Safety Plans (WSP) as codified safe drinking water supply management. The WSP approach is based on risk assessment and risk management principles, laid down in its Guidelines for Drinking Water Quality [4]. WSP is the most effective means of consistently ensuring the safety (quality and quantity) of drinking water supply through the use of a comprehensive risk assessment. Only some countries in the IPA Adriatic region have adopted WSP, none of them include climate change risk assessment with measures.

According to amended Drinking Water Directive (DWD) [14] from 6 October 2015 (2015/1787) WSP approach in Guidelines for Drinking Water Quality, together with standard EN 15975-2 concerning “security of drinking water supply, guidelines for risk and crisis management”, are internationally recognised principles on which the production, distribution, monitoring and analysis of parameters in drinking water is based. According to DWD risk assessment in Annex II of DWD has to be aligned to the latest updates of those principles.

Those Guidelines, together with standard EN 15975-2 concerning security of drinking water supply, are internationally recognised principles on which the production, distribution, monitoring and analysis of parameters in drinking water is based. Annex II to Directive 98/83/EC should therefore be aligned to the latest updates of those principles.

2. Definition of drinking water safety

The basic and essential requirements to ensure the safety of drinking-water are a “framework” for safe drinking-water; comprising health-based targets established by a competent health authority, adequate and properly managed systems (adequate infrastructure, proper monitoring and effective planning and management) and a system of independent surveillance. [4]

2.1 Water Safety Plans (WSP)

Water Safety Plans (WSPs) were developed by the World Health Organization (WHO) from 1994 to 2003 and were introduced in its 3rd edition of Guidelines for Drinking-water Quality in 2003 to ensure that all hazards and risks that could adversely affect drinking water safety are managed to assure the safety of drinking water under a “Framework for Safe Drinking-water” [2].

A **WSP** is widely defined as [3] *"a comprehensive risk assessment and risk management approach towards water safety management that encompasses all steps in water supply, from catchment to consumer"* (Fig. 1). It usually takes the form of a documented plan (or a number of plans) that identifies credible risks from catchment to consumer prioritizing those risks and puts in place and validates controls to mitigate them. It also requires processes to verify the effectiveness of the management control systems and the quality of produced water [4].

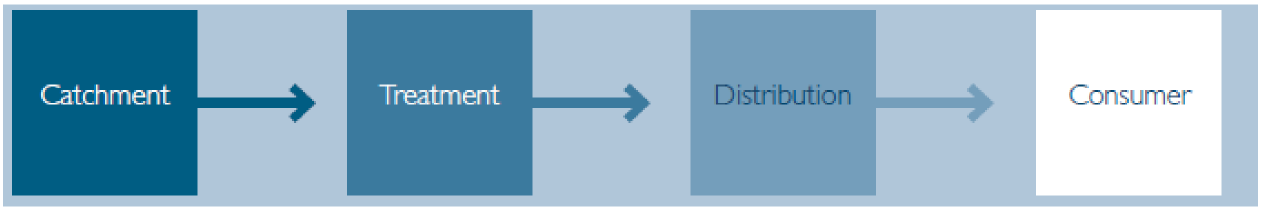


Fig. 1: WSP approach from catchment to consumer [5]

A WSP comprises, as a minimum, three essential actions [2] (Fig. 2) which are the responsibility of the drinking water supplier in order to ensure safe drinking water. These actions are:

- a system assessment,
- effective operational monitoring and
- management.

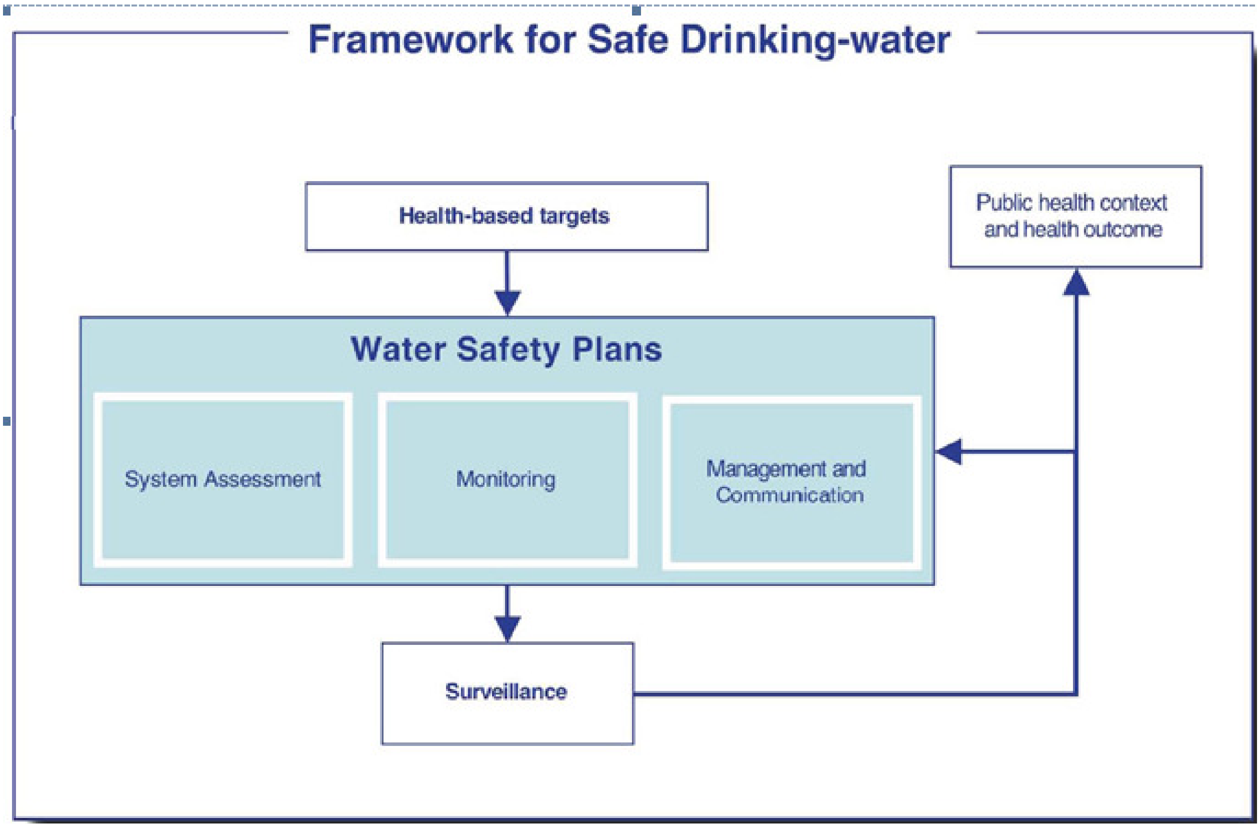


Fig. 2: Three essential actions of a WSP [2]

Fig. 3: The three administrative levels ensuring the successfull application of a WSP [6]

2.2 Hazard Analysis Critical Control Point (HACCP)

Some of the water utilities based the elements of their water safety process on application of **HACCP** (Hazard Analysis Critical Control Point).

Originating in the 1960's, HACCP was designed to ensure safety of food and beverages from microbiological hazards for the first NASA manned space missions thus preventing astronauts from falling victim to gastroenteritis while in space. The World Health Organization (WHO) guidelines for HACCP, Codex Alimentarius, have been adopted internationally as the primary recognized food safety methodology for risk management. [4]

The HACCP paradigm was based on prevention through control process and it facilitated the focusing of resources at **Critical Control Points** in the process at which control was essential to prevent or mitigate contamination. By including drinking water in the definition of food, a quality assurance system such as HACCP has to be applied.

2.3 WSP and HACCP definition and comparison

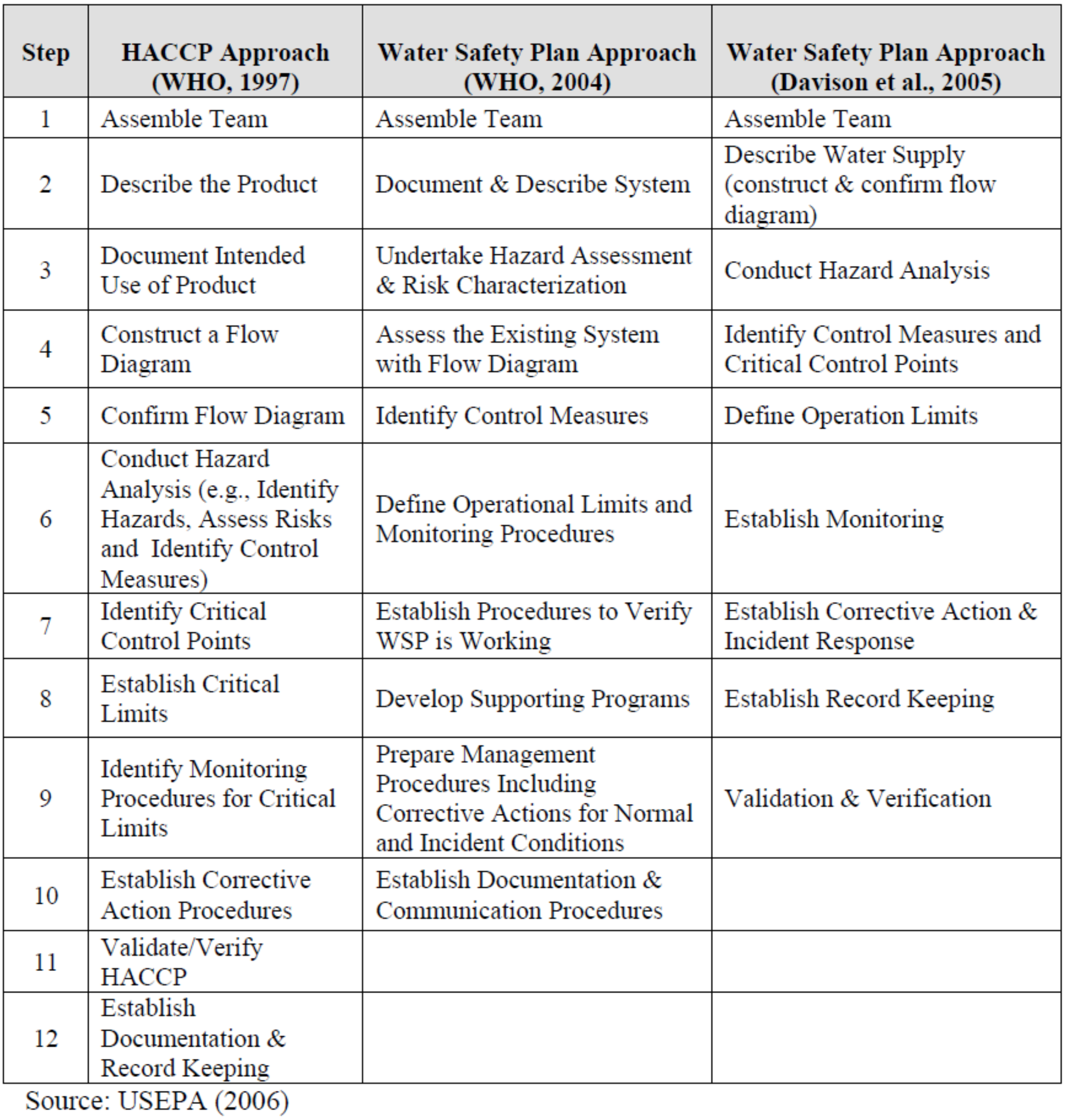
The HACCP process has evolved to become 'Food Safety Plan' (FSP) upon which the WSP term is based, and which encompasses a more holistic approach to food safety incorporating elements such as training, understanding legislative obligations and emergency preparedness and response procedures.

Both, the WSP and the FSP are risk-based. The major point of difference between the WSP and FSP approach is terminology – the WSP does not include the concept of critical control points, rather it seeks to underline the concept of **multiple barriers** by focusing on the need to implement control measures at each barrier in the water supply chain (catchment to consumer) without assigning the concept of criticality.

The definition of the term control measure, within the context of the WSP approach, reflects the importance that WHO places on/in? all control measures within the water supply chain. "*Those steps in a drinking water supply that directly affect drinking-water quality and that* collectively ensure that drinking-water consistently meets health based targets. They are activities and processes applied to prevent hazard occurrence". [20]

Today, it is reported that WSPs offer an internationally recognized systematic risk management approach to enhance water quality from source to tap that has been used in both developed and developing countries. Through the implementation of this risk management approach, water systems have seen to improved water quality, regulatory compliance, communication, asset management, and public health outcomes [3].

Table 1: HACCP and WSP approaches comparison step by step [2]



Step	HACCP Approach (WHO, 1997)	Water Safety Plan Approach (WHO, 2004)	Water Safety Plan Approach (Davison et al., 2005)
1	Assemble Team	Assemble Team	Assemble Team
2	Describe the Product	Document & Describe System	Describe Water Supply (construct & confirm flow diagram)
3	Document Intended Use of Product	Undertake Hazard Assessment & Risk Characterization	Conduct Hazard Analysis
4	Construct a Flow Diagram	Assess the Existing System with Flow Diagram	Identify Control Measures and Critical Control Points
5	Confirm Flow Diagram	Identify Control Measures	Define Operation Limits
6	Conduct Hazard Analysis (e.g., Identify Hazards, Assess Risks and Identify Control Measures)	Define Operational Limits and Monitoring Procedures	Establish Monitoring
7	Identify Critical Control Points	Establish Procedures to Verify WSP is Working	Establish Corrective Action & Incident Response
8	Establish Critical Limits	Develop Supporting Programs	Establish Record Keeping
9	Identify Monitoring Procedures for Critical Limits	Prepare Management Procedures Including Corrective Actions for Normal and Incident Conditions	Validation & Verification
10	Establish Corrective Action Procedures	Establish Documentation & Communication Procedures	
11	Validate/Verify HACCP		
12	Establish Documentation & Record Keeping		

Source: USEPA (2006)

2.4 Scheme for the implementation of WSP

As already stated in the introduction, WSPs have three components: system assessment, operational monitoring, and management and communication (Fig. 2), which are implemented through an 11-step process [5]:

(1) assemble the team,

(2) describe the water supply system,

(3) identify hazards and hazardous events and assess the risks,

(4) determine and validate control measures, reassess and prioritize the risks,

(5) develop, implement and maintain an improvement/upgrade plan,

(6) define monitoring of the control measures,

(7) verify the effectiveness of the WSP,

(8) prepare management procedures,

(9) develop supporting programs,

(10) plan and carry out periodic review of the WSP, and

(11) revise the WSP following an incident.

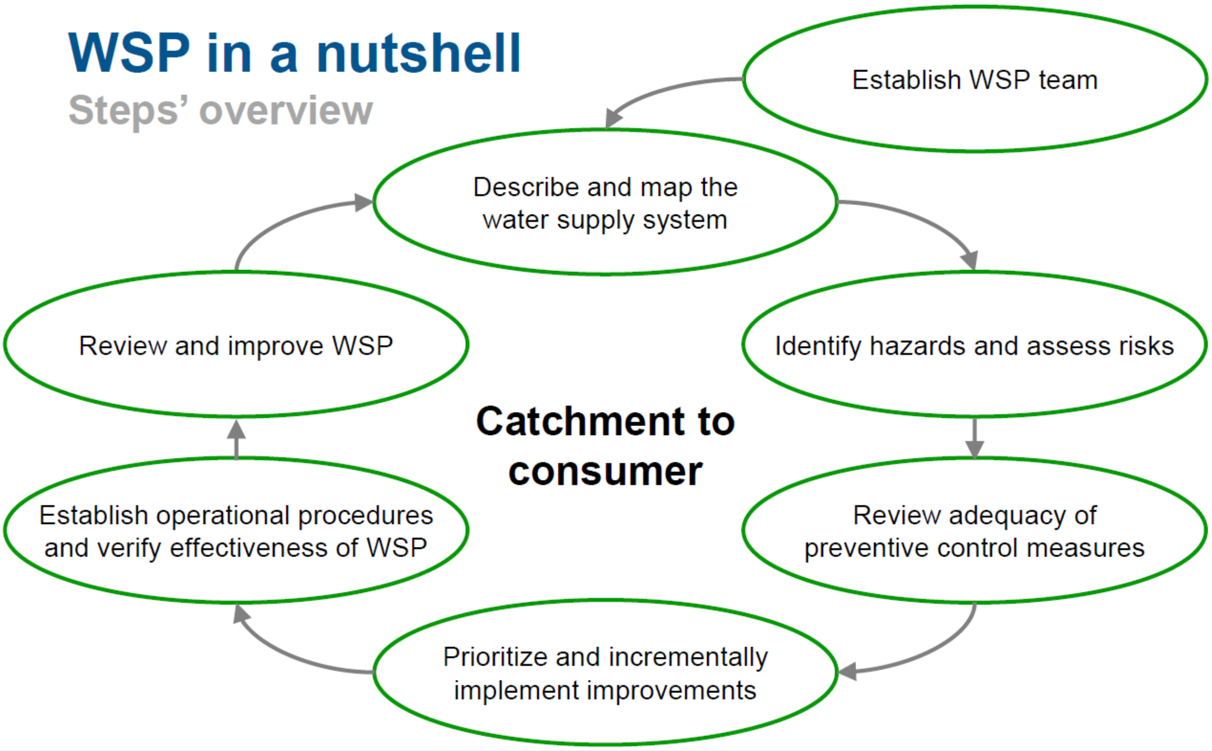


Fig. 4: WSP "catchment to consumer" approach [6]

The WHO has published manual in order to attempt to help and encourage the WUs to implement the WSP in the form of step by step guiding.

More detailed plan for the implementation of the WSP can be found in the step by step manual [5], developed from the WHO.

2.5 WSP world experience

Over thirty-five countries worldwide have multiple water systems that have well documented cases of either **voluntarily or mandatorily implemented WSPs**, or their equivalents under other names, that serve as a preventive risk management approach in an effort to ensure the safety of drinking water. These include Argentina, Australia, Austria, Bangladesh, Bhutan, Belgium, Bolivia, Brazil, Canada, China, Ecuador, France, Germany, Guyana, Honduras, Hungary, Iceland, India, Indonesia, Jamaica, Japan, Lithuania, Malaysia, Morocco, Nepal, The Netherlands, New Zealand, Peru, The Philippines, Portugal, Singapore, South Africa, Spain, Switzerland, Uganda, and The United Kingdom [3].

One third of countries have provisions on WSP-type approaches [6] in place:

–“Regulatory” implementation strategy with minimum requirements and enforcement mechanisms (e.g. Belgium, Hungary, Iceland, Switzerland, United Kingdom)

–“Soft” implementation strategy triggering that water suppliers find WSPs appropriate (e.g. Germany, Portugal)

Although WSPs have been implemented in more countries, a lack of documented cases in these areas suggests more research needs to be done in order to successfully advertise the benefits of the WSP approach throughout different regions of the world. (3)

As commented below that’s also the case in the DRINKADRIA area where although a lot of utilities implement equivalent of the WSP approach, they so not refer to them with this name, so it is not easy to conclude for the number of counties that adopt this approach.

Table 2: Guidelines organized by country concerning the HACCP and WSP approach [2]

Country/ Organization	Regulation or Regulatory Guideline	Website for current information	Reference
World Health Organization	Guidelines for Drinking Water Quality (3rd Edition)	www.who.int/water_sanitation_health/dwq/guidelines2/en/	Davison and Bartram (2004)
U.S./EPA	Aircraft Drinking Water Rule (under development)	http://www.epa.gov/safewater/airlinewater/regs.html	USEPA (2006)
Australia	Australian Drinking Water Guidelines (Guideline)	www.nhmrc.gov.au/publications/synopses/eh19syn.htm	NHMRC and NRMMC (2004)
New Zealand	Health (Drinking Water) Amendment Bill (Proposed regulation)	www.moh.govt.nz/water	
Switzerland	W1002 Regulatory guideline: Recommendations for a Simple Quality Assurance System for Water Supplies (Guideline)		Swiss Gas and Water Industry Association (2003)
	Hygiene Ordinance (SR 817.051, HyV), Article 11 (Regulation)		Bosshart (2003)
Iceland	Food legislation: Act no. 93/1995	http://english.ust.is/media/log/L1995-93_ensk.htm	Gunnarsdottir and Gissurarson (2006)
France	French National Transcription: Decree 2001-1220 (Dec. 20, 2001) Water Safety for Human Health, Risk Assessment and Management; Article 18-2 (Regulation)		Metge (2003); DeBier and Joret (2004)
Ontario, Canada	Water quality management standard based on HACCP, ISO 9001, and ISO14001 (Guideline)	http://www.ene.gov.on.ca/envision/env_reg/er/documents/2006/Drinking%20Water%20Quality%20Management%20Standard%20-%20October%202006.pdf	Ministry of the Environment (2006)

3. Particularities of the DRINKADRIA area and Implementation of WSP

For DRINKADRIA area, as already mentioned in the project proposal, dealing with cross-border water supply systems (CB WSS) and cross-regional water supply systems (CR WSS) water quality and quality assurance is a major issue, since the countries are many times entitled to different legislation requirements regarding not only water quality but also water quantity risks. The safeguarding gets even more uncertain in emergency situations that are highlighted from the climate change pressures, as wells as the large number of small scale water supplies in the DRINKADRIA area. Thus, a Water Safety Plan (WSP), modified to take into account the emergency incidents and the small scale supplies particularities, is the key, that could provide effective management of potable water systems, critical to ensure the delivery of safe drinking water.

3.1 Demographics and importance of WSP for the DRINKADRIA area

A report [7] of the small scale water supply systems in the Pan European region provided very useful information concerning the rural population of DRINKADRIA region (Table 3 and Figure 4) and thus small water supplies number. Except Greece and Italy that are included in the EU (European Union) countries, the SEE (South Eastern Europe) group contains most of the countries of DRINKADRIA area, with the exception of FYROM and Romania.

Important fact is that all the partner countries are above the European rural population average 26% (Table 4, Figure 5), that indicates the significance of small water supplies for DRINKADRIA area, as will be further explained in 2.2.

Table 3: Rural population in Europe (2008) [7]

Region	total population number in the region	percentage of population in the Pan European region	proportion of rural population
EU average	**494769000**	**56%**	26%
SEE	**56428000**	**6%**	45%
EECCA	**276819000**	**31%**	36%
other countries	**93736000**	**11%**	28%
Pan-European region	**889165000**	**100%**	30%

SEE = South Eastern Europe, EECCA = Easten European Caucasus and Central Asian Countries, EU = European Union

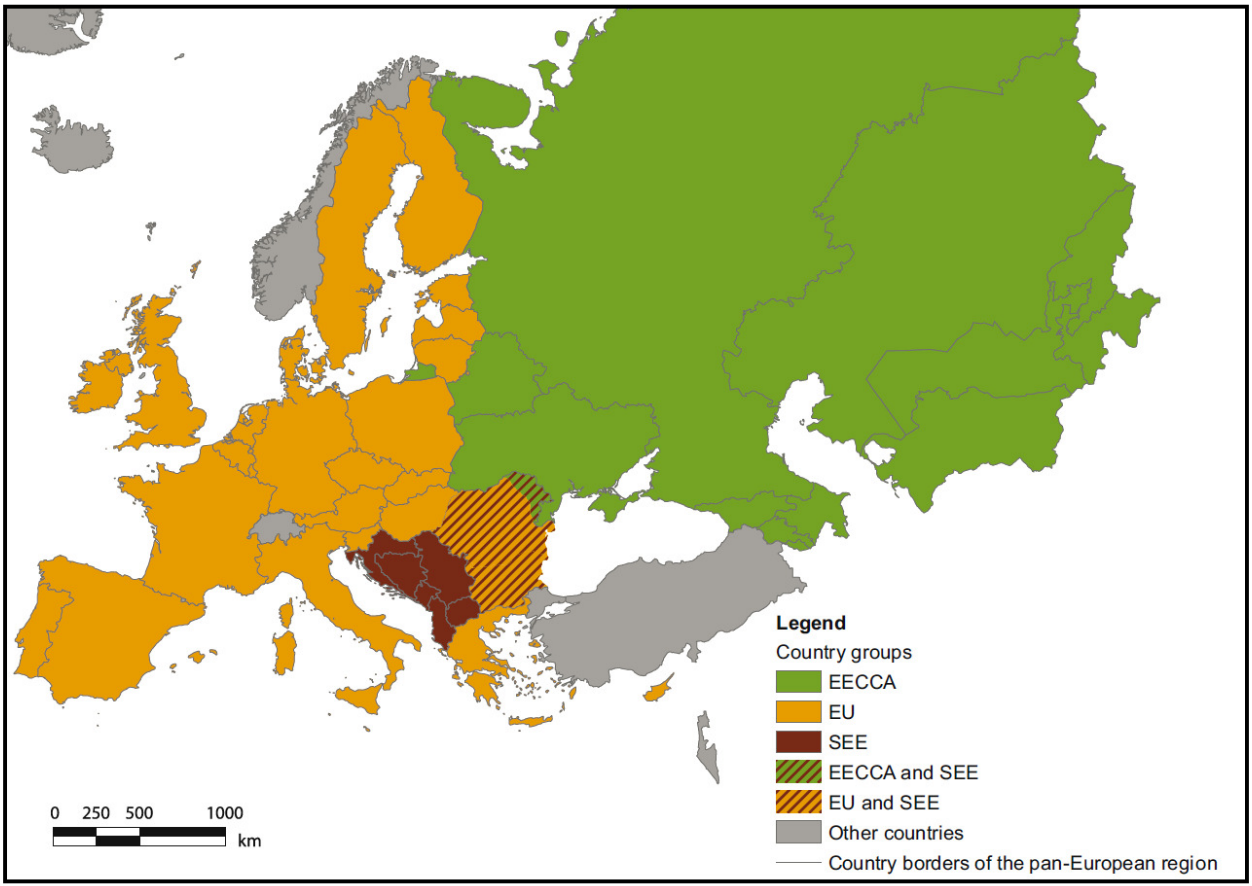


Fig. 4: Country groups in the Pan European region[1] *[7].*

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[1] *EU countries*: Austria, Belgium, Bulgaria, Croatia (from 2013), Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden and United Kingdom;

eastern European, Caucasus and central Asia countries: Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Republic of Moldova, Russian Federation, Tajikistan, Turkmenistan, Ukraine and Uzbekistan;

SEE countries (according to the definition of the WHO SEE Health Network): Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Montenegro, Republic of Moldova, Romania, Serbia and the Former Yugoslav Republic of Macedonia (FYROM);

other countries: Andorra, Iceland, Israel, Monaco, Norway, San Marino, Switzerland and Turkey.

The definition of a small-scale water supply can vary widely within and between countries. Frequently, small-scale water supplies are defined on the basis of legislatively specified criteria, such as population size, quantity of water provided, number of service connections or the type of supply technology used. No matter what criteria or terms are used to describe small-scale water supplies, usually it is not defined with the size itself that sets them apart from larger supplies, but rather regarding their administrative, managerial and operational characteristics, conditions and challenges.

For the **DRINKADRIA project more important are the "small-scale public water supplies"**, that are systems administered and managed by a distinct public entity (such as a municipality or water board association) responsible for the provision of drinking-water to the public in spatially limited area (for example, a small municipality or town). Water utilities, which are included in the DRINKADRIA project, can be divided into 2 size groups within the small water public supplies.

Small-scale water supplies are vital to supplying water to significant parts of the population in all countries of the European Region. This applies to both permanent residents and transient users (such as tourists, guests). Small-scale water supplies usually prevail in rural areas, including individual farms or settlements, hamlets, villages and small towns, or on small islands. Typically, they can also be found in vacation or leisure homes, trailer parks or camping grounds. Displaced, mobile, migrant and temporary populations — including occupiers of temporary homes, pilgrims, nomads, seasonal workers or participants of large festivals or fairs — may place additional stress on the management and operation of small-scale water supplies. Water supplies serving peri-urban areas (that is, the communities surrounding major towns and cities) are often beyond the reach of municipal services and are organized in the same way, therefore they can be also considered as small-scale water supplies.

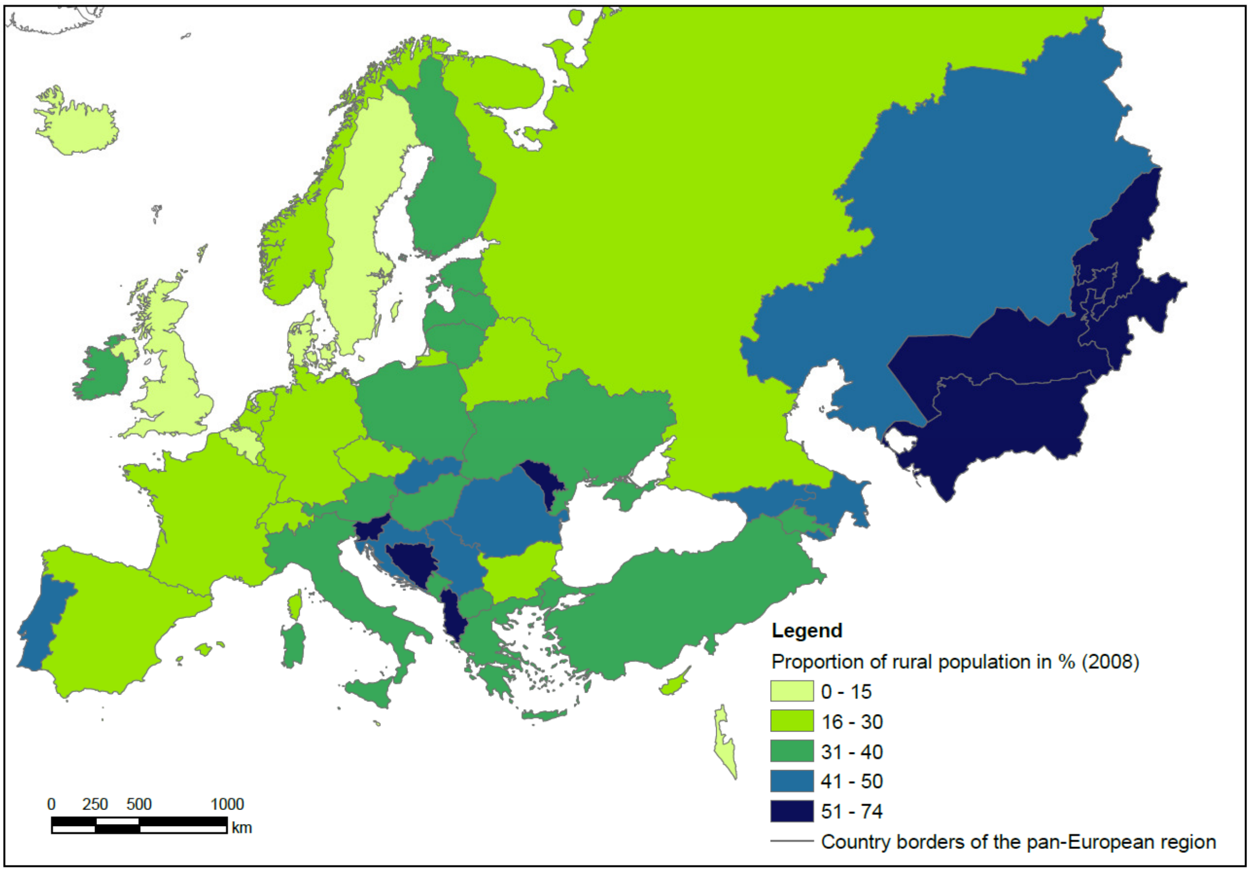


Fig. 5: Proportion of rural population in countries of the Pan-European region in 2008. [7]

Table 4: Proportion of rural population of DRINKADRIA partners compared to the grouping average [7]

	proportion of rural population %
DRINKADRIA partner countries	
Italy	31-40
Montenegro	31-40
Greece	31-40
Croatia	41-50
Serbia	41-50
Slovenia	51-74
Bosnia and Herzegovina	51-74
Albania	51-74
EU average	26
SEE	45
EECCA	36
other countries	28
Pan-European region	30

The WHO report [7] about the Pan-European region additionally provided us with following information:

- *Hulsmann estimates that 1 of 10 citizens of the EU receives drinking-water from small or very small systems, including private wells [12].*
- *In Italy, out of the approximately 11,500 drinking-water supplies, more than 7,100 served between 3 and 275 m^3 per day and approximately 2,800 served between 276 and 1,370 m^3 per day in 1999. Most of those small public supplies exploited spring or well water as their water supply sources.*
- *In Croatia there are 443 small water supply systems (serving approximately 50 to 3,000 people), which are not subject to regular water quality testing by the Public Health Institute. According to data collected in 2008 during a study by the Croatian Public Health Institute on the status of small-scale water supply systems, approximately 7% of the Croatian population is supplied by such systems.*
- *According to this study, approximately 70% of this 7% of the population receive water that is not in compliance with the respective standards. Approximately 14% of the population is supplied with water from private wells; however, no quality data are available for these supplies.*

3.2 Small water supplies WSP changes

As explained in 2.1, WSP are of large significance for the areas concerning the DRINKADRIA project, both because of the climate change pressure in the area, but also the significant percentage of small scale water supplies of potable water, as already stated in 2.1.

The WHO as well as the UNICEF water, sanitation and hygiene (WASH) programmes gave specific attention to the **implementation of WSP for the small scale supplies** publishing a notable number of guidelines and step by step manuals [5] [13]. These documents initially explaining the statistical data and their importance and specializing the WSP for small scale utilities in order to help the WU, stakeholders as well as the community to easier apply the WSP steps. Many of today’s national and international policy frameworks already recognize that further attention to this topic is needed.

The provision of safe and acceptable drinking-water of sufficient quantity and quality of small water supplies frequently represents a challenge. Experience has shown that differences from larger suppliers are administrative, managerial and operational characteristics and resourcing specifics. They are more vulnerable to breakdown and contamination than larger utilities.

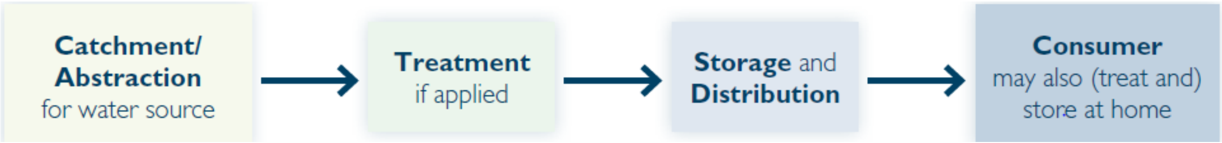


Fig. 6: ¨Catchment to consumer approach¨ for small communities [7]

More specifically attention should be given to the following fields:

(A) Regulations

• Small-scale water supplies are often not regulated or are regulated differently compared to larger supplies. The EU legislation is an example of this: according to the provisions of the Drinking Water Directive [14] (DWD), Member States may exempt supplies serving less than 10 m^3 a day or serving fewer than 50 individuals from the minimum requirements of the DWD, unless the water is supplied as part of a commercial or public activity. In cases in which regulatory requirements for small-scale water supplies exist, they are often not feasible, or enforcement mechanisms tend to be weak or ineffective, among other reasons, due to their large numbers and the geographical spread of small-scale water supplies.

• Regulations often require drinking-water quality monitoring frequencies based on the size of the population served. Minimum monitoring requirements for small-scale water supplies are comparatively rare and typically range between 1 and 4 analyses per year. Some jurisdictions even exclude private wells from any monitoring requirements. In combination with non-existent or less-stringent reporting requirements, in many countries, systematic evidence of the status of drinking-water quality in small-scale water supplies is not readily available.

In the frame of DRINKADRIA project analysis of legislation was performed, with the emphasis on drinking water on EU level and country level for all partner countries.

(B) Attention and sense of responsibility

• Experience has shown that small-scale water supplies usually receive less political attention. Managers and operators of small community-managed supplies or of small public supplies are rarely organized in professional networks or in lobby groups that could function as a mouthpiece for their interests. Therefore, financial and political support, both locally and nationally, are harder to coverage, resulting in limited and inconsistent resourcing.

• There is frequently a low level of awareness and knowledge of potential risks from water to health among rural populations as if to say: “My grandpa already drank our local groundwater and never got sick”.

• The inaccurate perception of the importance of water supply for public health protection may lead to a lack of a sense of responsibility among local decision-makers, resulting in comparatively little political priority and thus under resourcing of water supply.

(C) Staff and management

• Small-scale water supplies frequently lack of personnel with specialized knowledge. Often non-water professionals or undertrained individuals operate the supply. In community-managed or public supplies, staff regularly carries out many tasks within the community or municipality in addition to water supply. Due to the larger geographical spread covered by small-scale water supplies, and sometimes also their remoteness and isolation, operators do not have easy access to information, expert assistance and technical support. There is also a low level of networking in scientific and professional communities.

- Frequently, there is a lack of awareness, knowledge and application of internationally or nationally recognized good managerial and operational practices, including those recommended by the WHO Guidelines for Drinking water Quality [4] or relevant international standards. Integrated risk-assessment and risk-management approaches, such as the WHO-recommended Water Safety Plan approach, are not extensively applied.

(D) Water resources and treatment

- Small-scale water supplies are often vulnerable to contamination. In many rural contexts, there is often a lack of integrated approaches regarding water source protection, sanitary protection of drinking-water sources is frequently inadequate, protection zones are often not established, and sometimes owners and users do not know where the water supplied is coming from. Experience has shown that adequate disposal of waste and excreta, wastewater drainage, placement of septic systems, controlling animal access to water supplies and market hygiene in rural communities often pose challenges, along with little understanding in the general public of the importance of water resource protection. Especially in rural agricultural areas, common pollution risks include livestock, wildlife, poor manure management and inadequate local sanitation practices, which frequently result in poor microbial drinking-water quality and elevated nitrate levels.

- The use of water-treatment technologies is generally limited and not necessarily consistent with source water quality. In many rural settings, groundwater is used for drinking purposes without disinfection, regardless of its contamination level. Heavy rainfalls and snow thawing also exert significant strain on small-scale treatment systems. Small scale water supplies are less resilient to quality and quantity (for example water scarcity) issues, induced by the possible impacts of climate change.

- Small-scale water supplies are often more vulnerable to breakdown. Maintenance of infrastructures is frequently limited due to lack of knowledge and understanding, or lack of adequate resourcing (for example financial and personnel, spare parts or building materials). As a consequence, aged supply infrastructures, even of “improved” sources, are often disrupted or not in working condition. This, combined with the lack of electricity, can limit operations that affect water quality and quantity, and frequently lead to intermittent supply with negative impacts on personal, domestic and food hygiene conditions. Users may also turn to other, potentially “unimproved” and therefore unsafe sources as alternative sources of water supply.

- Small-scale water supplies have relatively greater capital costs for technical installations and per-unit costs of materials and construction are also generally greater. There is often a lack of financial mechanisms to cover the local costs for monitoring, maintenance and operation.

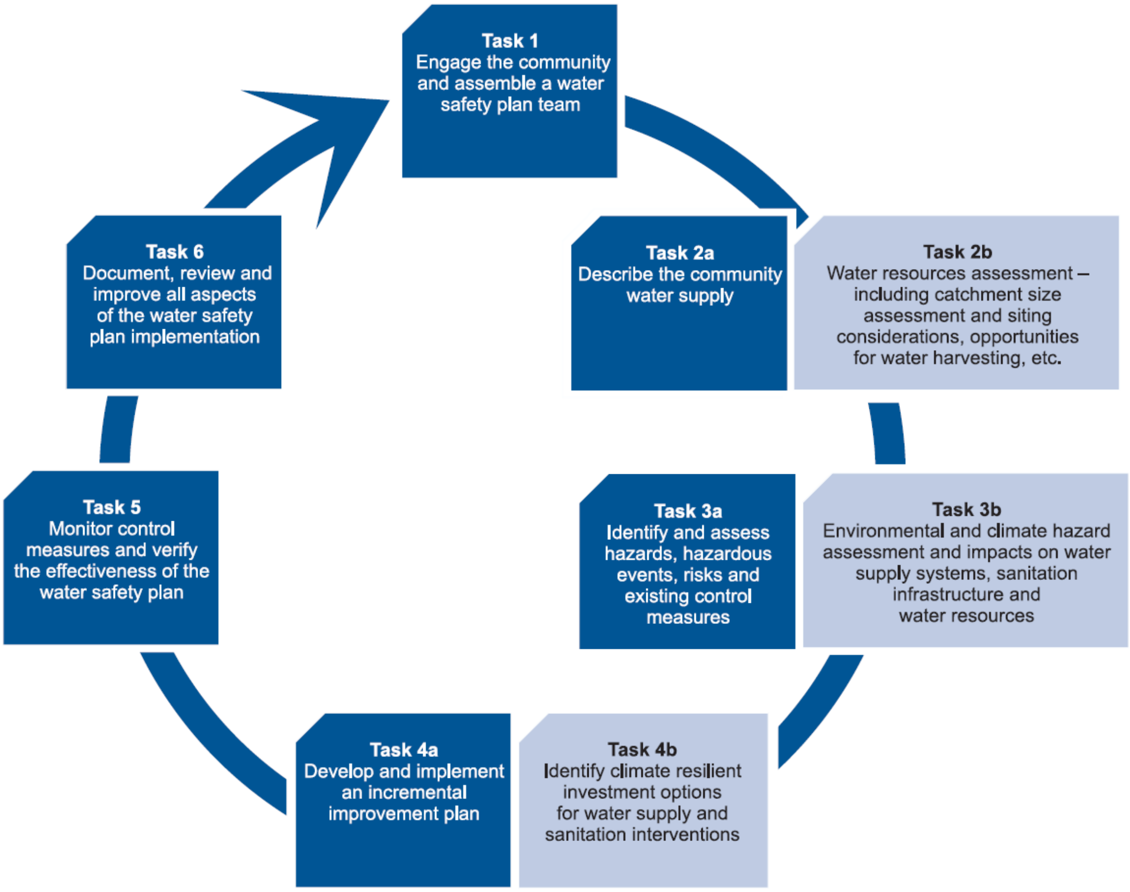


Fig. 7: The six tasks to develop and implement a water safety plan in small community water supplies [15]

3.3 Climate change and emergency situations - a need for modification of WSP

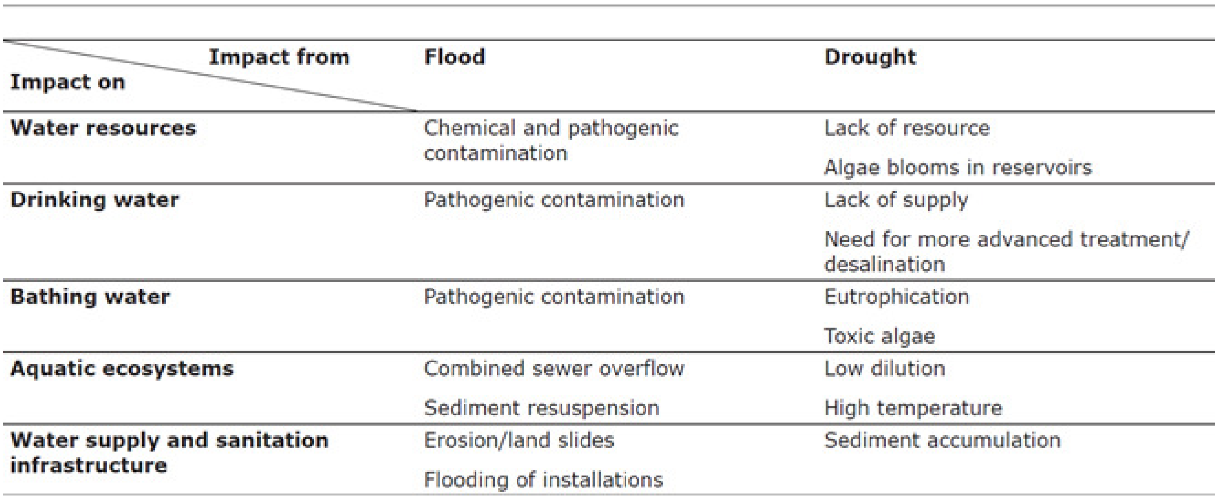
The WHO guidelines for drinking water quality [4] are the basis for international and national standards and drinking water quality regulations, as they contain advice for establishing incident response plans. During emergency situations, guideline values (for short-term exposure) for some, but not all, substances are increased. The guidelines also recommend WSPs to ensure safe drinking water through good water supply practice. They apply to all types and sizes of water supply systems. Because the WSP approach is flexible and adaptable to national situations, plans are suited to deal with changes in water quantity and quality (Table 6) resulting from climate change and extreme weather events.

As introduced for the WASH project technical report [15], the modified framework considering climate change is referred to as WSP-Plus (WSP-P), and extends the concept of safety to incorporate provision of safe supply as well as safe water quality.

Table 5: Effects of climate change and necessities that arise in the WU preparedness planning [6]

Specific "incident situation"	**Climate change and water Preparedness planning**
Effects of climate change impact precipitation patterns	**Necessities that arise**
Increased frequency, duration and intensity of rainfall	Need for increased resilience of water utilities
Increased risk of floods	WHO water safety plan approach supports adaptation management

Table 6: Overview of types of impacts from flood or drought extreme events [16]



Impact from / **Impact on**	**Flood**	**Drought**
Water resources	Chemical and pathogenic contamination	Lack of resource Algae blooms in reservoirs
Drinking water	Pathogenic contamination	Lack of supply Need for more advanced treatment/ desalination
Bathing water	Pathogenic contamination	Eutrophication Toxic algae
Aquatic ecosystems	Combined sewer overflow Sediment resuspension	Low dilution High temperature
Water supply and sanitation infrastructure	Erosion/land slides Flooding of installations	Sediment accumulation

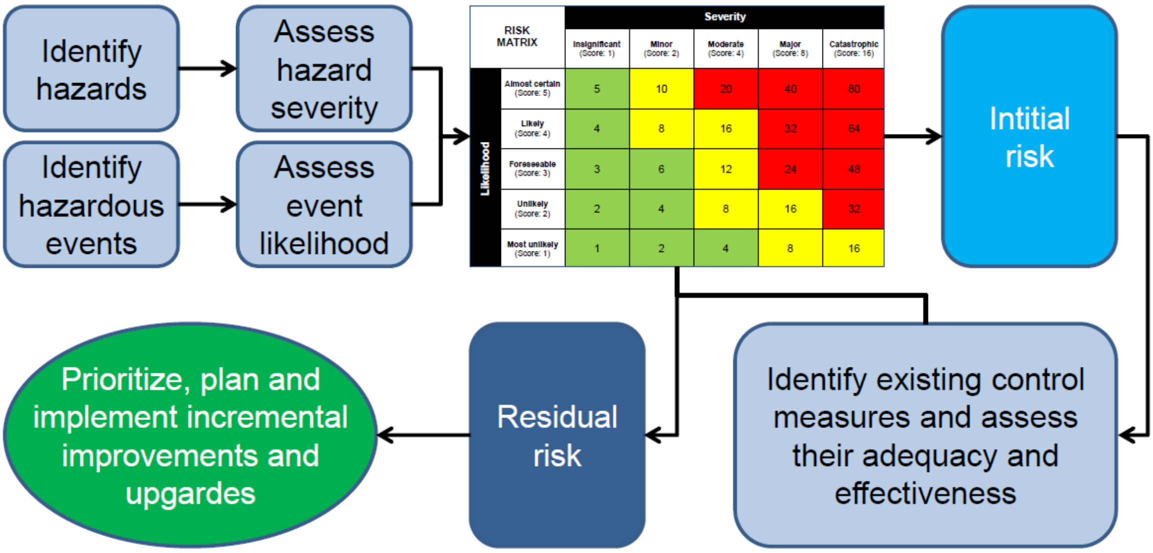
Key feature for a successful WSP application is the right definitions and evaluation of risks and hazard for all the states of the WSS from catchment to consumer (task 3 of the WSP implementation scheme in Figure 7).

For this reason Tables 7 and 8 describe possible hazards, impacts and measures for the avoidance of adverse consequences [15].

Table 7: Example of hazards and hazardous events to different stages of the WS chain [6]

Hazard	Supply step	Hazardous event
M & P	Catchment	High loads of turbidity (runoff) and pathogens (sewage overflow) in source water
M & C	Abstraction	Ingress of chemically and/or microbiologically contaminated flood water into (damaged) wells
M	Treatment	Source water quality beyond designed treatment capacities (i.e. coagulation, filtration and disinfection)
P	Treatment	Interruption of supply due to power failure
M	Distribution	Damaged/disrupted mains with ingress of flood water and/or sewerage

M Microbes, P Pathogens, C Chemicals



RISK MATRIX		Severity				
		Insignificant (Score: 1)	Minor (Score: 2)	Moderate (Score: 4)	Major (Score: 8)	Catastrophic (Score: 16)
Likelihood	Almost certain (Score: 5)	5	10	20	40	80
	Likely (Score: 4)	4	8	16	32	64
	Foreseeable (Score: 3)	3	6	12	24	48
	Unlikely (Score: 2)	2	4	8	16	32
	Most unlikely (Score: 1)	1	2	4	8	16

Fig. 8: WSP system assessment:validation of control measures [6]

*Table 8: Hazards impacts and measures taking into account the climate change [15] *continued*

Hazard	**Impact on water supply systems**		**Adaptation options**	**Implication for communities (+ = positive, – = negative)**
	Direct	**Indirect**		
Drought	Reduced water availability	Population movements to other areas, posing further stress on remaining water sources and use of unsafe sources	**Collection and storage of surface water runoff:** ■ Below ground tanks (i.e. cisterns) and excavations into which rainwater is directed from the ground surface ■ Small reservoirs with earthen bunds or embankments to contain runoff or river flows ■ Managed aquifer recharge: capturing and recharging excess runoff in the vicinity of a well or borehole	+ Stored runoff can be used for non-potable uses (e.g. garden irrigation), reducing pressure on higher quality (domestic) sources. In some regions stored water can be used for drinking in the dry season with adequate treatment + Storage provides a good alternative when water availability is insufficient, but technical, environmental, social or legal concerns may preclude development of reservoirs if they are too large + or – Potentially high costs depending on the scale of the project and location (availability of donors may help, but issues of sustainability when project completed) – Capturing runoff can affect downstream communities, reducing their water availability + or – Directing excess runoff down, for example, abandoned wells to recharge aquifers can fast-track contamination

*Table 8: Hazards impacts and measures taking into account the climate change [15] *continued*

Hazard	**Impact on water supply systems**		**Adaptation options**	**Implication for communities (+ = positive, – = negative)**
	Direct	**Indirect**		
Flooding	Damage to infrastructure (e.g. collapse of unlined wells when soil becomes saturated, and physical damage to wellhead)		**Improving resilience of protected wells to flooding** (including boreholes and hand dug wells) ■ Adaptation measures to the wellhead/spring box ■ Switching from unprotected to protected wells with hand pumps ■ Casing wells with watertight material ■ Raising the wellhead ■ Placing wellhead on mound to allow floodwater to drain away ■ Flood protection (e.g. levees, drainage ditches, artificial waterways, soil and water conservation on adjacent land to enhance infiltration and reduce runoff, etc.) ■ Area closure/re-vegetation/ afforestation ■ Household water treatment and hygiene behavioural training ■ Prepositioning of tool kits, test kits and disinfection kits **Post-construction support (PCS) for community-managed water supplies, e.g.** ■ Technical training for water system operator ■ Technical and engineering support, including provision of technical manuals ■ Financial and accounting assistance (e.g. in setting tariffs) ■ Help settling disputes ■ Help with maintenance, repairs and finding spare parts ■ Help finding external funding for O&M, expansion or repairs ■ Household visits to residents to discuss water system use, etc.	+ Only basic requirements to implement this technological option (which should be present in WSP team) including: basic knowledge of water supply technology and experience drilling a given type of well/basic concrete construction skills + Retro-fitting for flooding, including raising the wellhead on a plinth, can generally be accomplished with basic construction supplies at or close to the ground surface – Construction of new wells can be very expensive
		Inaccessibility of water sources	■ Flood protection (such as levees, drainage ditches, artificial waterways, etc.) ■ Raising wellhead	
	Inundation of wells		■ As above	

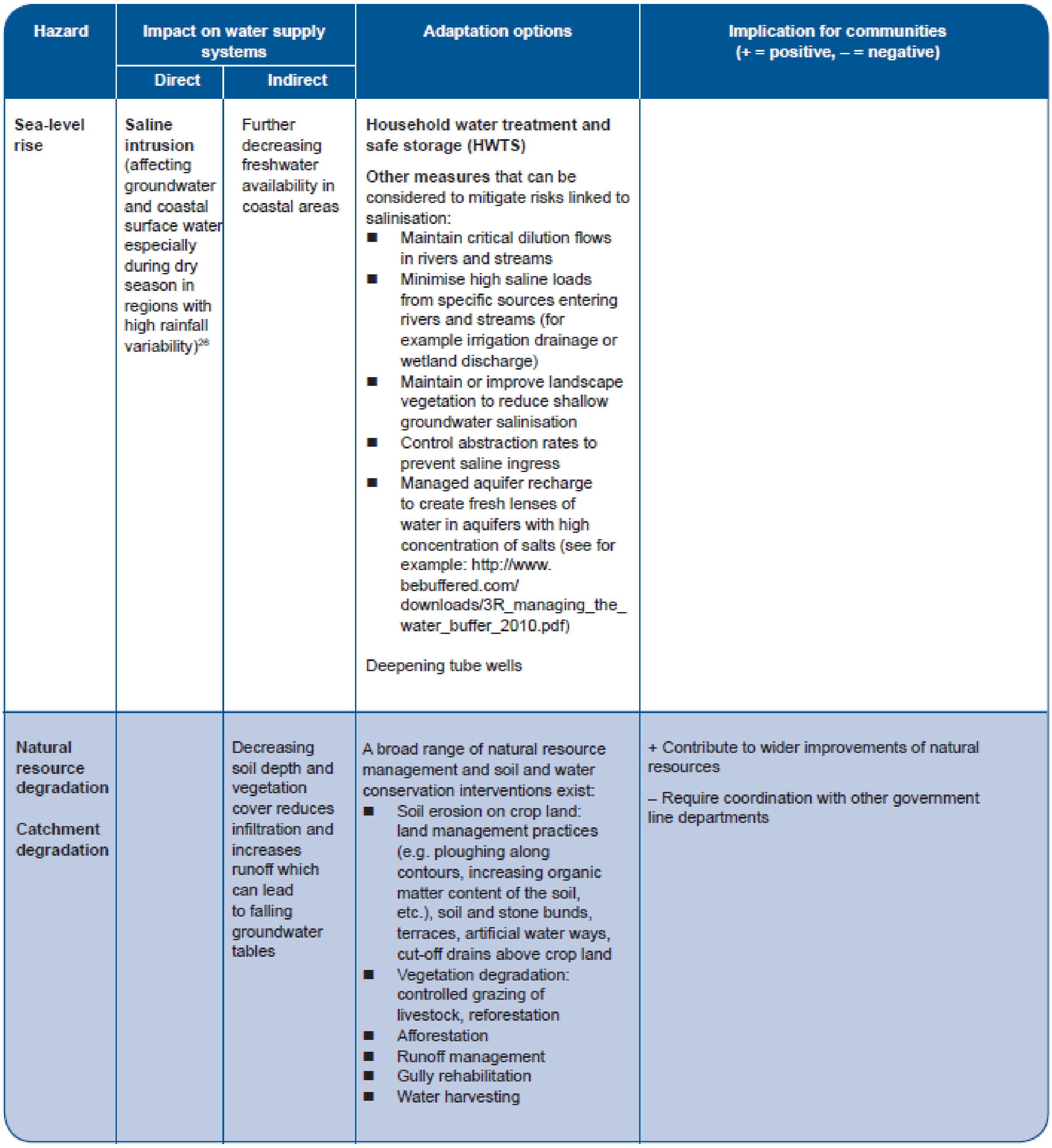
*Table 8: Hazards impacts and measures taking into account the climate change [15] *continued*

Hazard	**Impact on water supply systems**		**Adaptation options**	**Implication for communities (+ = positive, – = negative)**
	Direct	**Indirect**		
Flooding (continued)		Pollution of water sources (and consequent health effects, e.g. increase in waterborne diseases)	**Household water treatment and safe storage (HWTS)** A list of HWTS technologies is provided by Elliot et al., 2011, p 25 Including treatment of drinking water by heating	+ Relatively cheap and diffused HWTS technologies (new ones continuing to emerge) and easy to operate and maintain, hence accessible also at household level + and – Some technologies have few if any capital costs (e.g. chemical disinfectants), but must be purchased periodically; others (e.g. biosand filters) have relatively large up-front costs with little or no ongoing costs + and – Appropriate for crisis times (e.g. in refugee camps following natural disasters) also because of donor subsidies, but otherwise modest uptake and sustained use+ and – Boiling water is highly effective at eliminating all classes of pathogens but has numerous disadvantages in terms of the time to gather fuel, risk of deforestation in areas with limited alternative fuels, sometimes prohibitive costs, and degradation of indoor air quality leading to increased health hazards – Some HWTS technologies (e.g. chemical disinfectants) are consumable and need to be replaced frequently. Also, there might be problems of regular supply to rural areas, challenges in applying the appropriate dosage or rejection of use. Therefore, regular water quality testing is required – Potentially high costs associated with training and educating users
	Flooding of areas used for open defecation	Pollution of water sources (and consequent health effects, e.g. increase in waterborne diseases)	Initiation of community-led total sanitation (CLTS) approaches	+ Relatively cheap + Potential to empower and mobilise community members towards collective action beyond sanitation and hygiene
	Flooding of latrines	Consequent health effects, e.g. increase in waterborne diseases	**Adjustments to the location and design of latrines:** ■ Ensuring minimum distance between latrines and water sources ■ Relocation of latrines away from flood-prone and low-lying areas ■ Raising latrines and ensuring minimum distance between pit and water table is maintained ■ Short life or disposable pits ■ Composting latrines ■ Cess pits and sealed septic tanks, raising of toilet pan above flood level, non-return valves to prevent back-flows ■ Regular emptying	

*Table 8. Hazards impacts and measures taking into account the climate change [15] *continued*

Hazard	**Impact on water supply systems**		**Adaptation options**	**Implication for communities** **(+ = positive, – = negative)**
	Direct	**Indirect**		
Heatwaves		Damage to infrastructure	**Post-construction support (PCS) for community-managed water supplies (see above)**	
		Water quality problems, e.g. due to algal blooms (and consequent health effects, e.g. increase in waterborne diseases)	**Household water treatment and safe storage (HWTS)**	
Storm damage	Damage to infrastructure		**Post-construction support (PCS) for community-managed water supplies (see above)**	
		Landslides around water sources	■ Retention walls ■ Afforestation of a large area around landslide-prone slopes ■ Fencing to reduce further destruction of vegetation cover ■ Controlled grazing of livestock	– Communities may oppose fencing off areas as this might interfere with land use and livestock management practices
	Gully erosion, e.g. due to intense rainfall	Sedimentation and turbidity	**Control gully development/gully protection and rehabilitation** ■ Improvement of gully catchment to reduce and regulate runoff volume and peak amounts, including land management practices, soil and water conservation, afforestation, controlled grazing, etc. ■ Diversion of runoff water up-stream of the gully area, including cut-off drains, retention and infiltration ditches, etc. ■ Stabilisation of gullies by structural and vegetative measures, including gully head control, gully reshaping, check dams and vegetative measures inside gully to encourage deposition of sediments ■ Where possible, avoid building wells in gullies – or cap unused bores and ensure current wells are appropriately sealed from surface runoff	– Need to be maintained regularly (structures should be observed for damage especially during rainy season and after heavy storms): often not enough capacity to do so at community level. Therefore, coordination with and involvement of local authorities such as soil conservation officers, forest officers, etc. needs to be ensured

*Table 8. Hazards impacts and measures taking into account the climate change [15] *continued*



Hazard	Impact on water supply systems		Adaptation options	Implication for communities (+ = positive, – = negative)
	Direct	Indirect		
Sea-level rise	**Saline intrusion** (affecting groundwater and coastal surface water especially during dry season in regions with high rainfall variability)[28]	Further decreasing freshwater availability in coastal areas	**Household water treatment and safe storage (HWTS)** Other measures that can be considered to mitigate risks linked to salinisation: ■ Maintain critical dilution flows in rivers and streams ■ Minimise high saline loads from specific sources entering rivers and streams (for example irrigation drainage or wetland discharge) ■ Maintain or improve landscape vegetation to reduce shallow groundwater salinisation ■ Control abstraction rates to prevent saline ingress ■ Managed aquifer recharge to create fresh lenses of water in aquifers with high concentration of salts (see for example: http://www.bebuffered.com/downloads/3R_managing_the_water_buffer_2010.pdf) Deepening tube wells	
Natural resource degradation **Catchment degradation**		Decreasing soil depth and vegetation cover reduces infiltration and increases runoff which can lead to falling groundwater tables	A broad range of natural resource management and soil and water conservation interventions exist: ■ Soil erosion on crop land: land management practices (e.g. ploughing along contours, increasing organic matter content of the soil, etc.), soil and stone bunds, terraces, artificial water ways, cut-off drains above crop land ■ Vegetation degradation: controlled grazing of livestock, reforestation ■ Afforestation ■ Runoff management ■ Gully rehabilitation ■ Water harvesting	+ Contribute to wider improvements of natural resources – Require coordination with other government line departments

More detailed tables concerning all the stages of the water supply chain can be found in guidelines of the WHO [7].

4. Implementation of WSP and HACCP in the DRINKADRIA area

A brief questionnaire was prepared in order to investigate the implementation of HACCP and/or WSP in water utilities (WU) from partner countries in the DRINKADRIA area. The questionnaire found in the annex asked for the following information:

- the existence of a WSP or HACCP in the WU/ partner country,
- If the implementation of WSP or HACCP is a mandatory legal obligation.
- What are the contents of the WSP/HACCP and in which documents they are defined
- If risks for water quality and water shortage are determined
- the measures applied to deal with the water quality and quantity risks
- If alternative drinking water resources are determined

Answers were received for 13 WU from the DRINKADRIA partners (see Annex 2):

- 3 Croatian WU (Istria, Labin Istria, Pula Istria),
- 5 Italian WU (VERITAS Chioggia, Aquambiente Marche, ASTEA, ATAC Civitanova, ASSM)
- 1 Greek WU (Corfu),
- 1 Slovene WU (Nova Gorica),
- 1 Serbian WU (Belgrade),
- 1 Montenegro WU (Nikšić),

as well as for Bosnia & Herzegovina and Albania, that reported on general country level.

The results were grouped by country and are presented below in this form, in order to give a brief idea of the WSP/HACCP implementation state in the DRINKADRIA partner countries.

Croatia

All three Croatian WU of the Istrian peninsula reported that they implement a HACCP, since it is a legal obligation on country level, while two of them, WU Istria and WU Labin Istria additionally adopted a WSP, although it is not mandatory from legislation. Regarding the contents of the HACCP WU Istria mentions the definition of

- critical control points,
- critical limits,

- preventive specific measures in all stages of the technological process of production and distribution of water for human consumption.

While in the WSP, they define

- operational plan of measures for emergency and accidental water pollution for each WU (Sv. Ivan, Gradole, Butoniga),
- operational plan for the implementation of measures in the event of water shortage.

Comparing WU of Istria and WU Labin Istria, interesting is the fact that while the risks for the water quality are determined in HACCP and WSP for both utilities, the risks of water shortage are found in the HACCP for WU of Istria and in the WSP for WU Labin. For WU of Pula Istria only water quality risks are determined in HACCP. The risks that are taken into consideration are presented in the Table 9 for each WU.

Table 9. Comparison of risks considered from the three WU in the Istria peninsula

Risks that are considered/ WU in Croatia	WU Istria	WU Labin, Istria	WU Pula, Istria
Pollution (Microbiological, Chemical, Physical)	YES	YES	YES
Water shortage	YES	YES	NO
Floods	NO	YES	NO
Climate Change	NO	YES	NO

As far as the measures adoption for the diminishing of risks and the alternative resources are concerned, the answers varied since:

- The WU of Istria determines measures for water quality in HACCP and WSP, but for water quantity in HACCP by linking the system to the periphery and linking resources and taking advantage of the return process water.
- The WU of Pula determines the quality ones in HACCP, but no water quantity risks.
- The WU Labin gives no answer for the adoption of measures, but among the three is the only WU that determines alternative drinking water resources for the case of incident occasions.

Attention attracts the fact that in the small area of Istria Peninsula, there are so different practices concerning water safety and thus safety management plans. The WU of Pula that does not adopt a WSP only considers pollution risks, while the other two that adopt it still do both take into account water shortage, but only WU Labin considers floods and climate change.

Italy

Since the legislation does not impose the implementation of a WSP or HACCP, none of the 5 Italian WU adopts one, with the exception of VERITAS Chioggia. According to the answers of the WU there are guidelines for WSP in the country level also considering climate change but they are not obligatory.

VERITAS Chioggia implements a HACCP, where it determines only water quality risks concerning pollution (Microbiological, chemical and physical), as well as measures for their diminishing. Although they do not determine risks for water shortage, they define in the HACCP measures for the diminishing of water quantity, as well as alternative drinking water resources.

In the WU of Aquambiente Marche although they do not adopt WSP or HACCP plan they considered pollution risks (microbiological and chemical), as well as water shortage. Additionally they define measures for the water quality and quantity risks although they do not mention in which document.

Greece

The WU of Corfu does not imply either a WSP or a HACCP, since it was not mandatory from the country's legislation until now. The Programmes of Measures, elaborated according to the WFD, require that WSPs should be elaborated by the water utilities. The only quality risks that are taken into account are pollution risks (microbiological, chemical and physical), imposed from by DWD, but there are no measures for the diminishing of these risks except in the case a quality problem is reported or detected from the water quality monitoring. Since no risks both qualitative and quantitative are determined, no measures are reported for water quantity.

Slovenia

The WU of Nova Gorica implements both a HACCP and WSP although only adoption of a HACCP is obligatory from the county legislation.

Interesting is the fact that while the quality risks are defined in the HACCP, the risks for water shortage are defined in the WSP. Measures concerning the water quality and are determined in HACCP, but there are no measures for water shortage or alternative drinking water source.

Attention should be given to the fact that except the MB, CH, PHY the Cross Border small WU of Nova Gorica also takes into account the floods, water shortage , climate change and power failure events.

Serbia

WU of Belgrade adopts a HACCP, although it’s no legal obligation as stated in the questionnaire. In the HACCP document, they determine risks and measures concerning water quality pollutants (microbiological, chemical, physical), as well as the determination of alternative drinking resources. No water shortage risk and water quantity measures are determined.

Montenegro

WU Nikšić is the only one that implements a HACCP, although it is already obligatory from the country's legislation for all the WU. In HACCP both qualitative and quantitative water risks and measures are determined, as well as two alternative drinking water sources. The risks considered are pollution (microbiological, chemical and physical), as well as water shortage, while the quality measures focus on the water quality monitoring.

Bosnia & Herzegovina

In Bosnia & Herzegovina the situation is similar with the one reported from WU of Corfu, Greece, since there is no HACCP or WSP legal obligation. As a result, no safety plan is adopted and measures for water quality are determined in case only a water quality problem is reported.

Albania

No WSP or HACCP is implemented in Albania, since it is no legal obligation. Positive aspect is the ministry proposal in preparation that will consider WSP as criteria in the license procedure of the WU.

5. Comments and Conclusions

The WSP approach is easily applied to the different countries legislation, since a lot of step by step guides and guidelines have been published to facilitate the implementation procedure. Taking into account the small scale and the climate change is compulsory for the DRINKADRIA area, since significance percentage of WU could be characterized as small, while the climate change effects and emergency situation are of significant frequency in the area.

Interesting outcome of the questionnaire is how different are the approaches of water security, even in restricted areas like in Istria peninsula in Croatia. Since the legislation does not impose the implementation of WSP or HACCP, it relies on the WU whether it will adopt such a plan or not. Moreover, we can conclude to the fact that although some WU adopt HACCP or WSP they do not give emphasis to the quantitative aspect such as water shortage incidents, but rather the qualitative aspect even in the incident situations.

Attention should also be given to the fact that although a lot of countries implement a WSP type approach in the WU (like the case of Greece) to safeguard the supply of water in the emergency situation, they do not refer to it as WSP. As a result it is more difficult to make an overview of the benefits of the WSP.

Concluding to the benefits and added value of WSP, following advantages are reported by WU in the following fields:

- Health gains;
- Improved operations through more clarity on supply related risks;
- Reduction of water quality incidents;
- Fosters due diligence;
- Provides rationale for decision making;
- Stimulation of multi-stakeholder communication;
- WSP supports leverage of external financial support.

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Let’s grow up together

DRINK ADRIA

Adriatic IPA
Cross Border Cooperation 2007-2013

The project is co-funded by the European Union,
Instrument for Pre-Accession Assistance

Worckpackage 4

Activity 4.4 Water (re)sources protection and cross border water (re)sources management

Water Safety Plans

ANNEX 1

WP4 ACT4.4 QUESTIONNAIRE ABOUT HACCP PLANS AND WATER SAFETY PLANS FOR DRINKING WATER SUPPLY

Water utility (WU): ____

Does the WU have a HACCP plan: YES / NO

Does the WU have a Water Safety Plan: YES / NO

Contents of HACCP and /or WSP	In which document is this defined?
Risks for water quality are determined: YES / NO	☐HACCP plan ☐Water Safety Plan
Risks for water shortage are determined: YES / NO	☐HACCP plan ☐Water Safety Plan
Which risks are considered: ○ microbiological pollution ○ chemical pollution ○ physical pollution ○ floods ○ water shortage ○ climate change ○ ________________ ○ ________________ ○ ________________ Comment: ____ ____	☐HACCP plan ☐Water Safety Plan
Measures for diminishing risk for water quality are determined: YES / NO Comment: ____ ____	☐HACCP plan ☐Water Safety Plan
Measures for diminishing risk for water quantity are	☐HACCP plan

determined: YES / NO Comment: ____ ____	☐Water Safety Plan
Another issues concerning drinking water quality/quantity is considered: ____ ____	☐HACCP plan ☐Water Safety Plan
Alternative drinking water resources are determined: YES / NO Comment: ____ ____	☐HACCP plan ☐Water Safety Plan

Contact person for HACCP and WSP (for further communication and discussions):

Name: ___________________________________

e-mail: ___________________________________

Worckpackage 4

Activity 4.4 Water (re)sources protection and cross border water (re)sources management

Water Safety Plans

ANNEX 2

Water utility (WU):	CROATIA WU Istria	CROATIA WU Labin, Istria	CROATIA WUPula, Istria	ITALY VERITAS, Chioggia	ITALY Aquambiente Marche	ITALY ASTEA	ITALY ATAC Civitanova	ITALY ASSM Tolentino	GREECE WU Corfu	SLOVENIA WU Nova Gorica	SERBIA WU Belgrade	MONTENEGRO WU Nikšić	BiH in general	ALBANIA in general
Does the WU have a HACCP plan: YES / NO	yes	yes	yes	yes	no	no	no	no	NO	yes	yes	yes	no	no
Is HACCP plan legal obligation?	yes	yes	yes	no	no	no	no	no	no	yes	no?	yes WU Niksic is the only WU whith implemented HACCP	no	no
Does the WU have a Water Safety Plan: YES / NO	yes	yes	no	no	no	no	no	no	NO	yes	no	no	no	no
Is WSP legal obligation?	no			no guidelines for WSP exist, also considering climate change, but not obligatory					no	no	no	no	no	in preparation Ministry is considering WSP to be a criteria when asking for licensing
Contents of HACCP? In which document is this defined?	- critical control points - critical limits - preventive specific measures in all stages of the technological process of production and distribution of water for human consumption													
Contents of WSP? In which document is this defined?	- **operational plan** of measures for emergency and accidental **water pollution** for each WW (Sv. Ivan, Gradole , Butoniga) - **operational plan** for the implementation of measures in the event of **water shortage**													
Risks for water quality are determined: YES / NO.	yes HACCP WSP	yes HACCP WSP	yes HACCP	yes HACCP						yes HACCP	yes HACCP	yes HACCP		
Risks for water shortage are determined: YES / NO	yes HACCP	yes WSP	no	no						yes WSP	no	yes HACCP		
Which risks are considered:	Pollution: MB, CH, PHY Water sortage	Pollution: MB, CH, PHY Water sortage floods CC	Pollution: MB, CH, PHY	Pollution: MB, CH, PHY	Pollution: MB, CH Water shortage			Pollution: MB, CH	Pollution: MB, CH, PHY	Pollution: MB, CH, PHY Floods Water shortage CC power failure	Pollution: MB, CH, PHY	Pollution: MB, CH, PHY Water shortage		
Measures for diminishing risk for water quality are determined:	yes HACCP WSP	n.a.	yes HACCP	yes HACCP	yes ?				NO - Measures only after water quality problem - water quality monitoring	yes HACCP	yes HACCP	yes HACCP water quality momitoring	NO - Measures only after water quality problem - water quality monitoring	
Measures for diminishing risk for water quantity are determined: YES / NO	YES HACCP ? (questionn.) WSP Linking the system to the periphery and linking resources , the return process water	n.a.	no	yes HACCP	yes ?			YES Water Emergency Plan	NO	n.a.	no	yes HACCP		
Alternative drinking water resources are determined:	NO	YES	NO	yes HACCP	NO			YES		no	yes HACCP	yes (two alt. water sources) HACCP		
Name	Marijuča Nemarnik Mladen Nežić	Tina Paić	Jasminka Stupar Irena Ankon-Premate	Stefano Della Sala Paola Miana	Giacomo Balzani	Simone Baglioni	Gianluca Squadroni		Vasilis Kanakoudis	Žorž Matjaž		Vušković Savo		
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Worckpackage 4

Activity 4.4 Water (re)sources protection and cross border water (re)sources management

Water Safety Plans

ANNEX 3

WP4 ACT4.4 QUESTIONNAIRE ABOUT HACCP PLANS AND WATER SAFETY PLANS FOR DRINKING WATER SUPPLY

Water utility (WU): Water utility of Istria

Does the WU have a HACCP plan: [✓ YES] / NO

Does the WU have a Water Safety Plan: [✓ YES] / NO

Contents of HACCP and /or WSP	In which document is this defined?
- With implementation of the HACCP system, Water utility of Istria identified the critical control points, defined critical limits and preventive specific measures in all stages of the technological process of production and distribution of water for human consumption	HACCP - General document for application of HACCP principles, PSL IVB 02, version 2 from 01.02.2014. - HACCP plan for plant Sv. Ivan and belonging water supply system, POS BZT 02, version 5 from 30.05.2014. - HACCP plan for plant Gradole and belonging water supply system, POS GRD 02, version 4 from 30.05.2014. - HACCP plan for plant Butoniga and belonging water supply system, POS BTN o2, version 6 from 19.09.2014.
- We have made operational plan of measures for emergency and accidental pollution of water for each plant (Sv. Ivan, Gradole , Butoniga) and a working unit, also for all water resources where we listed possible sources of danger and their resolution	WTP - Operational plan for emergency and accidental water pollution of Water utility of Istria, number: 91-60/1-2014, from 15. travnja 2014. - Operational plan in case of emergency and accidental pollution of drinking water sources , number: 91-60/2-2014, from 10. travnja 2014. -

- The operational plan for the implementation of measures in the event of water shortage defined disorders in water supply and emergency measures and duties of the Water utility of Istria and duties of consumers.	- Operational Plan for the implementation of measures in the event of water shortages, July 2012.
Risks for water quality are determined: [✓ YES] / NO	☑HACCP plan ☑Water Safety Plan
Risks for water shortage are determined: [✓ YES] / NO	☑HACCP plan ☐Water Safety Plan
Which risks are considered: [✓ ○ microbiological pollution] [✓ ○ chemical pollution] [✓ ○ physical pollution] ○ floods [✓ ○ water shortage] ○ climate change ○ _______________ ○ _______________ ○ _______________	☑HACCP plan ☑Water Safety Plan
Measures for diminishing risk for water quality are determined: [✓ YES] / NO	☑HACCP plan ☑Water Safety Plan
Measures for diminishing risk for water quantity are determined: YES / NO Comment: Linking the system to the periphery and linking resources , the return process water	☑HACCP plan ☐Water Safety Plan
Another issues concerning drinking water quality/quantity is considered: Comment: We respect all regulations.	☑HACCP plan ☐Water Safety Plan
Alternative drinking water resources are determined:	☐HACCP plan

YES / [✓ NO]	☐Water Safety Plan

Contact person for HACCP and WSP (for further communication and discussions):

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Broj: 130-2/2015.

Datum: 31.08.2015.

RH

ISTARSKA ŽUPANIJA

Upravni odjel za održivi razvoj

Pula,Flanatička 29

n/r Ljiljana Dravec

Bruno Kostelić

PREDMET: Upitnik u sklopu provedbe aktivnosti Istarske županije u implementaciji EU projekta DRINKADRIA a odnosi se na HACCP planove i Planove zaštite voda.

Poštovani,

Na Vaše traženje prema dopisu od 28.08.2015. KLASA:351-01/14-01/81, URBROJ:2163/1-08-02/2-15-03 , u prilogu Vam dostavljamo ispunjeni upitnik.

Za dodatna pojašnjenja stojimo na raspolaganju.

S poštovanjem!

DIREKTOR

Dino Škopac mag.ing.mech.

ISO 9001 HACCP BUREAU VERITAS Certification

VODOVOD LABIN d.o.o. LABIN

Društvo upisano kod Trgovačkog suda u Rijeci pod brojem Tt-95/381-3, MBS 040003155, temeljni kapital uplaćen u cjelosti 10.419.400,00 kn,
žiro račun - Erste & Steiermärkische Bank d.d. Rijeka; IBAN broj: HR5424020061100387135, HR0924020061500265304,
žiro račun - Privredna banka Zagreb d.d. Zagreb; IBAN broj: HR0723400091110178489, zastupan po upravi - direktor Dino Škopac, mag.ing.mech.

WP4 ACT4.4 QUESTIONNAIRE ABOUT HACCP PLANS AND WATER SAFETY PLANS FOR DRINKING WATER SUPPLY

WP4 TOČKA 4.4 UPITNIK O HACCP SUSTAVU I PLANOVIMA ZAŠTITE VODA ZA PIĆE

Water utility (WU) / ***Naziv vodovoda***: VODOVOD LABIN d.o.o.

Does the WU have a HACCP plan / ***Posjeduje li vodovod HACCP plan***: [✓ YES] / NO

Does the WU have a Water Safety Plan / ***Posjeduje li vodovod Plan zaštite voda***: [✓ YES] / NO

Contents of HACCP and /or WSP / ***Sadržaj HACCPa i/ili Plana zaštite voda***	In which document is this defined? ***/ U kojem je dokumentu definirano?***
Risks for water quality are determined / ***Rizik od pogoršanja kvalitete voda***: [✓ YES] / NO	☒HACCP plan ☒Water Safety Plan / ***Plan zaštite voda***
Risks for water shortage are determined / ***Rizik od količinskih pomanjkanja voda***: [✓ YES] / NO	☐HACCP plan ☒ Water Safety Plan / ***Plan zaštite voda***
Which risks are considered: / ***Koji su rizici uključeni:*** ● microbiological pollution ● chemical pollution ● physical pollution ● floods ● water shortage ● climate change ○ ______________ ○ ______________ ○ ______________	☐HACCP plan ☒ Water Safety Plan / ***Plan zaštite voda***

Comment / ***Komentar:***	
Measures for diminishing risk for water quality are determined / ***Mjere za smanjenje rizika od pogoršanja kvalitete voda su definirane:*** [✓ YES] / NO Comment / ***Komentar:***	☒HACCP plan ☒ Water Safety Plan / ***Plan zaštite voda***
Measures for diminishing risk for water quantity are determined / ***Mjere za smanjenje rizika od količinskog pomanjkanja voda su definirane::*** [✓ YES]/ NO Comment / ***Komentar:***	☐HACCP plan ☒ Water Safety Plan / ***Plan zaštite voda***
Another issues concerning drinking water quality/quantity is considered / ***Sljedeći elementi koji se odnose na kvalitetu/kvantitetu pitkih voda su uključeni:*** INCIDENT NA CESTOVNOJ PROMETNICI (SUDARI I PREVRTANJA AUTOCISTERNI S OPASNIM TVARIMA) - GLAVNA PROMETNICA PROLAZI KROZ I ZAŠTITNU ZONU	☐HACCP plan ☐ Water Safety Plan / ***Plan zaštite voda***
Alternative drinking water resources are determined / ***Alternativni izvori pitkih voda su definirani:*** [✓ YES] / NO Comment / ***Komentar:***	☒HACCP plan ☐ Water Safety Plan / ***Plan zaštite voda***

Contact person for HACCP and WSP (for further communication and discussions) / ***Kontakt osoba za HACCP I Plan zaštite voda (za buduću komunikaciju i diskusiju):***

Name / ***Ime:*** TINA PAIĆ

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WP4 ACT4.4 QUESTIONNAIRE ABOUT HACCP PLANS AND WATER SAFETY PLANS FOR DRINKING WATER SUPPLY

WP4 TOČKA 4.4 UPITNIK O HACCP SUSTAVU I PLANOVIMA ZAŠTITE VODA ZA PIĆE

Water utility (WU) / ***Naziv vodovoda***: _________VODOVOD PULA d.o.o. _______________

Does the WU have a HACCP plan / ***Posjeduje li vodovod HACCP plan***: **YES** / ~~**NO**~~

Does the WU have a Water Safety Plan / ***Posjeduje li vodovod Plan zaštite voda***: ~~YES~~ / **NO**

Contents of HACCP and /or WSP / ***Sadržaj HACCPa i/ili Plana zaštite voda***	In which document is this defined? / ***U kojem je dokumentu definirano?*** ***HACCP plan i operativni planovi***
Risks for water quality are determined / ***Rizik od pogoršanja kvalitete voda***: **YES** / ~~**NO**~~	☒HACCP plan ☐Water Safety Plan / ***Plan zaštite voda***
Risks for water shortage are determined / ***Rizik od količinskih pomanjkanja voda***: : ~~YES~~ / **NO**	☐HACCP plan ☐ Water Safety Plan / ***Plan zaštite voda***
Which risks are considered: / ***Koji su rizici uključeni:*** o microbiological pollution o chemical pollution o physical pollution ~~o floods~~ ~~o water shortage~~ ~~o climate change~~ o _________/______ o ________________ o ________________	☒HACCP plan ☐ Water Safety Plan / ***Plan zaštite voda***

Comment / ***Komentar:*** ___/____ ____	
Measures for diminishing risk for water quality are determined / ***Mjere za smanjenje rizika od pogoršanja kvalitete voda su definirane:*** **YES** / ~~**NO**~~ Comment / ***Komentar:*** __________/_________________________________ ____	☒HACCP plan ☐ Water Safety Plan / ***Plan zaštite voda***
Measures for diminishing risk for water quantity are determined / ***Mjere za smanjenje rizika od količinskog pomanjkanja voda su definirane:*** : ~~**YES**~~ / **NO** Comment / ***Komentar:*** ___________/________________________________ ____	☐HACCP plan ☐ Water Safety Plan / ***Plan zaštite voda***
Another issues concerning drinking water quality/quantity is considered / ***Sljedeći elementi koji se odnose na kvalitetu/kvantitetu pitkih voda su uključeni:*** ____________________/________________________________ ____	☐HACCP plan ☐ Water Safety Plan / ***Plan zaštite voda***
Alternative drinking water resources are determined / ***Alternativni izvori pitkih voda su definirani:*** ~~**YES**~~ / **NO** Comment / ***Komentar:*** ____ ____	☐HACCP plan ☐ Water Safety Plan / ***Plan zaštite voda***

Contact person for HACCP and WSP (for further communication and discussions) / ***Kontakt osoba za HACCP I Plan zaštite voda (za buduću komunikaciju i diskusiju):***

Name / ***Ime:*** Jasminka Stupar, dipl.oec - Voditeljica Službe upravljanja kvalitetom, okolišem I kontroling, i Irena Ankon-Premate dipl.biol. - Rukovoditeljica Laboratorijsko-tehnološkog odjela,

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WP4 ACT4.4 QUESTIONNAIRE ABOUT HACCP PLANS AND WATER SAFETY PLANS FOR DRINKING WATER SUPPLY

Water utility (WU): __VERITAS SpA – Unità Locale di Chioggia___________________

Does the WU have a HACCP plan: **YES**/ NO

Does the WU have a Water Safety Plan: YES / **NO**

Contents of HACCP and /or WSP: PIANO DI AUTOCONTROLLO REDATTO AI SENSI NORMATIVA REGIONE VENETO DGRV n° 15 del 09/02/2009	In which document is this defined?
Risks for water quality are determined: **YES** / NO	✓HACCP plan ☐Water Safety Plan
Risks for water shortage are determined: YES / **NO**	☐HACCP plan ☐Water Safety Plan
Which risks are considered: ○ **microbiological pollution** ○ **chemical pollution** ○ **physical pollution** ○ floods ○ water shortage ○ climate change ○ ________________ ○ ________________ ○ ________________ Comment: ____ ____	✓HACCP plan ☐Water Safety Plan
Measures for diminishing risk for water quality are determined: **YES** / NO Comment: ____ ____	✓HACCP plan ☐Water Safety Plan

Measures for diminishing risk for water quantity are determined: **YES** / NO Comment: ____ ____	✓HACCP plan ☐Water Safety Plan
Another issues concerning drinking water quality/quantity is considered: ____ ____	☐HACCP plan ☐Water Safety Plan
Alternative drinking water resources are determined: **YES** / NO Comment: ____ ____	✓HACCP plan ☐Water Safety Plan

Contact person for HACCP and WSP (for further communication and discussions):

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e-mail: _s.dellasala@gruppoveritas.it_____________________________

Name: _Paola Miana __________________________________

e-mail: _p.miana@gruppoveritas.it__________________________________

WP4 ACT4.4 QUESTIONNAIRE ABOUT HACCP PLANS AND WATER SAFETY PLANS FOR DRINKING WATER SUPPLY

Water utility (WU): ACQUAMBIENTE MARCHE SRL

Does the WU have a HACCP plan: YES / [✓ NO]

Does the WU have a Water Safety Plan: YES / [✓ NO]

Contents of HACCP and /or WSP	In which document is this defined?
Risks for water quality are determined: [✓ YES] / NO	☐HACCP plan ☐Water Safety Plan
Risks for water shortage are determined: [✓ YES] / NO	☐HACCP plan ☐Water Safety Plan
Which risks are considered: ☒ microbiological pollution ☒ chemical pollution ○ physical pollution ○ floods ☒ water shortage ○ climate change ○ ______________ ○ ______________ ○ ______________ Comment: ______________________________________ ____	☐HACCP plan ☐Water Safety Plan
Measures for diminishing risk for water quality are determined: [✓ YES] / NO Comment: ______________________________________ ____	☐HACCP plan ☐Water Safety Plan
Measures for diminishing risk for water quantity are	☐HACCP plan

determined: ~~YES~~ / NO Comment: ____________________ ____________________	☐Water Safety Plan
Another issues concerning drinking water quality/quantity is considered: ____________________ ____________________	☐HACCP plan ☐Water Safety Plan
Alternative drinking water resources are determined: ~~YES~~ / NO Comment: ____________________ ____________________	☐HACCP plan ☐Water Safety Plan

Contact person for HACCP and WSP (for further communication and discussions):

Name: Giacomo Balzani

e-mail: g.balzani@acquambientemarche.it

WP4 ACT4.4 QUESTIONNAIRE ABOUT HACCP PLANS AND WATER SAFETY PLANS FOR DRINKING WATER SUPPLY

Water utility (WU):	ASTEA SpA
Does the WU have a HACCP plan:	NO
Does the WU have a Water Safety Plan:	NO

Contents of HACCP and /or WSP	In which document is this defined?
Risks for water quality are determined: YES / NO	☐HACCP plan ☐Water Safety Plan
Risks for water shortage are determined: YES / NO	☐HACCP plan ☐Water Safety Plan
Which risks are considered: o microbiological pollution o chemical pollution o physical pollution o floods o water shortage o climate change o ________________ o ________________ o ________________ Comment: ____ ____	☐HACCP plan ☐Water Safety Plan
Measures for diminishing risk for water quality are determined: YES / NO Comment: ____ ____	☐HACCP plan ☐Water Safety Plan
Measures for diminishing risk for water quantity are determined: YES / NO Comment: ____	☐HACCP plan ☐Water Safety Plan

____	
Another issues concerning drinking water quality/quantity is considered: ____ ____	☐HACCP plan ☐Water Safety Plan
Alternative drinking water resources are determined: YES / NO Comment: ____________________________________ ____	☐HACCP plan ☐Water Safety Plan

Contact person for HACCP and WSP (for further communication and discussions):

Name: BAGLIONI SIMONE

e-mail: simone.baglioni@gruppoastea.it

Prot. 2996/07/15

3 1 AGO. 2015

WP4 ACT4.4 QUESTIONNAIRE ABOUT HACCP PLANS AND WATER SAFETY PLANS FOR DRINKING WATER SUPPLY

Water utility (WU): __**ATAC CIVITANOVA S.P.A.**__________________

Does the WU have a HACCP plan: YES / **NO**

Does the WU have a Water Safety Plan: YES / **NO**

Contents of HACCP and /or WSP	In which document is this defined?
Risks for water quality are determined: YES / NO	☐HACCP plan ☐Water Safety Plan
Risks for water shortage are determined: YES / NO	☐HACCP plan ☐Water Safety Plan
Which risks are considered: ○ microbiological pollution ○ chemical pollution ○ physical pollution ○ floods ○ water shortage ○ climate change ○ ______________ ○ ______________ ○ ______________ Comment: ____________________________ ______________________________________	☐HACCP plan ☐Water Safety Plan
Measures for diminishing risk for water quality are determined: YES / NO Comment: ____________________________ ______________________________________	☐HACCP plan ☐Water Safety Plan

Measures for diminishing risk for water quantity are determined: YES / NO Comment: ______________________________ ______________________________________	☐HACCP plan ☐Water Safety Plan
Another issues concerning drinking water quality/quantity is considered: ______________________________________ ______________________________________	☐HACCP plan ☐Water Safety Plan
Alternative drinking water resources are determined: YES / NO Comment: ______________________________ ______________________________________	☐HACCP plan ☐Water Safety Plan

Contact person for HACCP and WSP (for further communication and discussions):

Name: **Dr. GIANLUCA SQUADRONI**___________

e-mail: **g.squadroni@atac-civitanova.it**_____

The project is co-funded by the European Union,
Instrument for Pre-Accession Assistance

WP4 ACT4.4 QUESTIONNAIRE ABOUT HACCP PLANS AND WATER SAFETY PLANS FOR DRINKING WATER SUPPLY

Water utility (WU): A.S.S.M. SpA – TOLENTINO (MC) - ITALY

Does the WU have a HACCP plan: YES / [✓ NO]

Does the WU have a Water Safety Plan: YES / [✓ NO]

Contents of HACCP and /or WSP	In which document is this defined? Water Emergency Plan
Risks for water quality are determined: YES / NO	☐HACCP plan ☐Water Safety Plan ☒Other: Water Emergency Plan
Risks for water shortage are determined: YES / NO	☐HACCP plan ☐Water Safety Plan ☒Other: Water Emergency Plan
Which risks are considered: ○ microbiological pollution ○ chemical pollution ○ physical pollution ○ floods ○ water shortage ○ climate change ○ ______________ ○ ______________ ○ ______________ Comment: Water undergoes treatment with hypochlorite disinfection and UV lamps	☐HACCP plan ☐Water Safety Plan ☒Other: Water Emergency Plan
Measures for diminishing risk for water quality are determined: YES / NO Comment: ______________________________	☐HACCP plan ☐Water Safety Plan

______________________________	☒Other: Water Emergency Plan
Measures for diminishing risk for water quantity are determined: YES / NO Comment: Water supply is measured and recorded periodically or continuously	☐HACCP plan ☐Water Safety Plan ☒Other: Water Emergency Plan
Another issues concerning drinking water quality/quantity is considered: ______________________________ ______________________________	☐HACCP plan ☐Water Safety Plan
Alternative drinking water resources are determined: YES / NO Comment: There are alternative sources of supply, normally unused, available in time of crisis	☐HACCP plan ☐Water Safety Plan ☒Other: Water Emergency Plan

Contact person for HACCP and WSP (for further communication and discussions):

Name: Water Supply Department

e-mail: segreteria@assm.it

WP4 ACT4.4 QUESTIONNAIRE ABOUT HACCP PLANS AND WATER SAFETY PLANS FOR DRINKING WATER SUPPLY

Water utility (WU): Water Supply and Sewage Enterprise of Corfu, Greece

Does the WU have a HACCP plan: **NO**

Does the WU have a Water Safety Plan: **NO**

Contents of HACCP and /or WSP	In which document is this defined?
Risks for water quality are determined: **NO**	☐HACCP plan ☐Water Safety Plan
Risks for water shortage are determined: **NO**	☐HACCP plan ☐Water Safety Plan
Which risks are considered (marked in yellow): ○ **microbiological pollution** ○ **chemical pollution** ○ **physical pollution** ○ floods ○ water shortage ○ climate change ○ ________________ ○ ________________ ○ ________________ Comment: The microbiological, chemical & physical risks are considered as part of the obligations of the water utility according the JMD Y2/2600/2001.	☐HACCP plan ☐Water Safety Plan
Measures for diminishing risk for water quality are determined: YES / NO Comment: Measures are taken only after localizing a water quality problem. Proactive measures include the sampling procedures followed by the water utility according to the JMD	☐HACCP plan ☐Water Safety Plan

The project is co-funded by the European Union,
Instrument for Pre-Accession Assistance

Y2/2600/2001 (monitoring procedures).	
Measures for diminishing risk for water quantity are determined: NO Comment: ______________________________________ ____	☐HACCP plan ☐Water Safety Plan
Another issues concerning drinking water quality/quantity is considered: Water samples are tested for quality in external laboratories accredited with ISO 17025 according to the European and national legislation.	☐HACCP plan ☐Water Safety Plan
Alternative drinking water resources are determined: YES / NO Comment: ______________________________________ ____	☐HACCP plan ☐Water Safety Plan

Comment: WSPs were not a legal obligation until now. The Programmes of Measures elaborated under the River Basin Management Plans require that all large water utilities should develop WSPs.

Contact person for HACCP and WSP (for further communication and discussions):

Name: Associate Professor Vasilis Kanakoudis

e-mail: bkanakoud@civ.uth.gr

WP4 ACT4.4 QUESTIONNAIRE ABOUT HACCP PLANS AND WATER SAFETY PLANS FOR DRINKING WATER SUPPLY

Water utility (WU): ____________**MRZLEK**______________________________

Does the WU have a HACCP plan: [✓ YES] / NO

Does the WU have a Water Safety Plan: [✓ YES] / NO

Contents of HACCP and /or WSP	In which document is this defined?
Risks for water quality are determined: [✓ YES] / NO	☑HACCP plan ☐Water Safety Plan
Risks for water shortage are determined: [✓ YES] / NO	☐HACCP plan ☑Water Safety Plan
Which risks are considered: ● microbiological pollution ● chemical pollution ● physical pollution ● floods ● water shortage ● climate change ● _power failure___ ○ ________________ ○ ________________ Comment: ____ ____	☑HACCP plan ☑Water Safety Plan
Measures for diminishing risk for water quality are determined: [✓ YES] / NO Comment: ____ ____	☑HACCP plan ☐Water Safety Plan
Measures for diminishing risk for water quantity are	☐HACCP plan

The project is co-funded by the European Union, Instrument for Pre-Accession Assistance

determined: YES / NO Comment: ______________________________________ ____	☐Water Safety Plan
Another issues concerning drinking water quality/quantity is considered: ____ ____	☐HACCP plan ☐Water Safety Plan
Alternative drinking water resources are determined: YES / [✓ NO] Comment: ______________________________________ ____	☐HACCP plan ☐Water Safety Plan

Contact person for HACCP and WSP (for further communication and discussions):

Name: ___Žorž Matjaž_____________________________

e-mail: ____matjaz.zorz@vik-ng.si____________________________

WP4 ACT4.4 QUESTIONNAIRE ABOUT HACCP PLANS AND WATER SAFETY PLANS FOR DRINKING WATER SUPPLY

Water utility (WU): Belgrade Waterworks and Sewerage

Does the WU have a HACCP plan: **YES** / NO

Does the WU have a Water Safety Plan: YES / **NO**

Contents of HACCP and /or WSP	In which document is this defined?
Risks for water quality are determined: **YES** / NO	☑HACCP plan ☐Water Safety Plan
Risks for water shortage are determined: YES / **NO**	☐HACCP plan ☐Water Safety Plan
Which risks are considered: ○ microbiological pollution☑ ○ chemical pollution☑ ○ physical pollution☑ ○ floods ○ water shortage ○ climate change ○ ______________ ○ ______________ ○ ______________ Comment: ____ ____	☑HACCP plan ☐Water Safety Plan
Measures for diminishing risk for water quality are determined: **YES** / NO Comment: ____ ____	☑HACCP plan ☐Water Safety Plan
Measures for diminishing risk for water quantity are determined: YES / **NO** Comment: ____ ____	☐HACCP plan ☐Water Safety Plan

Another issues concerning drinking water quality/quantity is considered: ____________________/__________________ ____	☐HACCP plan ☐Water Safety Plan
Alternative drinking water resources are determined: **YES** / NO Comment: ________________________________ ____	☑HACCP plan ☐Water Safety Plan

Contact person for HACCP and WSP (for further communication and discussions)

Subject: Fwd: RE: DRINKADRIA WP4 ACT4.4 – DWP and WSP_REMINDER
From: Petra Žvab Rožič <petra.zvab@guest.arnes.si>
Date: 9.9.2015 15:47
To: Barbara Čenčur Curk <barbara.cencur@geo.ntf.uni-lj.si>

A boš ti odgovorila?

Lp, Petra

-------- Izvorno sporočilo --------

Zadeva:RE: DRINKADRIA WP4 ACT4.4 – DWP and WSP_REMINDER
Datum:09.09.2015 15:35
Pošiljatelj: Melina Džajić - Valjevac <melina.dzajic-valjevac@heis.ba>
Prejemnik:'Petra Žvab Rožič' <petra.zvab@guest.arnes.si>
Odgovor na:<melina.dzajic-valjevac@heis.ba>

Dear Petra,

Regarding WSP questionnaire, I have been in telephone contact with the water utilities that are in cross-boundary region of the Adriatic Sea river basin: Public utility Neum, Public utility Ljubuški, Public utility Čapljina, Public utility Trebinje, Public utility Vodogradnja (Tomislavgrad) , Public utility Tomislavgrad, Public utility Posušje. None of them does not have HACCP plan nor Water Safety Plans, and actual situation in B&H are more less the same for all water utility companies.

Some of PU have internal regulations that prescribe procedure of how to react if there is some damage on pipeline, or if they have bad results on water quality (microbiological and chemical).

General risk for water quality and quantity for water sources are elaborated as a part of elaborat that define water protection zones. According to B&H legislative each PU have to check water quality (in the laboratories of the Institute for public health, or similar), in different frequency and number of monitoring places. Reactions after the results of the analyses are individual, and mainly directed to the adjustment of disinfection system, or closing down the problematic sections.

So, actualy all of those water utility services would have fulfilled questieoneries on the same way - No, No, No…J . Is it ok if I send you one page „report“ on questionnaire campagne (copy/paste from this e-mail)…including the contact data that I have used, instead of sending you those Questionnaires mainly empty, with two „No“ answers on the top .

Regards,

Mr Melina Džajić - Valjevac | MSc Chem.Sc.| Magistar hemijskih nauka|

Lead researcher | Vodeći istraživač |

Hydro-Engineering Institute Sarajevo (HEIS)| Institut za hidrotehniku d.d Sarajevo |

Stjepana Tomića 1 | 71000 Sarajevo | Bosnia and Herzegovina |

Tel/fax: | +387 33 212 466 |

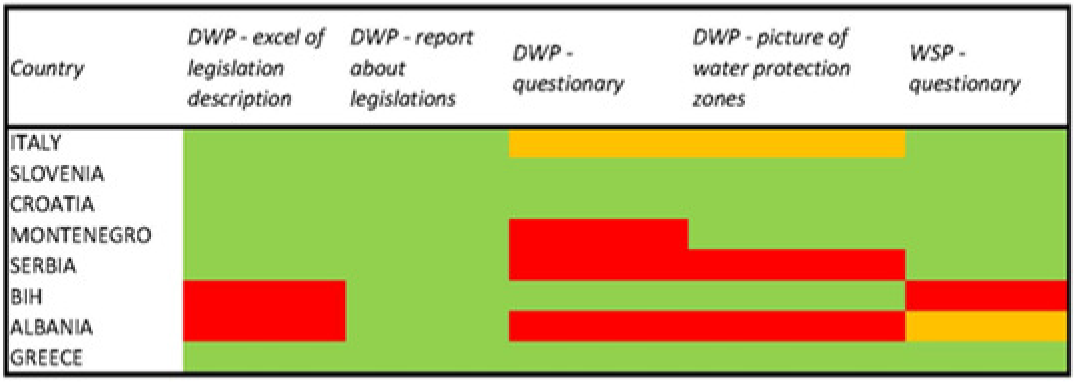
E-mail: melina.dzajic-valjevac@heis.ba| Web: www.heis.ba |

From: Petra Žvab Rožič [mailto:petra.zvab@guest.arnes.si]
Sent: Wednesday, September 09, 2015 12:47 PM
To: EAltran@acegas.ts.it; mromano@acegasapsamga.it; rsilvoni@acegasapsamga.it; spiselli@acegasapsamga.it; paolo.sossi@acegas-aps.it; cucchi@units.it; calligar@units.it; p.miana@gruppoveritas.it; s.dellasala@gruppoveritas.it; nardi@ato3marche.it; ivan.portoghese@ba.irsa.cnr.it; serena.liso@ba.irsa.cnr.it; costantino.masciopinto@ba.irsa.cnr.it; Matjaz.Hvalic@vik-ng.si; barbara.cencur@ntf.uni-lj.si; mihael.brencic@ntf.uni-lj.si; Ljiljana.dravec@istra-istria.hr; Bruno.Kostelic@istra-istria.hr; Melita.Cohilj@ivb.hr; barbara.karleusa@gradri.uniri.hr; ivana.radman@gradri.uniri.hr; jterzic@hgi-cgs.hr; tmarkovic@hgi-cgs.hr; Dejan.Dimkic@jcerni.co.rs; Branislava.Matic@jcerni.co.rs; arlinda.ibrahimllari@gmail.com; anisaaliaj1@gmail.com; melina.dzajic-valjevac@heis.ba; anel.hrnjic@heis.ba; anapiccolotti@yahoo.co.uk; papovicmira@yahoo.com; darko.kovac@vodovodnk.me; k.kiriaki@1723.syzefxis.gov.gr; bkanakoud@civ.uth.gr; vasilis.kanakoudis@gmail.com; papadopoulouana@yahoo.gr; tsitsif@otenet.gr; petra.zvab@guest.arnes.si
Subject: DRINKADRIA WP4 ACT4.4 – DWP and WSP_REMINDER

Dear partners,

I would like to remind you again to sent us all the necessary information and data about *Drinking Water Protection zones (DWP)* and *Water Safety Planes (WSP)*. This request applies to those partners (countries) who have not yet sent the documents (see the table). Please send the missing data ASAP and not later than **11th September**. Everyone else thank you very much!

We will prepare presentations about this two topics for meeting in Corfu that we can discuss about them.



Country	DWP - excel of legislation description	DWP - report about legislations	DWP - questionary	DWP - picture of water protection zones	WSP - questionary
ITALY	🟩	🟩	🟧	🟧	🟩
SLOVENIA	🟩	🟩	🟩	🟩	🟩
CROATIA	🟩	🟩	🟩	🟩	🟩
MONTENEGRO	🟩	🟩	🟥	🟩	🟩
SERBIA	🟩	🟩	🟥	🟥	🟩
BIH	🟥	🟩	🟩	🟩	🟥
ALBANIA	🟥	🟩	🟥	🟥	🟧
GREECE	🟩	🟩	🟩	🟩	🟩

(Legend: green = receives, orange = informed but not yet prepeared, red = waiting for and no information)

See you soon and best regards,

Petra

asist. dr. Petra Žvab Rožič, univ. dipl. inž. geol.

Univerza v Ljubljani, Naravoslovnotehniška fakulteta, Oddelek za geologijo

University of Ljubljana, Faculty of Natural Sciences and Engineering, Department of Geology

Aškerčeva 12, SI-1000 Ljubljana, Slovenia

Privoz 11, SI-1000 Ljubljana, Slovenia

Tel: +386 1 2445 413

Fax: +386 1 4704 560

E-mail: petra.zvab@guest.arnes.si

Subject: Re: DRINKADRIA WP4 ACT4.4 - Water Safety Plans
From: Arlinda Ibrahimllari <arlinda.ibrahimllari@gmail.com>
Date: 8.9.2015 13:15
To: Barbara Čenčur Curk <barbara.cencur@geo.ntf.uni-lj.si>
CC: Petra Žvab Rožič <petra.zvab@guest.arnes.si>

Dear Barbara,

we are almost certain that there is no water utility in Albania with a Water Safety Plan. None of the water utilities would do it on their own initiative.

Maybe the Ministry of Public Health, State Sanitary Secretariat might know something or have a "model" that every utility should adopt in Albania, we will definitively ask them. I think that is all that we can offer.

Please write me back for any other question in this regard,

Bests from Albania,
Arlinda

Arlinda Ibrahimllari / Manager of the Waste Water Services Department/ Chair of the YWPs Group Albania

+355 68 60 94 294/ arlinda.ibrahimllari@gmail.com

Water Supply and Sewerage Enterprise of Korca UKKO Sh.A. Office: +355 82 24 30 72 / Fax: +355 82 24 57 59
Rr. “Unaza e Qytetit”, Blloku i ri i Sportit
http://www.ukko-al.com

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On Fri, Jul 31, 2015 at 11:55 AM, Barbara Čenčur Curk <barbara.cencur@geo.ntf.uni-lj.si> wrote:

> Dear partners,
>
> I am sending you a very short questionnaire regarding water safety plans and water management.
>
> I would like to ask you to check whether your water utility has water safety plan and what are the main parts of it. I assume you do not have measures in case of diminishing of water quantity. But you for sure measures in case of water pollution are determined. Determination of risks and measures for water pollution are mostly parts of HACCP documents.
> I am asking Albanian colleagues to answer it in general for water utilities in Albania, or only for one. The same for Greek colleagues - maybe for water utility from Korfu.
>
> If you have water safety plan, please send it to me. I am asking you also to complete very short questionnaire, which is attached (by 25 August) to:

> petra.zvab@guest.arnes.si
> and
> barbara.cencur@ntf.uni-lj.si
>
> Best regards
> Barbara

Subject: Re: DRINKADRIA WP4 ACT4.4 - Water Safety Plans
From: Arlinda Ibrahimllari <arlinda.ibrahimllari@gmail.com>
Date: 9.9.2015 10:56
To: Barbara Čenčur Curk <barbara.cencur@geo.ntf.uni-lj.si>
CC: Anisa Aliaj <anisaaliaj1@gmail.com>

Dear Barbara,

we talked today with the Ministry and we got informations as follow:

- Recently they have started to train the specialist of the Ministry about HCCAP and WSP.
- Initially they intent to draft some first models but for this the Ministry mentioned that they require some support (maybe a project can realize this?!).
- Another point to me mentioned is that they will recommend the Albanian Water Authority that especially for water utilities or water suppliers, WSM to be a criteria when asking for licensing.

At the moment, there are no obligatory measures undertaken by the Ministry or Water Authority. There is also no law in force!
SHUKALB from the other side is trying to put into its training Program (courses) for Albania how an Utility can draft its own WSP. Let's hope in the future we will help also the water sector in Albania to have a mandatory WSP and HACCP for each water supplier of drinking water.

For any other question do not hesitate to write me back,
Arlinda

Arlinda Ibrahimllari / Manager of the Waste Water Services Department/ Chair of the YWPs Group Albania

+355 68 60 94 294/ arlinda.ibrahimllari@gmail.com

Water Supply and Sewerage Enterprise of Korca UKKO Sh.A. Office: +355 82 24 30 72 / Fax: +355 82 24 57 59
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http://www.ukko-al.com

Facebook Twitter Google Plus Linkedin Skype

On Wed, Sep 9, 2015 at 8:18 AM, Barbara Čenčur Curk <barbara.cencur@geo.ntf.uni-lj.si> wrote:

> Dear Arlinda,
> than k you for your answer. It would be nice if you can get an information from the Ministry whether HACCP proceedure is obligatory for water suppliers and drinking water.

> BR
> Barbara
>
> On 8.9.2015 13:15, Arlinda Ibrahimllari wrote:
>
> > Dear Barbara,
> >
> > we are almost certain that there is no water utility in Albania with a Water Safety Plan. None of the water utilities would do it on their own initiative.
> >
> > Maybe the Ministry of Public Health, State Sanitary Secretariat might know something or have a "model" that every utility should adopt in Albania, we will definitively ask them. I think that is all that we can offer.
> >
> > Please write me back for any other question in this regard,
> >
> > Bests from Albania,
> > Arlinda
> >
> > **Arlinda Ibrahimllari** / Manager of the Waste Water Services Department/ Chair of the YWPs Group Albania
> >
> > +355 68 60 94 294/ arlinda.ibrahimllari@gmail.com
> >
> > **Water Supply and Sewerage Enterprise of Korca UKKO Sh.A.** Office: +355 82 24 30 72 / Fax: +355 82 24 57 59
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> > On Fri, Jul 31, 2015 at 11:55 AM, Barbara Čenčur Curk <barbara.cencur@geo.ntf.uni-lj.si> wrote:
> >
> > > Dear partners,
> > >
> > > I am sending you a very short questionnaire regarding water safety plans and water management.
> > >
> > > I would like to ask you to check whether your water utility has water safety plan and what are the main parts of it. I assume you do not have measures in case of diminishing of water quantity. But you for sure measures in case of water pollution are determined. Determination of risks and measures for water pollution are mostly parts of HACCP documents.
> > > I am asking Albanian colleagues to answer it in general for water utilities in Albania, or only for one. The same for Greek colleagues - maybe for water utility from Korfu.

> > If you have water safety plan, please send it to me. I am asking you also to complete very short questionnaire, which is attached (by 25 August) to:
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> > Best regards
> > Barbara