LIFE14 CCA/GR/000389 - AgroClimaWater
Promoting water efficiency and supporting the shift towards a climate resilient agriculture in Mediterranean countries

Deliverable C3.3: Water Management Adaptation Strategy

Action C3: Selection of the pilot farms and formulation of the adaptation strategy for the three F.ORs

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Terminology / Abbreviations

Term	Description
AWMS	Agricultural Water Management System
B	Borax
CaO	Calcium oxide
Cu	Copper
DAC	Decentralized Administration of Crete
DEYA	Municipal Water & Sewage Company
DEYAVA	Inter municipal Water & Sewage Company of the Northern Coast of the Prefecture of Chania (Diamimotiki Epihirisi Ydrefsis Apohetefsis Voriou Axona)
e.g.	For example
e.t.c.	et cetera
EC	European Commission
EEC	European Economic Community
EU	European Union
FEK	Government Gazette / Official Journal of the Hellenic Republic
Fig.	Figure
GAPs	Good Agricultural Practices
GOEB	General Organization of Land Reclamation
GR	Greece
ha	Hectare
HCVAs	High Conservation Values areas
JMC	Joint Ministerial Decision
K	Potassium
K.E.DH.P.	Platanias Municipality Development Enterprise
K_2O	Soluble Potash / Potassium oxide
kg	Kilogram
m^3	Cubic meters
MgO	Magnesium oxide
mm	Millimeter
Mo	Molybdenum
N	Nitrogen
Na_2O	Sodium oxide
NK	Nitrogen - potassium
NP	Nitrogen - phosphorus
NPK	Nitrogen - phosphorus - potassium
NVZ	Nitrate Vulnerable Zone
O.A.K.	Organization for the Development of Crete
OJ	Official Journal
OM	Horizontal measure
P	Phosphorous
P.A.	Priority Axis
P_2O_5	Phosphoric Acid / Diphosphorus pentoxide
PPP	Plant Protection Products
S	Surfur
S.A.	Societe Anonume
SM	Supplementary measure
SO_3	Sulfur trioxide
sq.km	Square kilometer
tn	Tone
TOEB	Local Organization of Land Reclamation
WFD	Water Framework Directive
WMAS	Water Management Adaptation Strategy

Zn	Zinc

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INTRODUCTION

The present Water Management Adaptation Strategy (WMAS) is developed in the frame of Action C3 of the project LIFE AgroClimaWater based on the "Agricultural Water Management System (AWMS) implementation guidelines" developed in Action C2, as a tool for agricultural adaptation to climate. The AWMS structure is utilized in order to formulate three WMASs, one for each of the three participants F.ORs in the project:

- Platanias Municipality Development Enterprise, in Platanias Municipality, in Crete, Greece
- Agricultural Cooperative Partnership Mirabello Union S.A., in Agios Nikolaos Municipality, in Crete, Greece
- Assofruit Italia Società Cooperativa Agricola, in Metapontino, Italy

In addition, the results from the assessment of the current status on water efficiency by the thee F.ORs as well as of the water resources and High Conservation Values areas (HCVAs) status, as they are presented in the deliverable C.2 "Report on Assessment of Water efficiency", are utilized in order to establish the measures of AWMS that should be applied towards the enhancement of water efficiency by participant FORs.

The three WMAS were developed in order to motivate the farmers to foster practices that enhance sustainable management of water resources and to cope with the impacts of the prominent climate change. Moreover, through these WMASs the EWS standard's 4th principle, in reference to the efficient water consumption and governance practices, is implemented as a lot of related measures are proposed to be adopted by the F.ORs and their farmers.

The particular deliverable is divided into three parts, each one presenting the WMAS of each participant F.OR.

Every part is formed by the following sections:

- Description of Current status where a brief description of the pilot area is presented. Apart from the general information about the description of the pilot sub-basins, available information regarding the amounts of water consumption and the sources that are utilized for abstraction are also presented. Also, the main characteristics of the agrochemicals and the agricultural practices that are applied in the volunteer orchards that participate in AgroClimaWater project are described, as well as the main results of the investigation of K.E.DH.P.'s governance strategy and the assessment of its readiness to take adaptive actions are analyzed.
- Impact assessment where the status and the potential impacts of the applied agricultural practices in the water sources (groundwater and surface water sources) and the HCVAs that are located within Voukolies and Maleme sub-basins, related to their quality and quantity, are presented.
- The water management adaptation strategy where apart from the final text of the strategy, the Good Agricultural practices, the Governance actions and the Floods and droughts action plan proposed in the frame of LIFE AgroClimaWater as well as the relative to agriculture measures included in the River Basin Management Plan of Crete Water District (GR13) are presented and they are taking into account for the formation of the WMAS strategy are presented.

PART A - WATER MANAGEMENT ADAPTATION STRATEGY OF K.E.DH.P.

1. INTRODUCTION

The particular part presents the WMAS for Platanias Municipality Development Enterprise (K.E.DH.P.). The Platanias Municipality Development Enterprise (K.E.DH.P.) is based in the Municipality of Platanias. It was set up after the merger of four former Legal Entities (Platanias Municipality Development Enterprise, Kolymvari Municipality Development Enterprise, Voukolies Municipality Development Enterprise and Mousoures Municipality Development Enterprise).

The main objective of K.E.DH.P. is the planning of actions and the provision of services referred to areas of social protection and solidarity, environment, education and culture. Analytically, as far as the environment is concerned, K.E.DH.P. is responsible for the following:

- Olive fly control,
- Elaboration and implementation of research and technology,
- Elaboration of local programs for upgrading the physical architectural and cultural environment in the context of national and European policies,
- Management and adoption of restoration and environmental protection measures
- Design and implementation of programs concerning the protection and management of water resources, soil and air quality and pollution abatement,
- Implementation of environmental national and European programs,
- Development and promotion of the regional products,
- Protection of sea coast and streams.
- Development and implementation of integrated management systems in the cultivation of olives, vines and other local products.

2. DESCRIPTION OF CURRENT STATUS

2.1. Pilot area of Voukolies and Maleme sub-basins

In the frame of project LIFE AgroClimaWater and within the administrative borders of Platanias municipality, Tavronitis river basin catchment area was selected for the implementation of the project after a two stage evaluation process applied in the frame of project's Action A.1. In particular within Tavronitis basin the two pilot sub – basins, "Voukolies" and "Maleme", covering a total area of about 33.3 sq.km were selected for the formulation and implementation of a water management adaptation to climate change strategy by K.E.DH.P..

2.2. Water consumption and water sources utilized for abstraction

The water consumed by all the water uses within the catchment area of the pilot basins of Voukolies and Maleme is presented in Table 1, as it was estimated in the deliverable C2 "Identification and assessment of water efficiency in the three F.ORs before LIFE AgroClimaWater". The total volume of water consumed per year is 956.476 m^3. This quantity is equally allocated to potable (52,13%) and irrigation use (47,87%).

Table 1: Water consumption in Voukolies - Maleme sub-basins

POTABLE WATER	***Domestic***	***Enterprises***	***Touristic***	***Other uses***	***Sub-total***
Quantity (m^3/year)	308.042	82.087	107.804	651	***498.584***
Percentage (%)	61,78	16,46	21,62	0,13	***100,00***
IRRIGATION WATER	***Networks***		***Wells/Boreholes***		***Sub-total***
Quantity (m^3/year)	166.194		291.698		***457.892***
Percentage (%)	36,30		63,70		***100,00***
TOTAL WATER CONSUMPTION	***Potable Water***		***Irrigation Water***		***Total***
Quantity (m^3/year)	498.584		457.892		956.476
Percentage (%)	52,13		47,87		100,00

The settlements that are located within the catchment area are presented in Fig. 1 and the sources utilized for abstraction of potable and irrigation water in Fig. 2. Within the catchment area, the potable water is provided by Intermunicipal Water & Sewage Company of the Northern Coast of the Prefecture of Chania (DEYAVA). Four boreholes are utilized by DEYAVA that introduced water into the potable water in order to satisfy water demand from households, enterprises, tourism and other uses. Respectively, the irrigation water is provided by collective irrigation networks by the Municipality of Platanias and Organization for the Development of Crete S.A. (O.A.K. S.A.) and TOEB Kolymvariou as well as by 65 private wells.

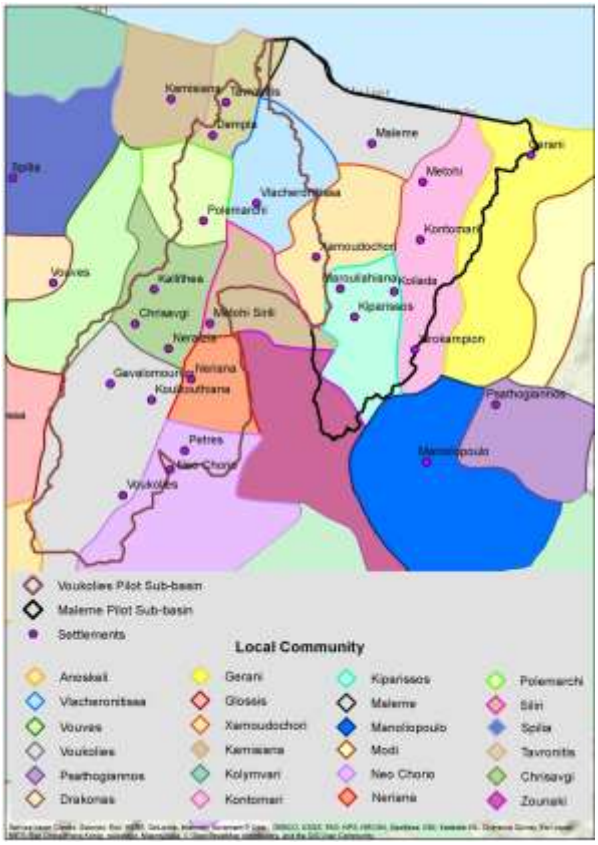


Fig. 1: Geodatabase Map Extract, depicting the settlements of Platanias and Voukolies municipal units located within the pilot basins

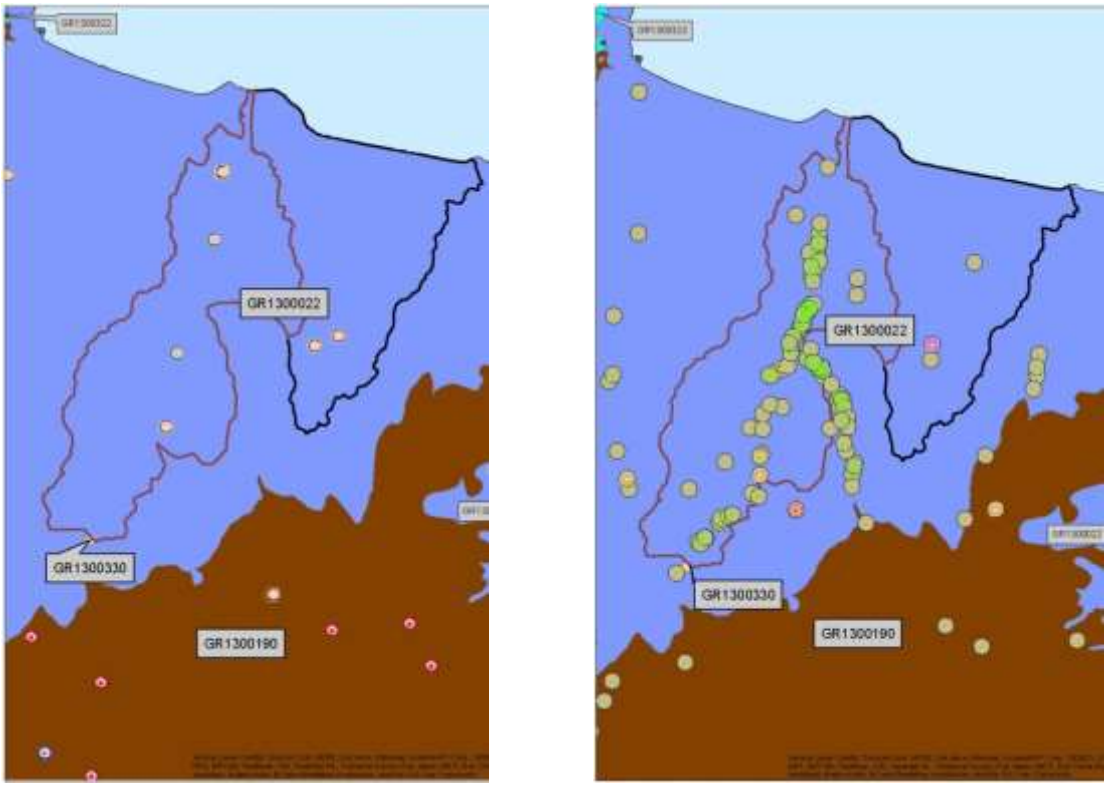


Fig. 2: Geodatabase Map Extract, depicting the abstraction points for potable (1st map) and irrigation (2nd map) use in Voukolies & Maleme sub-basis based on the water usage legal permits issued

Regarding the use of irrigation water, data collected by the 1st AWMS form revealed that 47 olive and the 8 citrus orchards irrigated in a total of 100 orchards.
Concerning the irrigation of olive orchards, the provided data present a significant deviation from what is considered as typical irrigation water requirements for olive trees in the area. Depending on climatic factors, full irrigation of olive orchards in North-Western Crete typically requires 228-270 mm of water (BEWARE project, 2005; Doupis et al., 2013), while the relevant limits on water use for irrigating olive trees, as set by the Decentralized Administration of Crete (DAC) in relevant local legislation (Decision published at FEK 2055B/2015) are 250-300 mm. However, according to farmers' interview data, the average annual application of irrigation water was only 63 mm, ranging from 17 to 334 mm. Based on the reported values, the vast majority of irrigated olive orchards could not be characterized as receiving adequate amounts of water and it is questionable if it can actually be beneficial in reducing water stress and increasing orchard productivity.
Concerning the water use in citrus orchards, provided data are much closer to reality, although they also present a significant variation, for reasons similar to those reported for olive orchards. The average annual water use reported was 325 mm, with typical requirements for citrus trees in the area estimated to be around 500 mm (BEWARE project, 2005) and the limits set by the DAC being 400-500mm. However, extreme values included two orchards representing the minimum (75 mm/year) and maximum (800 mm/year) values reported.

2.3. Use of agrochemicals

100 registered orchards that are located within Voukolies – Maleme sub-basins participated in LIFE AgroClimaWater project. From these orchards 91 are olive orchards, 8 citrus orchards and 1 avocado orchard. The single avocado orchard was excluded from the evaluation because it was not included in the original plan of studying crops and also its origin from tropical environments (very high irrigation needs) it could not be considered as representative for the agricultural sector in the area.
From the 99 registered orchards in Platanias the 17% are organic, the 83% are conventional and the 73% are fertilized. Also, 56% of the total orchards are irrigated, while the rest 44% are rainfed orchards.
A total of 10 PPPs are applied in the 84% of the registered orchards (or 83 out of 99) and more specific the 76% (or 75 out of 99) are olive orchards and the 8% (or 8 out of 99) are citrus orchards. From these PPPs the 20% (2 out of 10) contain priority substance (Chlorpyrifos-ethyl) and another 20% (2 out of 10) contain specific pollutants (Dimethoate and Copper) (Table 2). In 3% (or 3 out of 99) of the registered orchards 2 PPPs (DURSBAN & PYRINEX) which contain the priority substance of chlorpyrifos-ethyl are applied whine in 50% (or 50 out of 99) of the registered orchards 2 PPPs (ROGOR & COPPER) which contain the specific pollutants of dimethoate and copper are applied.

Table 2: PPPs with priority substances and specific pollutants per crop in Platanias area

	Commercial Name	Application in:	
		Olive	Citrus

PPPs with chlorpyrifos-ethyl	DURSBAN 480 EC & PYRINEX	0	3
PPPs with dimethoate	Rogor L 40 EC	47	3
PPPs with copper	COPPER (Cu containing in fungicides	9	1

Table 3 represents the classification of the applied PPPs according to H-phrases and their application per crop. In 2% (or 2 out of 99) of the registered orchards one PPP (DURSBAN) classified as "very toxic to aquatic life" (H400) is applied only in citrus orchards. In almost half of the registered (47.5% or 47 out of 99) orchards in Voukolies – Maleme sub-basins a total of 5 PPPs (DECIS, PROTEUS, PYRETHRON, PYRINEX & COPPER) classified as "very toxic to aquatic life with long lasting effects" (H410) as applied. In addition, 2 PPPs (ROUNDUP & ROGOR) classified as "toxic to aquatic life with long lasting effects" (H411) are used in the 62.6% (or 62 out of 99) of the total orchards and other 2 PPPs which "may cause long lasting harmful effects to aquatic life" (H413) are used in the 39.4% (or 39 out of 99) of the registered orchards.

Table 3: PPPs with H-phrases per crop in Platanias area

	PPPs with h-phrases	Orchards where PPPs with h-phrases are used			% of orchards in the pilot area
		Crop	Number	%	
H400	DURSBAN	Citrus	2	25	2.0
H410	DECIS	Olive	21	23,1	47.5
		Citrus	1	12,5	
	PROTEUS	Olive	9	9,9	
	PYRETHRON	Olive	7	7,7	
	PYRINEX	Citrus	1	12,5	
	COPPER	Olive	9	9,9	
		Citrus	1	12,5	
H411	ROUNDUP	Olive	35	38.5	62.6
		Citrus	2	25.0	
	ROGOR	Olive	45	49.5	
		Citrus	3	37.5	
H413	ROUNDUP	Olive	35	38.5	39.4
		Citrus	2	25.0	
	DURSBAN	Citrus	2	25.0	

As far as the fertilizers are concerned in Platanias area 20 distinct types of fertilizers are applied (Table 4). The 85% of them (17 out of 20) are inorganic while the rest of them (15% or 3 out of 20) are composite organic fertilizers. From the total of 20 fertilizers applied, 80% are compound/ multinutrient fertilizers (NP, NK or NPK), while 20% of them (4 out of 20) are straight fertilizers (N, P or K). In general, the 70% (14 out of 20) of the applied fertilizers are characterized by low concentrations (less or equal to 20%) of primary and secondary nutrients. Borax was the only fertilizer used for the application of a micronutrient in high quantities, due to the importance of B in olive tree nutrition. It is applied in 15 out of 91 (16.5%) of olive orchards but in small

typical dosages per tree and per year and thus the potential environmental risk linked to its use is relatively low.

Table 4: Type and mineral elements (%) of fertilizers used in Platanias pilot area

Fertilizer	Mineral elements (%)							
	N	P_2O_5	K_2O	CaO	MgO	S/SO_3	Na_2O	B
Organic fertilizer 1	5	5	5					
Organic fertilizer 2	9	5	4					
Organic fertilizer 3	6	6	6					
Calcium ammonium nitrate	26	0	0	8				
Ammonium sulphate	21	0	0			24		
Potassium Sulphate	0	0	50			18		
Potassium Nitrate	13	0	46					
Urea	46	0	0					
Ammonium phosphate – sulphate	16	20	0			13		
Borax ($Na_2B_4O_7.10H_2O$)						15	16.5	11.5
Fertilizer 11-15-15	11	15	15					
Fertilizer 20-10-10	20	10	10			9		
OLIFERT 19-6-15	19	6	15		2	4		0.5
SOLINUR 20-20-20	20	20	20					
Fertilizer 21-7-14	21	7	14					
COMPLESAL 12-12-17	12	12	17		2			
COMPLESAL 12-8-16	12	8	16		3	10		0.02
COMPLESAL 18-6-12	18	6	12		2			0.25
HAIFA 18-8-18	18	8	18		2			
Fertilizer 15-15-15	15	15	15					

Although the majority of the applied fertilizers are characterized by low nutrient concentrations and as a result low environmental risk, the excess fertilization can cause eutrophication of surface water bodies and specifically pollution caused by nitrates and phosphorus. Eutrophication results in the excessive growth of aquatic plant life, depletion of dissolved oxygen thus suffocating fish and other animal life. The combination of the above and ANNEX VIII of WFD according to which substances which contribute to eutrophication (in particular, nitrates and phosphates) are considered to be Main Pollutants leads to the conclusion that all fertilizers utilized in the three pilot areas (as they contain nitrates and/or phosphorus) are considered as Main Pollutants. In groundwater, nitrates pollution causes the accumulation of high concentration of nitrates in water, compromising the quality of water and resulting in water not suitable for drinking.

The substances that are included in the fertilizers used in Platanias are in most cases not hazardous for the aquatic environment, when utilized properly. The only exception is the Ammonium Sulphate, as this substance is toxic to aquatic life with long lasting

effects (H411). Ammonium Sulphate is applied only in olive orchards and especially in 10.1% (or 10 out of 99) of the registered orchards.

Moreover, substances that have been characterized as specific pollutants according to the Greek legislation have been detected among the main components of the fertilizer "*SOLINUR 20-20-20*" which contains both Molybdenum (Mo) and Zinc (Zn) and it is utilized in 11% of the total registered orchards, 10 of which are olive and 1 is citrus orchard.

2.4. Other agricultural practices applied

The ratio of 11.4:1 among the olive and citrus orchards included in the data collection procedure is higher than the typical ratio of 5.7:1 for the pilot area.
From the 91 olive orchards included (Table 5), 16 were organic (17.6%), while the percentages of fully or partially irrigated vs rainfed orchards were almost equally distributed (47 irrigated orchards, or 51.6% and 44 rainfed orchards, or 48.4%).

Table 5: Indicative data collected through the 1st AWMS form, for 91 olive orchards in the pilot sub-basins of Maleme and Voukolies

Parameter	All orchards	Conven-tional	Organic	Irrigated	Rainfed
Number of orchards	91	75	16	47	44
Soil cultivation applied (number of cases)	17	14	3	9	8
Weed mowing (number of cases)	50	34	16	21	29
Use of cover crops (number of cases)	0	0	0	0	0
Grazing (number of cases)	0	0	0	0	0
Pruning applied (number of cases)	91	75	16	47	44
Summer pruning (number of cases)	0	0	0	0	0
Burning of prunings (number of cases)	79	69	10	41	38
Shredding of prunings (number of cases)	12	6	6	6	6
Application of organic material from external sources (number of cases)	11	5	6	1	10

Soil cultivation was applied once per year to 18.7% of orchards, a practice that, depending on the slope of the area, may have a negative impact on soil erosion and soil fertility. Weed mowing was applied once or twice per year in 50 orchards (54.9%), while cover crops were not grown during winter in none of the orchards. Although the status of the orchard floor during the winter months cannot be judged by the existing set of data, the non-application of cover crops, in combination with chemical control of weeds in 38.4% of the orchards, implies that there is bare soil during winter in a significant percentage of the orchards, reducing the potential for water storage in the soil during the rainy season. Intentional grazing by livestock is not a typical practice in the area (0% of the orchards), in contrast with other areas in Crete.

Pruning is a typical practice applied in all orchards once per year (winter time), although its efficiency could not be judged by the data collected through the AWMS forms. No summer pruning is applied in the area, in contrast to other olive growing areas in Greece. Estimates on mean weight of prunings are not available, since it is a parameter not recorded by farmers. Considering the management of pruning wood, burning is the practice applied by the vast majority of farmers, with 82.4% burning it at the orchard and 4.4% use it for heating (fireplace). Shredding of prunings and dispersion to the orchard is limited to 13.1% of the orchards. Therefore, a potential source of organic material that could be used for mulching and increasing of soil organic matter is wasted in 86.9% of the orchards. Considering the application of organic material from external sources, this is also quite low in olive orchards, with manure applied in only 8 orchards (8.8%) and compost in 3 (3.3%) of them. Manure application rates could be considered as adequate, with mean application rates per year ranging from 5 to 7.5 tn/ha, in 5 out of 8 orchards (62.5%), while application of compost is considered as limited, at rates around 0.6 tn/ha in the 3 orchards. It is worth mentioning that manure and compost application is at low percentages even in organic orchards, with 3 cases in 16 orchards for each material, i.e. a percentage of 18.7%.

As far as citrus orchards are concerned from the 8 citrus orchards included (Table 6), 1 was organic, while all orchards were irrigated, as it is the typical practice in citrus orchards in the pilot area. Soil cultivation was applied in 2 orchards (25%), a practice that, depending on the slope of the area, may have a negative impact on soil erosion and soil fertility. Weed mowing was applied once or twice per year in 6 orchards (75%), while cover crops were not grown during winter in none of the orchards. Chemical control of weeds was applied in 2 orchards (25%).

Table 6: Indicative data collected through the 1st AWMS form, for 8 citrus orchards in the pilot sub-basins of Maleme and Voukolies

Parameter	All orchards	Conventional	Organic
Number of orchards Orange trees Lemon trees	8 7 1	7 6 1	1 1 0
Irrigation applied (number of cases)	8	7	1
Soil cultivation applied (number of cases)	2	2	0
Weed mowing (number of cases)	6	5	1
Use of cover crops (number of cases)	0	0	0
Grazing (number of cases)	0	0	0
Pruning applied (number of cases)	8	7	1
Summer pruning (number of cases)	0	0	0
Burning of prunings (number of cases)	8	7	1
Shredding of prunings (number of cases)	0	0	0
Application of organic material from external sources (number of cases)	1	1	0

Pruning is a typical practice applied in all orchards once per year (winter time), although its efficiency could not be judged by the data collected through the AWMS forms. In general, pruning of citrus trees is not as intense as in olive orchards. No summer pruning was applied, which is typical for the area. Estimates on mean weight of prunings are not available, since it is a parameter not recorded by farmers. Considering the management of pruning wood, burning in the orchard was the common practice applied in all 8 orchards. Shredding of prunings and dispersion to the orchard was not applied in any orchard. In general, use of organic material from external sources (manure, compost, etc.) was minimal and was not practiced at all in any of the fully productive orchards. The only orchard where a low amount of compost (750 kg/ha) was applied was the young lemon tree orchard.

2.5. The governance strategy of K.E.DH.P.

Effective F.ORs governance in relation to water management constitutes one of the major factors that has to be taken into account for the development of the water resources management strategy of each F.OR. This is also underlined by EWS Standard, according to which one out of the four principles is dedicated to water governance and aims at achieving equitable and transparent management of water resources. The current status of K.E.DH.P.'s governance strategy was investigated and its readiness to take adaptive actions was assessed in the context of Action C2 by evaluating the responses in the 3rd form of the Agricultural Water Management System.

The overall readiness of K.E.DH.P. in relation to water governance directions indicated by the 4th principle of EWS was identified as low. More specifically, the main findings of the assessment are summarized below:

- Except for the maintenance of a list of the applicable water legislation, K.E.DH.P. has not established the appropriate procedures and documentation in order to ensure compliance with the legal requirements related to water management.
- None procedure and documentation are established that link water management to the management of other resources.
- The water efficiency increasing potential is considered as low, since water losses during irrigation are not estimated and there are no increasing water efficiency actions documented and implemented.
- There are no water related dissemination activities, either internal or external, implemented and also there are no actions documented and implemented related to the management of incidents. Therefore, the current degree of transparency on water management for K.E.DH.P. is considered as low.
- Since there is no documented and evaluated implementation of Good Agricultural Practices, the current potential of K.E.DH.P. to ensure continuous improvement in water management is considered as low.
- With regard to the economic transparency of water management the current readiness status is considered as low since the investments made for maintenance and improvement of the water management are not reported, while an environmental cost analysis has not been compiled yet.
- Currently, there is no water management strategy established, implemented and monitored.

3. RESULTS OF IMPACT ASSESSMENT

3.1. Impacts on water quantity

As shown in the Fig. 2, the water consumed by the water users in the pilot sub-basins is abstracted from the groundwater system of Porous aquifer of Campos Chanion (GR1300022). According to Fig. 3, although the water table of the aquifer is varied during the year from 5 to 10 meters, the annual water balance of the source is assumed stable.

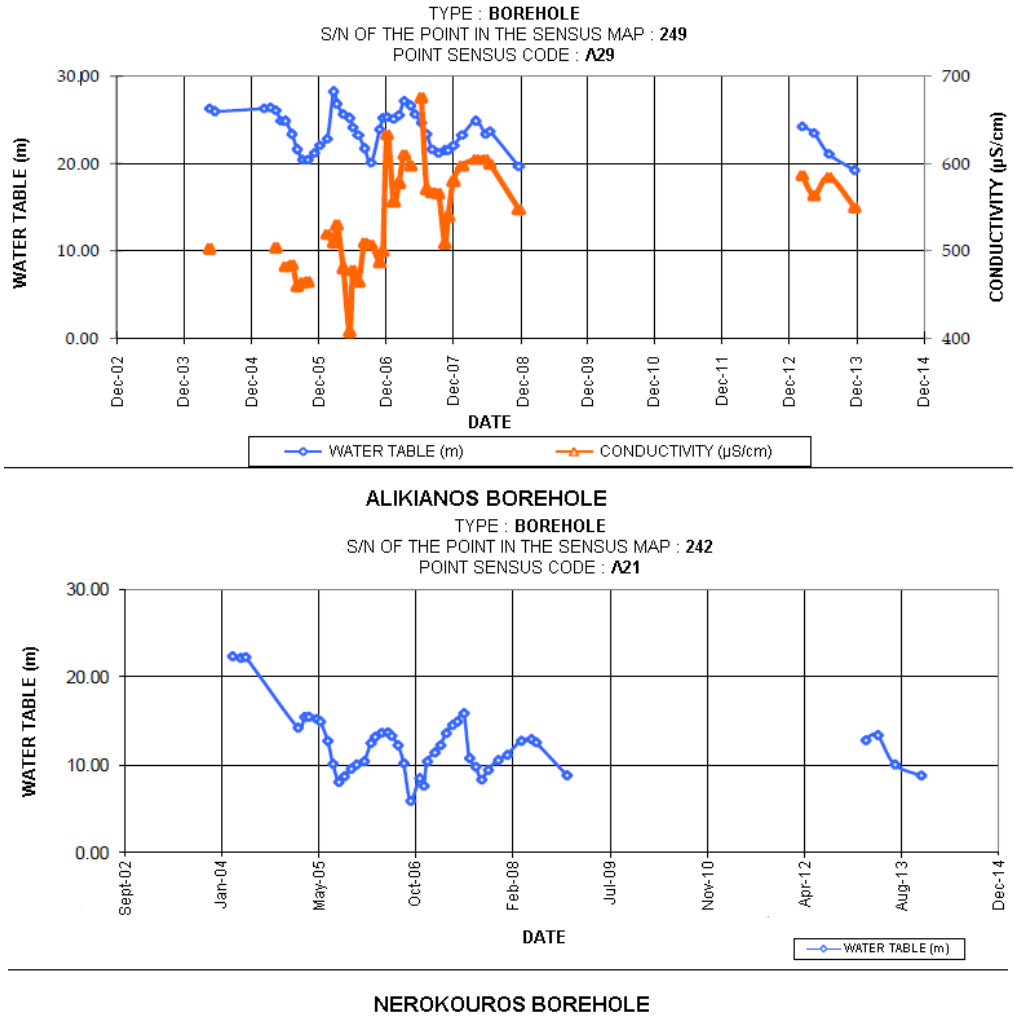


Fig. 3: Water table and conductivity of Porous aquifer of Campos Chanion (GR1300022) (source: "The water status of groundwater bodies of Crete" M. Kritsotakis, S. Pavlidou, 2013)

In addition, according to the river management plant of Water District of Crete, the quantitative water status of the water system is assessed as good (Table 7) with no increasing trend for further deterioration.

Table 7: Groundwater bodies in Voukolies and Maleme sub-basins

Code	Name	Aquifer Type	Anthropogenic Pressures / Impacts	Natural Pressures / impacts	Quantitative Status	Comments	Increasing trend of pollutant
GR1300022	Porous aquifer of Campos Chanion	porous	No	-	Good	-	No

Based on the previous information no significant environmental and/ or socioeconomic impacts have been identified on the water body by anthropogenic pressures, agricultural included or natural pressures.
Considering the water consumed by all the water uses within the catchment area of the pilot basins of Voukolies and Maleme that is presented in Table 1, its quantity is equally allocated to potable (52,13 %) and irrigation use (47,87%). Thus, any impacts on water abstraction are attributed to both uses in the same degree.

3.2. Impacts on water quality and affected destinations

The Voukolies – Maleme sub-basins could be divided into 4 sub-basins based on the four surface water bodies that have been recognised according to the River Basin Management Plan of Crete District (13) (Special Secretariat for Water, 2015).
According to the risk assessment analysis which is presented in sub-deliverable C2.2 "Runoff, leaching and erosion risk assessment", 2 out of 4 sub-basins (GR3901R000301057N and GR3901R000301007N) are characterized by high runoff risk potential and the other 2 (GR3901R000301006N and Maleme) by moderate runoff potential. In addition, the orchards that are fertilized and in which PPPs are applied and they are located in areas with runoff potential higher than moderate are equal to 84% and 81% of the total registered orchards, respectively.
As far as erosion potential is concerned only one (GR3901R000301057N) of the four sub-basins, is characterized by high erosion risk potential and other three (GR3901R000301006N, GR3901R000301007N and Maleme) are characterized by moderate erosion potential. In addition, the orchards that are fertilized and in which PPPs are applied and they are located in areas with runoff potential higher than moderate are equal to 46% and 45% of the total registered orchards, respectively.
The leaching potential in the pilot area is varied from low to moderate with the largest part characterized by low potential. More specific, the coastal sub-basin of Voukolies (GR3901R000301006N) is presented as low, while for the other three sub-basins (GR3901R000301057N, GR3901R000301007N and Maleme) the corresponding class is moderate. The percentage of the register orchards in which fertilizers and PPPs are used and located in areas with leaching potential higher that moderate is equal to 61% and 59%, respectively.
In general, the 85% (or 85 out of 100) of the registered orchards are fertilized while in the 83% (83 out of 100) of the registered orchards PPPs are used. Moreover, in the 50% of the registered parcels, PPPs used contain specific pollutants (copper, dimethoate or both of them) and in the 3% of the registered parcels, PPPs used contain a priority substance (Chlorpyrifos-ethyl). In 2 registered orchards (2%), which both of them are located in the sub-basin GR3901R000301007N, PPPs classified as H400 are used and in 47 registered orchards (47%), PPPs classified as H410 are used. The percentage of orchards such PPPs are applied in each sub-basin is varied from 25% the minimum, 5 orchards out of 20 located in sub-basin Maleme, to 66.7% the maximum, 8 out of 12 in GR3901R000301057N.
The 11 potentially affected destinations located within Voukolies – Maleme sub-basins are mentioned in Table 8 and they are presented in Fig. 4.
For 2 out 9 potentially surface affected destinations within Voukolies - Maleme sub-basins it is known that either their status or the status of their interrelated water systems is at least good. In particular, these are the surface water body of the Coast

of Chania Gulf (GR1339C0002N) and the HCV area of Bathing waters of Maleme beach (GRBW139323085). For the rest surface affected destination their status is unknown. As far as the two groundwater bodies is concerned the qualitative status of both water bodies, Porous aquifer of Campos Chanion (GR1300022) and Gypsum karst aquifer of Crete (GR1300330) has been identified as good.

Table 8: Potentially affected destinations within Voukolies – Maleme sub-basins

Code	Name	Type	Ecological Status	Chemical status	Qualitative Status	Quantitative status	Pressures/ Threats/ Impacts
GR3901R000301006N	Tavronitis	Surface water body	Unknown	Unknown	-	-	Settlements without WTP, number of IPPC plans, livestock, percentage of cultivated area
GR3901R000301007N	Tavronitis	Surface water body	Unknown	Unknown	-	-	Number of IPPC plans, livestock, percentage of cultivated area
GR3901R000301057N	Tavronitis	Surface water body	Unknown	Unknown	-	-	Settlements without WTP, number of IPPC plans, livestock, percentage of cultivated area
Maleme	Maleme	Surface water body	Unknown	Unknown	-	-	Unknown
GR1300022	Porous of Campos Chanion	Groundwater body	-	-	Good	Good	None
GR1300330	Cypsum Karst of Crete	Groundwater body	-	-	Good	Good	Excess sulphate values due to layers of gypsum
Y434KRI203	Tavronits estuary and marsh	Wetland	-	-	-	-	-
Y434KRI202	Sfakoryako estuary	Wetland	-	-	-	-	-
GRBW139323085	Maleme beach	Bathing water	-	-	Excellent	-	Wastewater disposal from sewage treatment plant, potential discharge of pollutant from the agricultural sector through estuaries and streams
GR1339C0002N	Coast of Chania Gulf	Coastal water	Good	Good	-		-
GR4340003	Chersonisos Rodopou – Paralia Maleme	Site of community importance	-	-	-	-	Cultivation – increase of agricultural area (medium), grazing (medium), fertilization (medium), irrigation – temporary transition from dry to mesic or wet conditions due to irrigation (low), use of biocides, hormones and chemicals (medium)

According to the River Based Management Plan of Crete District (GR 13) the ecological and chemical status of the 4 surface bodies (rivers) located in the pilot area are unknown. Based on the same plan, the agricultural activities that are applied within the catchment area of each water body are intensive and more specific they are highly intensive in three out of four sub-basins (GR1339R000301006N, GR1339R000301057N and Maleme) and rather intensive in the fourth sub-basin

(GR1339R000301007N) according to the percentages of its catchment area which are used for agricultural activities.

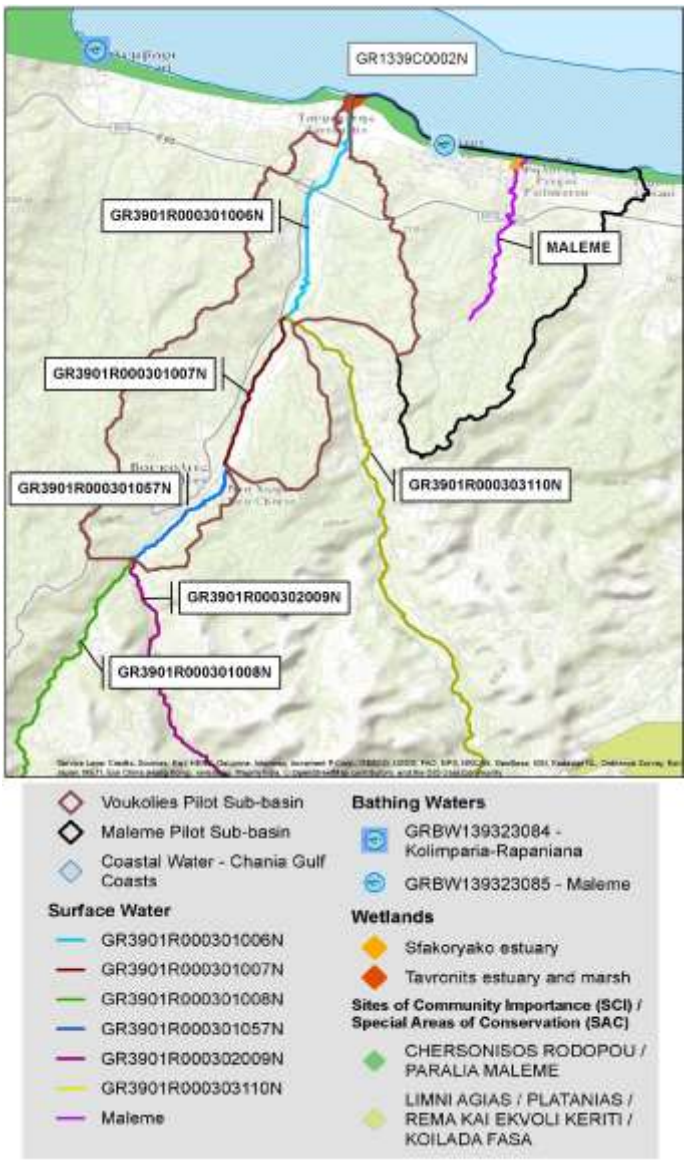


Fig. 4: Potentially affected surface water bodies and HCV areas in Voukolies – Maleme sub-basins

Considering also the information that:

- the run off and erosion risk potential for the entire basin is categorized higher than the moderate
- fertilizers and PPPs are used in the majority of the register farms
- the 70% of the used PPPs contains substances that are hazardous for the aquatic environment (H400 or H410) and the 20% of all the applied PPPs contains the specific pollutants (Copper, Dimethoate).

It can be assumed that in cases where non good agricultural practices are applied, the agricultural activities can impact all the surface water bodies due to the runoff and erosion risk potential considering also the fact that the 55% of the registered orchards are irrigated. Nevertheless, since the chemical status of all surface river water bodies is unknown, there are no data to assess the impacts impose to them by anthropogenic

activities/pressures and agriculture particularly so far. The identification of their status is a demanding process and should be elaborated by the relevant authorities.
Regarding the impacts of agricultural activities on the 3 out of 5 HCV areas (Y434KRI203, Y434KRI202 and GR4340003), they could not be also assessed since they interrelated with surface bodies with unknown ecological and chemical status. However, as far the impacts on the bathing water of Maleme and the coast of Chania Gulf are concerned, as their status is either good or excellent it can be assumed the agricultural activities have no impact them in terms of their quality so far.
In reference to the groundwater bodies, according to the River Based Management Plan of Crete District (GR 13) the qualitative status of the 2 groundwater bodies, Porous aquifer of Campos Chanion (GR1300022) and Gypsum karst aquifer of Crete (GR1300330) located in the pilot area is good. Considering also the information that:

- The agricultural activities that are applied are intensive
- The leaching potential is moderate
- The information on the used fertilizers and PPPs

it can be assumed that the agricultural activities have no impact on the groundwater bodies in terms of their quality so far. In addition, the area has not designated as a Nitrate Vulnerable Zone (NVZ) for the purposes of the EU Nitrate Directive. However, it can be assumed that in cases where non good agricultural practices are applied, there is a moderate potential to be polluted by substances contained in the agrochemical used.

4. FORMATION OF WATER MANAGEMENT ADAPTATION STRATEGY OF KEDHP

The WMAS for KEDHP was formed taking into account the results of deliverable C3.1 "Proposal of farm specific Action Plans (GAPs and monitoring measurement equipment)" and C3.2 "Governance actions and floods and droughts action plan for the participant FORs" as well as the main measures that are relative to the agriculture and are included in the Programme of Measures of the River Basin Management Plan of Water District of Crete-G13 (Special Secretariat for Water, 2015) as they are briefly presented in the following sections.

4.1. Good Agricultural Practices for water efficiency enhancement

The Good Agricultural Practices (GAPs), proposed by the LIFE AgroClimaWater (Action C3, deliverable C3.1) project and will be implemented and monitored during the next period constitute a vital component of the water management strategy of K.E.DH.P..
The main aim of these GAPs is to enhance water use efficiency during the cultivation process and to contribute to the environmental protection of water resources and protected areas, as well as to protect crop productivity and farmers income in the view of climate change. The GAPs proposed are the following:

- **Reduction of water evaporation losses from soil surface**

This can be achieved through:

a) *Soil mulching*. This practice includes the weed mowing during the high water demand season (late spring and summer period). This practice can be implemented at least one (second half of spring – water demand season) or more times both in olives and citrus crops, while possible restrictions have to be considered for farms with high slopes.

b) *No weed control*. Based on this practice natural vegetation can remain on farm during rainy season (Oct – Apr). Additionally, sowing legumes in rainy season can also contribute to reducing water evaporation losses from soil surface as well as providing olive trees with nitrates during summer period after the weed mowing.

c) *Weed mowing*. This practice is expected to be the most applicable technique both on olive and citrus crops, while practicing the shredding of pruned wood is expected to enhance soil mulching too. Specifically, shredding pruned wood of small diameter can be applied on orchard surface late winter to early spring. This practice can be implemented on low land olives trees farms and with restrictions it may be applied to farms with high slopes. Finally, to reduce evaporation losses both in olive and citrus trees avoiding bare soil with no tillage is recommended.

- **Reduction of transpiration water losses through winter pruning and summer pruning**

Appropriate winter pruning can be applied in order to obtain the optimal balance between leaf area and yield. Moreover, summer pruning can be applied to reduce the transpiring leaves and reduce radiation competition; summer pruning can be implemented one time during July. These practices can be applied in olive trees while for citrus possible restrictions may be applied during summer pruning. In addition during this project the effectiveness of Kaoline for reducing the transpiration water

losses will be investigated. Kaoline will be applied on olive trees through spraying applications during summer period.

- **Reduction deep percolation water and nutrient losses**

This can be achieved through:

a) *Increasing organic matter*. Application of locally available organic matter could be used for improving the soil water holding capacity. In this way the rapid vertical movement of water along the soil profile can be reduced. This practice can be applied during autumn.

b) *Fertigation*. In irrigated orchards where there is the option of fertigation, fertilizers can be applied through this method in order to minimize nitrate losses to ground water (more applicable for citrus). The fertigation during spring and summer period may lead to 10 until 30% savings in water and nutrients compared to the quantities conventionally applied. The application of this practice in irrigated olives depending the infrastructure.

- **Reduction of surface runoff**

Based on this intervention the surface runoff can be minimized especially in sloppy areas. This can be achieved by physical reduction of surface runoff introduced along the contour lines in the orchard. The benefits of this practice could be more obvious for olive trees farms in high slope.

- **Measures in order to maximize the efficiency of irrigation**

Adjusting irrigation water application according to actual farm needs can significantly contribute to water saving. This can be achieved based on weekly bulletins that will be available on IOTSP on crop irrigation water requirements (meteorological conditions, soil type, crop) for irrigated olive trees and citrus. In addition, depending on the specific farm, a plan for irrigation network improvement and repair can be established. Based on this plan, a set of water-meters and volumetric valves can be introduced in each orchard, in order to provide farmers with the tools to precisely control the amount of irrigation water that is applied to the orchard. Establishing and checking the irrigation network in each farm and after the accurate estimation of evapotranspiration losses an application of regulated deficit irrigation could be of high priority for reducing water use up to 20-30% in olive trees and 10-15% in citrus, with no negative effects on yield quality and quantity.

- **Rationalization of fertilizers and agrochemicals utilized**

In order to minimize the risk for water pollution by agrochemicals, the principles of integrated management can be applied in the cultivation process. Moreover, a specific fertilizing schedule for each orchard has to be considered, in order to use the necessary quantity and minimize the risk of ground and surface water pollution by fertilizers. The fertilizing schedule may be applied in each farm based on soil and leaf nutrients analysis.

Ten pilot farms were selected based on a methodology presented in Deliverable "Proposal of farm specific Action Plans" (Action C3) in order to apply the GAPs presented above. The location of each pilot farm in the pilot sub-basins in illustrated in Fig. 5, while the GAPs applied in each farm are listed in Table 9. More details about GAPs implementation can be found in the farm specific action plans compiled in the context of Deliverable "Proposal of farm specific Action Plans" (Action C3).

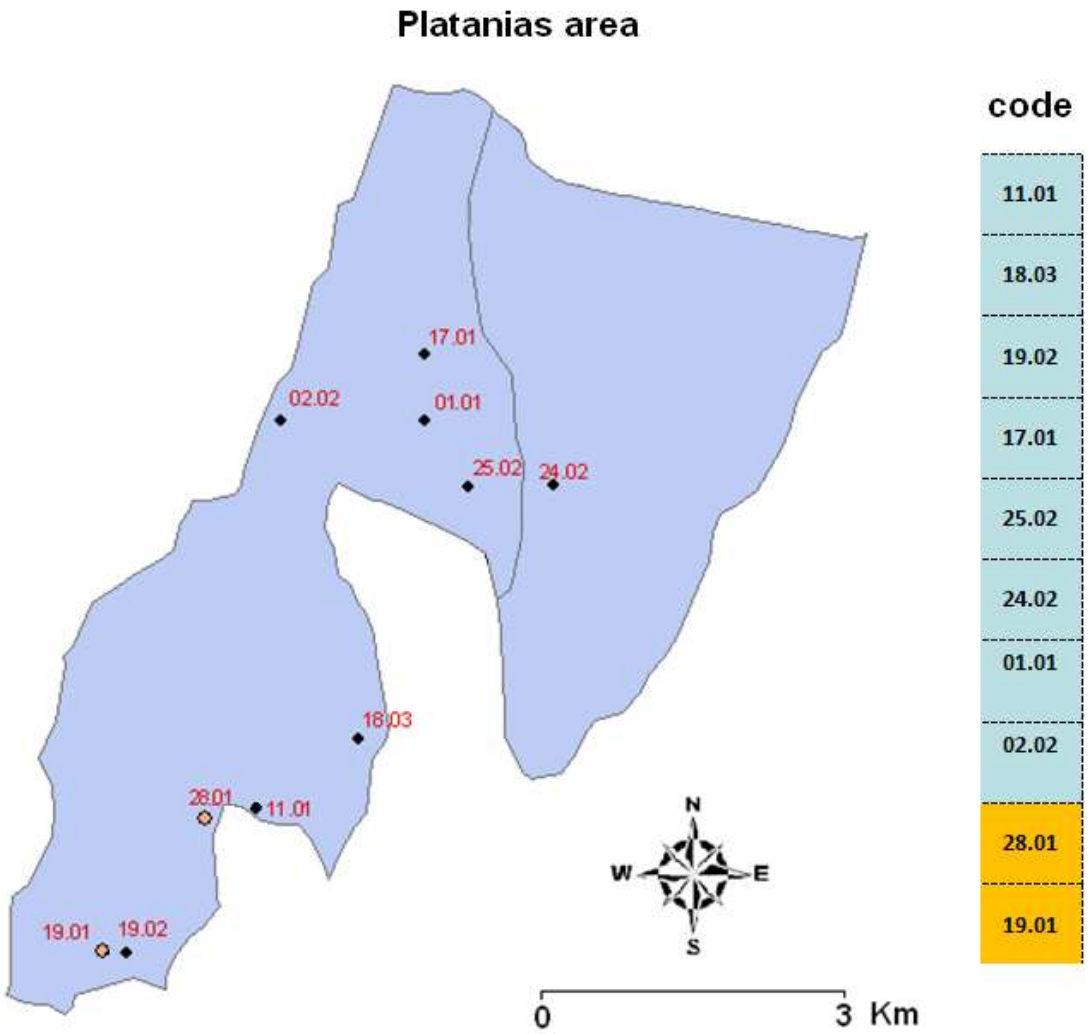


Fig. 5: The selected 10 pilot farms in Voukolies and Maleme sub-basins with the corresponding codes (blue colour represents olive orchards, while yellow citrus orchards).

Table 9: GAPs scheduled to be applied in the 10 pilot farms of K.E.DH.P. Codes marked with yellow indicate citrus farms.

Code	Crop	Weed Mowing	No weed control during winter	Cover Crops	No soil tillage	Pruning Winter-summer	Shredding of prunings	Kaolin application	Organic material addition	Fertilizing scheduling/ Fertigation/ Foliar application of nutrients	Irrigation network improvement	Irrigation scheduling/ deficit irrigation	Physical reduction of surface runoff
11.01	Olive	x	x	x	x	x	x	x	x	x /x /x	x	x /x	
18.03	Olive	x	x	x	x	x	x	x	x	x /x /x	x	x /x	x
19.02	Olive	x	x	x	x	x	x	x	x	x /x /x	x	x /x	
17.01	Olive	x	x	x	x	x	x	x	x	x /x /x	x	x /x	
25.02	Olive	x	x	x	x	x	x	x	x	x /x /x	x	x /x	x
24.02	Olive	x	x	x	x	x	x	x	x	x /x /x	x	x /x	
01.01	Olive	x	x	x	x	x	x	x	x	x / - /x	x		
02.02	Olive	x	x	x	x	x	x	x	x	x / - /x			
28.01	Citrus-Orange	x	x	x	x	x			x	x /x /x	x	x /x	
19.01	Citrus-Lemon	x	x	x	x	x			x	x /x /x	x	x /x	

4.2. K.E.DH.P.'s Governance Actions for equitable and transparent water governance

Water governance within K.E.DH.P. constitutes the framework under which efficient and sustainable water management can be achieved and therefore it is included as an integral part of the present strategy aiming at:

1. Ensuring conformance with water related legal requirements.
2. Identifying and managing interrelations of water with other resources used in agricultural sector.
3. Adaptive capacity building (information, training and raise public awareness).
4. Promoting the participation of the agricultural sector in decision making with respect to the management of the water basin.
5. Ensuring preparedness and response to environmental incidents on the area caused by eventual accidents and adverse weather conditions.

Therefore a set of actions was developed, described in detail in "Governance actions and floods and droughts action plan for the participant FORs" Deliverable C3.2 (Action C3) accompanied by the corresponding procedures and documentation, which are summarized as follows:

- **Ensuring compliance with all legal requirements linked to water use:** A procedure is established for following up legal matters on water. Moreover, an assignment was created according to which a person or department is identified who will ensure compliance with legal requirements linked to water.
- **Linking water management to the management of other resources**: The quantitative relation of: a) water and energy use and b) water and other resources than energy has to be identified and optimized. Therefore, the appropriate recording system has been developed in order to quantify the aforementioned relations. The assessment of recording results can indicate improvement potential in water management in relation to energy and other resources.
- **Raising efficiency of water consumption**: Three specific actions are proposed in order for K.E.DH.P. F.OR. to raise its efficiency of water consumption. The first action is related to the identification of water losses and their destination and therefore the appropriate methodology and documentation was developed. The second action is the planning, implementation and monitoring of measures that will enhance water efficiency. A set of measures are identified from the GAPs pool presented above which aim to improve water efficiency and more specifically: a) Calculation of evapotranspiration losses, b) Plan for farm irrigation network improvement and c) Deficit irrigation. The results of the above GAPs implementation are recorded and the year after year comparison can indicate the increasing water efficiency potential of each practice. The final action includes the calculation of total water consumption per unit of product.
- **Ensuring transparency on water management**: In the context of promoting and ensuring transparency on water management resources, F.OR. have to be devoted to ensure attentive communication with River Basin Committee. Thus, a person or -if possible- a department has to be defined which will represent and report on River Basin Committee activities and vice versa. The appropriate assignment has been created. Towards the internal dissemination of sustainable water management, the Water Steward of each F.OR. has to make sure that all the personnel of the F.OR. as well as the farmers are duly informed of F.ORs' water policy and the basic elements of WMAS, the objectives, the problems and drawbacks, the achievements, etc.

Moreover, promotional campaigns in topics related to irrigation scheduling, and GAPs implementation.

With regard to increasing the preparedness of K.E.DH.P. to efficiently cope with unexpected situations, floods and droughts action plans were developed, as these two situations are considered of major concern for K.E.DH.P. A summary of floods & droughts action plans is provided in the next section.

- **Ensuring continuous improvement**: The pool of GAPs presented in the previous section can be considered as a robust basis for continuous improvement of water management within K.E.DH.P. The improvement potential of each GAP is under investigation and more details about implementation, monitoring and evaluation are presented in detail in the corresponding deliverable developed in the context of the current action (Proposal of farm specific Action Plans). Moreover, taking into account the fact that such practices are not currently applied or there are sparsely applied, their implementation under a water management scheme can be considered as innovative.
- **Ensuring transparency on economic aspects of water management**: Two actions are proposed in order for K.E.DH.P. to maintain transparency on the economic aspect of water management. With regard to the first action, the investments related to maintenance and improvement of water management have to be reported. Concerning the second action, an environmental cost analysis has to be performed.

4.3. Floods & Droughts Action Plan for management of incidents

Under the scope of formulation of the adaptation strategy for F.ORs the "Floods and Droughts Action Plan" was developed by the LIFE AgroClimaWater (Action C3, deliverable C3.2) in order to ensure the preparedness and response of F.ORs to environmental incidents caused by the imminent climate change.

Two are the main components of floods action plan:

- identification of flood risk and
- management of floods

The **river flood risk assessment** is based on the corresponding reports developed by Hellenic Special Secretariat for Water in compliance with Directive 2007/60/EC, and more specifically on preliminary flood risk assessment of Crete Water District and flood hazard and flood risk maps. The results demonstrated that a high flood risk zone was identified (GR13RAK0010) in Tavronitis basin, located along Tavronitis main river courses. As stated in Preliminary Floods Risk Assessment report, floods in the high flood risk zone are accompanied by damages in the agricultural areas. With regard to flash floods risk assessment, which were based on the results of surface runoff potential estimation in the context of Action C2, overall the contribution of the agriculture activity developed in Tavronitis basin to the development of flash floods is moderate to high, and this is mainly attributed to significant rainfalls experienced in the southern part of the basin and to the steep slopes of the topographic relief.

With regard to **flood management**, actions and measures proposed to be implemented were divided into two categories having in mind to mitigate: a) flash floods and b) river floods. The 1st category includes practices that aim to reduce farms contribution to flash floods. Therefore, several practices from the pool identified in the previous section were proposed that can contribute (directly or indirectly) in runoff potential reduction (no weed control, no soil tillage, physical reduction of

surface runoff), while some other practices were also included (conservation buffers, avoidance of vehicle movements and wheel ruts on wet soil, avoidance to the best possible degree, of heavy machinery use within the farm). Concerning river flood management several measures and practices were proposed that can be implemented both by F.OR's Management and F.OR's Members categorized as actions and measures applied before flood, during flood and after flood.

In a similar manner, the droughts action plan was developed, which comprises of two main sections:

- a) the drought risk assessment section, in which the potential of drought occurrence is assessed and
- b) the drought risk management section, in which specific actions are proposed in order to enforce the drought preparedness level of the F.OR.

According to the Water Resources Management Plan of Crete Water District the development of a strategic plan for the mitigation of water scarcity and droughts has been included in the list of measures that will be implemented (measure code: GR13SM02-01). Since this strategic plan is not existing, information about **drought risk assessment** were retrieved from alternative scientific sources. It is crucial to mention that summer period is normally dry for Crete according to the average climate conditions and therefore it cannot be considered as drought incident. Therefore, summer droughts cannot be considered of high risk for the agricultural production in Platanias, since they constitute representative climate conditions during a critical time span of cultivation period. Prolonged droughts, on the other hand, is the major risk for agricultural production in Platanias area, since water resources availability is decreasing. The results of drought indices application from several studies indicated that prolonged droughts frequency should be of major concern for K.E.DH.P. and therefore drought management actions have to be proposed. With regard to **drought management**, the application of several GAPs selected from the pool presented above are proposed to be implemented, preventive and as operational actions, since the majority of them aim to water saving and therefore they can significantly contribute to droughts management.

4.4. Measures of River Basin Management Plan of Crete Water District (GR13) relative to agriculture

The Programme of Measures consists part of the River Basin Management Plan of Crete Water District (GR13) (Special Secretariat for Water, 2015) and the "mechanism" for the achievement of the environmental goals that are mentioned in the plan.

The Programme of Measures is updated every six years, while any new or revised measure established under an updated programme shall be made operational within three years of their establishment.

According to the project's research team discretion (as none relevant categorization is applied in the River Basin Management Plan of Crete Water District) the measures that are related to the agricultural sector are presented as follows:

Basic Measures

- **Measures for the promotion of efficient and sustainable water use**

a) Establishment of strategic plan to deal with drought and water scarcity phenomena - GR13OM02-01: Development of a strategic plan to address extreme

drought and water scarcity phenomena for Crete Water District which will include mainly preventive measures (drought contingency planning), based on a combination of alternative solutions and measures to address the effects of water scarcity and drought.

b) Promotion of projects' planning and implementation related with maintenance and restoration of proper function of existing irrigation water pipelines - GR13OM02-03: Identification and registration of parts of irrigation water pipelines, which over time have suffered from significant damages. Determination of priorities and preparation of replacement capacity study of existing open and tertiary irrigation pipes with pipes under pressure.

c) Determination of specifications and establishment of incentives for the sustainable management of rainwater - GR13OM02-05: The measure include the preparation of a manual with specifications in reference to rainwater collection and reuse, as well as the establishment of incentives for the construction of tanks for the collection of rainwater in greenhouse crops, livestock and tourist facilities, especially in areas with increased water demand or high altitudes.

d) Reduction of water abstraction for irrigation through the improvement of irrigation techniques - GR13OM02-10: Promotion of measures and incentives for the improvement irrigation techniques with water saving systems. Publication of relevant guidelines.

e) Encouragement of cultivation of traditional non-water consuming crops - GR130OM02-11: It is proposed the funding of specific programmes for the restructure of existing crops with new crops that are characterized as non-water consuming (eg. rainfed olive varieties, arid vegetable varieties etc.)

f) Encouragement and strengthening of the expansion of localized irrigation methods (drip irrigation) in cultivations in which such irrigation methods can be applied - GR13OM02-12: Expansion of drip irrigation in all irrigated tree crops and increase of the percentage of such systems on other crops (strawberry, asparagus, tree crops, etc.).

- **Measures for the protection of water intended for potable water**

Prohibited activities in the protection zones where potable water abstraction works from groundwater aquifers are existed - GR13OM03-02: In these zones the installation and operation of new activities of high pollution is prohibited. The relevant activities are mentioned in the first category of Article 3 of N. 1650/1986 (OJ A'160), such as intensive agricultural crops with use of pesticides – agrochemicals, livestock facilities and general any similar activity which can be potential source of pollution for groundwater equal or greater than the above mentioned.

- **Measures for the control of exploitation of surface and groundwater**

a) Rationalization of limits (minimum/maximum) of the necessary quantities of irrigation water in accordance with the climate conditions of Crete, the type of crop and the agricultural applied methods - GR13OM04-02: According to the JMC F16/6631/1989 the minimum and maximum limits of the necessary quantities of irrigation water for the sustainable use of water resources in irrigation per type of crop and Water District have been determined. These limits have been estimated per month for the period April-September and they are applied cumulative.

b) Record of water quantities from the abstraction points of surface water or/and groundwater for drinking, irrigation from organized networks (TOEB, GOEB), Municipalities, DEYA, other water services and large consumers - GR13OM04-04: This measure includes the establishment of recording systems (water meters, lever meters,

etc.) at water abstraction points for drinking, irrigation and industrial use for the cover of needs of collective networks and the needs for irrigation and industry.

- **Measures for priority and other substances**

Register of pollution sources (emissions, discharges, losses) - GR13OM10-01: The Water Directorates of the Regions establish a list that includes maps, emissions, discharges and losses of all priority substances and pollutants listed in part A, Annex I of this Decision and their concentrations in sediment and biota, for each river basin or part of that area situated within their administrative boundaries. The register records the potential sources of pollution and it is the basis for the elaboration of those substances reduction action plan. Also, it should be investigated whether the increased concentrations of certain substances are due to anthropogenic causes or natural processes.

Supplementary Measures

- **Administrative measures**

Enforcement of necessary measures in order to tackle water scarcity problems or other emergencies - GR13SM02-01: The General Secretary of Decentralized Administration of Crete may adopt a decision in order to implement short-term measures in areas with intense problem in order to maintain the water "status" and to cover the water needs.

- **Measures for Good agricultural practices**

Implementation of Codes of Good Agricultural Practices for the purpose of water economy, water protection and reduction of pollution caused by nitrates - GR13SM06-01: Information and awareness of farmers in reference to proper irrigation and fertilization practices of different cultivations and promotion of other farming techniques that could reduce the water pollution from agricultural sources. Development of software/applications for easy identification of irrigation and fertigation doses per crop type and growth stage.

- **Measures for research, development and demonstration projects (best practices)**

Establishment and organization of pilot farms - GR13SM14-03 : Integration of pilot farms into scientific and technical assistance programmes in reference to the organization and management of the farms, utilizing the latest technologies and techniques, applying exemplary various measures of Codes of Good Agricultural Practices (KOGP) and Cross Compliance, utilizing any funding program etc. in order to encourage also other farmers in the adoption and implementation of the same procedures and methods.

- **Educational measures**

Organization of information days, for new technologies, modern farming techniques, environmental protection, fertility of agricultural soils, etc. - GR13SM15-01: The proposed measure aims to increase the awareness of farmers and to encourage the adoption of best practices which will improve the productivity and efficiency of their cultivations, highlighting simultaneously the need for the protection of the agricultural environment and the maintain of the efficiency of agricultural land and the sustainable use of natural resources.

- **Measures for negotiated environmental agreements**

Agreements between public – agricultural sector - GR13SM16-02: Promotion of voluntary agreements between the public and the agricultural sector in reference to

the monitoring of water use and pollution. These programmes try to persuade farmers (through education) for the advantages of good water management.

4.5. Water Management Adaptation Strategy for K.E.DH.P.

Taking into account the above mentioned Good Agricultural Practices, Governance actions and Flood and Drought action plan proposed in the frame of LIFE AGROCLIMAWATER as well as some of the relative to agriculture measures of the River Basin Management Plan of Crete Water District (GR13) presented above, considering the ability Farmers' Organization to contribute to their implementation.
The water management adaptation strategy (WMAS) for K.E.DH.P. was developed in the context of the project LIFE AgroClimaWater.
The WMAS is structured in priority axes, measures and sub-measures which should be implemented by K.E.DH.P. and its farmers in order to enhance the sustainable management of water resources and to cope with the impacts of the prominent climate change.
In the following section the text of the WMAS for K.E.DH.P. is presented. The true copy of WMAS as it was signed by the board of directors of Platanias Municipality Development Enterprise is presented in APPENDIX I.

WATER MANAGEMENT STRATEGY AIMING TO THE ADAPTATION OF AGRICULTURE TO CLIMATE CHANGE – PLATANIAS MUNICIPALITY DEVELOPMENT ENTERPRISE "K.E.DH.P."	
GENERAL DESCRIPTION	The proposed water management strategy focuses on the efficient management of water resources available to agriculture, in view of the potentially new climatic conditions resulting from climate change. The present draft proposal was developed in the context of the project LIFE AgroClimaWater for the partner PLATANIAS MUNICIPALITY DEVELOPMENT ENTERPRISE (K.E.DH.P.), after assessment of the current status of its organization structure, the condition of the water bodies in its pilot area for the project, as well as the prevailing farming practices for the crop in the pilot area (citrus and stone fruits).
VISION	To manage agricultural water in such a way as to ensure the protection of water bodies and the related ecosystems, the agricultural production and the balanced development in the pilot area.
STRATEGY OBJECTIVES	The proposed strategy will be addressed through the implementation of three cross cutting priority targets (axes), as follows: **Target 1**: The optimization of structure and function of farmers' organization in relation to water management in agriculture. **Target 2**: The introduction of water-related Good Agricultural Practices for the crops in the pilot area and specifically citrus and stone fruits.

Target 3: The contribution of agriculture for the implementation of the River Management Plan of Crete (GR13).

CONTENT

In order to achieve the targets above, the proposed strategy focuses on measures to ensure compliance to the EU and national legislation for water, the identification and management of interactions of water with other resources used in agriculture, the development of adaptive capacity of farmers to climate change through training and awareness raising, encouragement of participation of K.E.DH.P. in the decision-making processes for the Platanias – Voukolies river basins. Lastly, it proposes measures to ensure readiness for addressing environmental incidences caused by accidents or extreme weather.

In addition, it proposes the implementation of actions/measures related to the minimization of water use, through the rationalization of irrigation, the reduction of water losses due to runoff, to percolation, to evaporation from soil and to transpiration by plants and by enhancement of water retention by soil. Also, it relates to the Good Agricultural Practice with regard to the use of agrochemicals (Fertilizers, Plant Protection Products, etc.).

Finally, one more area of measures in the focus of the present strategy proposal is related to the contribution of the Farmer Organization to local authorities' efforts to implement the River Management Plan in the basin under question, as well as to the Management Plan for Floods and Droughts.

PRIORITY AXES

The proposed strategy is based on three Priority Axes (P.A.), 11 measures and 47 sub-measures, which are necessary for its implementation. K.E.DH.P., with the assistance of the LIFE AGROCLIMAWATER partners will implement this strategy for a three-year period. The measures that refer to Farmers' Organization management and administration should be implemented by Farmers' Organization management (P.A. 1), whilst the ones referring to the farming practices (P.A.2) will be implemented and recorded by the farmers – owners of the ten pilot farms of the project. Finally, as regards the P.A. 3, K.E.DH.P. should take into account the proposed, relevant to agriculture, measures in the River Management Plan and in the Flood and Drought Plan of Crete, in order to contribute, to the extent possible, to their implementation.

PRIORITY AXIS 1: ORGANIZATION AND MANAGEMENT FOR WATER USE IN AGRICULTURE

The objective of this axis is to achieve and maintain effective and transparent management of water resources through the implementation of suitable management and administrative

tools in a Farmers' Organization level.

MEASURE 1.1: COMPLIANCE WITH WATER LEGISLATION

This measure focuses on the implementation of the appropriate procedures to ensure compliance with EU and national legislation for water management in the agricultural sector.

Sub-measure 1.1.1: "Assignment to a specific section or a person within the Farmers' Organization of the responsibility for the compliance to legislation as regards to water management"

Sub-measure 1.1.2: "Development, implementation and monitoring of processes to ensure compliance with the current legislation as regards to water abstraction and distribution, including issuance of the respective licenses"

MEASURE 1.2: RECORDING AND MONITORING OF THE USE OF WATER AND OTHER RESOURCES

This measure aims to improve the relation between usage of water and other resources in agriculture.

Sub-measure 1.2.1: "Measurement, recording and reporting of water usage and of its losses"

Sub-measure 1.2.2: "Recording, evaluation and optimization of the quantitative relationship between water and other resources used by agriculture, e.g. energy, fuels, fertilizers, Plant Protection Products, etc.)"

MEASURE 1.3: SUSTAINABLE WATER MANAGEMENT

This measure aims to abate the excessive consumption of the available water resources, through their rational management and the identification of alternative water resources that could be used.

Sub-measure 1.3.1 "Implementation and monitoring of the present strategy for the effective use and water saving in agriculture"

Sub-measure 1.3.2: "Introduction and implementation of novel measures and target-setting for the improvement of Farmers' Organization and river basin management"

MEASURE 1.4: TRANSPARENCE OF COST ISSUES IN THE WATER MANAGEMENT

This measure focuses on the recording, evaluation and dissemination of data and targets with regard to the investments on water management.

Sub-measure 1.4.1: "Recording and dissemination of the investments made for the maintenance and improvement of water management"

Sub-measure 1.4.2: "Evaluation of current and planned

investments for the implementation of water management strategy"

MEASURE 1.5: DISSEMINATION OF INFORMATION AND PUBLIC AWARENESS RAISING ON WATER MANAGEMENT IN AGRICULTURE

The accurate and timely provision of information to the consumers and the interested stakeholders is a significant prerequisite for the sustainable use of water resources. So, this is the aim of the present measure.

Sub-measure 1.5.1: "Planning and implementation of training actions for farmers, with regard to the water management strategy and the measures adopted by the Farmers' Organization"

Sub-measure 1.5.2: "Provision of information and consultancy on the requirements for water, for nutrients and for plant protection, according to the crop, the growth stage, taking into account the development of technology"

Sub-measure 1.5.3: "Awareness raising and training of farming community for the Good Agricultural Practices for water management at a farm and at the area level"

Sub-measure 1.5.4: "Provision of information and training of farmers for the mitigation of extreme weather events (e.g. prolonged drought) and water related accidents during the implementation of agricultural practices"

Sub-measure 1.5.5: "Participation of both Farmers' Organization and its farmers-members to the initiatives of local and regional authorities on the management and the protection of water resources"

MEASURE1.6: CERTIFIED WATER USE IN AGRICULTURE

This measure aims to prepare Farmers' Organization to implement a water management plan according to the requirements of the EWS standard, as this has been described in the LIFE AgroClimaWater project. The utmost goal is to contribute to the EU target for sustainability of water resources use through the evaluation, the control and dissemination of appropriate practices. K.E.DH.P. will be supported in this by the other partners of the project.

Sub-measure 1.6.1: "Development by K.E.DH.P. of a water management system according to the EWS Standard"

Sub-measure 1.6.2: "Pilot implementation and monitoring of the systems' procedures during the life time of the LIFE project"

Sub-measure 1.6.3: "Revision of the procedures at the end of the LIFE project"

Sub-measure 1.6.4: "Evaluation of the preparedness of applying for certification to the competent certification body"

PRIORITY AXIS 2: IMPLEMENTATION OF GOOD AGRICULTURAL PRACTICES

The objective of this priority is the effective usage of water and to design the appropriate use of agrochemicals on crops, so as to improve, or at least maintain the current status of water resources and protected areas in the Voukolies and Maleme sub-basins. These specific measures will be implemented on the 10 pilot farms of the LIFE project, while all other farmers will be informed, so that they will be triggered to implement them on a wider area.

MEASURE 2.1: GOOD AGRICULTURAL PRACTICE FOR THE USE OF AGROCHEMICALS

Using fertilizers and Plant Protection Products (PPPs) is necessary for crop growth and health, but has to be adjusted to the soil properties and to the available technology and equipment, so as to avoid excessive use and the possibility to contaminate the water bodies.

Sub-measure 2.1.1: "Secure good growth conditions by balanced fertilization of the crops in the pilot farms"

Sub-measure 2.1.2: "Justified and well planned usage of fertilizers and PPPs, according to soil and weather conditions and crop needs"

Sub-measure 2.1.3: "Assessment of nitrogen and phosphorus balance by crop at field level, as a measure to avoid environmental impacts"

Sub-measure 2.1.4: "Adoption of specific measures for the transport, storage and packaging disposal of agrochemicals to deter leakage risks"

Sub-measure 2.1.5: "Careful maintenance of fertilization and PPPs application equipment to also deter leakage risks"

MEASURE 2.2: EFFICIENT PLANNING AND IMPLEMENTATION OF IRRIGATION

Farmers should take all necessary measures for the protection of the water bodies, -as a minimum contribution- for the maintenance of the ecological balance and the protection of the local society. Materialization of the present measure and of its sub-measures focuses on the proper irrigation planning with the objective to achieve the sustainable use of the available water resources and the minimization of losses by the farming activities.

Sub-measure 2.2.1: "Establishment of a system to measure, record and report the volume of irrigation water used and lost in the agricultural sector"

Sub-measure 2.2.2: "Determination of water need according to the growth stage of the crops and adjustment of water use to these needs when drafting the irrigation

schedule"

Sub-measure 2.2.3: "Recording and monitoring of soil conditions and saturation status of soil-water for the determination of water availability and crop water needs"

Sub-measure 2.2.4: "Implementation of effective irrigation, by selection of the most appropriate method and timeliness of irrigation equipment"

Sub-measure 2.2.5: "Implementation of suitable measures, in order to reduce losses from the water distribution network and the irrigation equipment"

MEASURE 2.3: OTHER GOOD AGRICULTURAL PRACTICES FOR WATER MANAGEMENT

In the frame of Good Agricultural Practices, all the farming practices are included in relation to soil and crop management, with ultimate target the optimization of evapotranspiration, runoff and percolation, but also the stabilization of soil.

Sub-measure 2.3.1: "Implementation of appropriate farming practices for soil cover for reduction of losses due to evaporation"

Sub-measure 2.3.2: "Implementation of best practices for weed mowing and crop pruning, in order to minimize losses due to evapotranspiration"

Sub-measure 2.3.3: "Implementation of farming practices to increase water retention by soil and minimization of deep percolation"

Sub-measure 2.3.4: "Establishment of effective techniques and practices for containment of runoff and development of suitable structures for retardation of water movement and to increase soil moisture"

Sub-measure 2.3.5: "Use of annual cover crops, in order to stabilize soil and its structure as well as to increase its filtration capacity"

Sub-measure 2.3.6: "Evaluation and assessment of leaching potential, erosion and filtration potential at a farm or area level"

PRIORITY AXIS 3: CONTRIBUTION TO THE IMPLEMENTATION OF THE RIVER MANAGEMENT PLANS IN THE BASIN

The objective of this priority axis is the contribution of the Farmers' Organization for the implementation of basic and supplementary measures contained in the River Management Plan and the Floods and Droughts Plan for the farming sector.

MEASURE 3.1: IMPLEMENTATION OF THE RIVER MANAGEMENT PLAN OF CRETE

In the frame of the River Management Plan of Crete (GR13) a number of basic and supplementary measures are proposed for farming. The contribution of Farmers' Organizations and their farmers-members is very important for their implementation.

Sub-measure 3.1.1: "Reduction of water abstraction for irrigation through the improvement of irrigation techniques- GR13OM02-10"

Sub-measure 3.1.2: "Encouragement of cultivation of traditional non-water consuming crops - GR13OM02-11"

Sub-measure 3.1.3: "Encouragement and strengthening of the expansion of localized irrigation methods (drip irrigation) in cultivations in which such irrigation methods can be applied - GR13OM02-12"

Sub-measure 3.1.4: "Activities that are prohibited in the protection zones where potable water abstraction works from groundwater aquifers are existed - GR13OM03-02"

Sub-measure 3.1.5: "Rationalization of limits (minimum/maximum) of the necessary quantities of irrigation water in accordance with the climate conditions of Crete, the type of crop and the agricultural applied methods - GR13OM04-02"

Sub-measure 3.1.6: "Record of water quantities from the abstraction points of surface water or/and groundwater for drinking, irrigation from organized networks (TOEB, GOEB), Municipalities, DEYA, other water services and large consumers - GR13OM04-04"

Sub-measure 3.1.7: "Register of pollution sources (emissions, discharges, losses) - GR13OM10-01"

Sub-measure 3.1.8: "Enforcement of necessary measures in order to tackle water scarcity problems or other emergencies - GR13SM02-01"

Sub-measure 3.1.9: "Implementation of Codes of Good Agricultural Practices for the purpose of water economy, water protection and reduction of pollution caused by nitrates - GR13SM06-01"

Sub-measure 3.1.10: "Establishment and organization of pilot farms - GR13SM14-03"

Sub-measure 3.1.11: "Agreements between public – agricultural sector - GR13SM16-02"

MEASURE 3.2: ADDRESSING EXTREME CLIMATIC CONDITIONS

Through this measure, Farmers' Organization has to adopt and contribute to the implementation of measures that will be included in the forthcoming Floods and Droughts Plans for Crete, so as to ensure their preparedness regarding the possible future extreme climatic conditions. In addition, practices that mitigate the impacts of such conditions should

be implemented at a farm level.

Sub-measure 3.2.1: "Implementation of any measures that will be provided in the forthcoming Floods and Droughts plans for the agricultural sector"

Sub-measure 3.2.2: "Implementation of Good Agricultural Practices proposed in Priority axis 2, so as to assist for the mitigation of extreme weather impacts, e.g. reduction of runoff and evapotranspiration, increase of soil moisture"

Sub-measure 3.2.3: "Training of farmers for measures and practices for crop protection from extreme weather"

PART B - WATER MANAGEMENT ADAPTATION STRATEGY OF MIRABELLO

1. INTRODUCTION

This part presents the WMAS for Agricultural Cooperative Partnership Mirabello Union S.A. The Agricultural Cooperative Partnership Mirabello Union S.A. (EAS Mirabello) is based in the Municipality of Ag. Nikolaos and it is the second agricultural cooperative Farmers' organization of the former province of Mirabello. It was founded in 1937, it is consisted of 24 members (Agricultural Cooperatives of Mirabello province), it represents 7.250 producers and it is active in supporting and marketing of local agricultural products and its members.

The main scope of EAS Mirabello is to provide agricultural supplies and related products for the support of agricultural production (agriculture - livestock) of Mirabello and to gather and market the excellent virgin olive oil of the area.

Also, among the main objectives of EAS Mirabello are the following:

- The gathering, treatment and marketing of agricultural products (by-products sub-products), livestock products, olive oil, vineyards products, wine, citrus and cereals.
- The purchase and marketing of agricultural and professional tools.
- The establishment and operation of laboratories for microbiological, chemical, soil etc. analysis, research and development as well as quality control of products.
- The submission and implementation of European and National research and operational projects.
- The undertaken of projects in order to offer services and distribute in the producers any type of financial assistance provided by the State or the European Union.
- The undertaken of projects with the form of Partnership between Public and Private sectors.
- The establishment of stores for agricultural, forestry, handicraft etc. products.
- The providence of consulting, accounting and tax services to serve the agricultural cooperatives and the members of EAS Mirabello as well as individual farmers.
- The providence of biological sewage services.
- The intervention and adoption of any measures for the protection of agricultural products.
- The establishment and operation of agrotouristic units, the development of ecotourism, social tourism and agrotouristic as well as handicraft works.
- The organization of pilot or experimental farms on agricultural lands and to assist its members in the organization of collective crops or other common farms.
- The organization of experimental stations and the establishment and operation of facilities for this purpose.
- The providence in the members of the EAS Mirabello of any kind of scientific and technical assistance in order to facilitate and improve the production and the reduction of its costs.
- The organization of technical and cooperative education or training of elected officials or employees and executives and employees of members, as well as farmers in order to improve the production process and the environmental protection.
- The guarantee of the quality of its products or the products of its members with a special mark.
- The organization of conferences that are related with the agricultural products and the participation in similar conferences abroad.

- The cooperation with Universities and Technical Education Institutes with the aim of research and development of agricultural sector.
- The cooperation with local authorities for the promotion of issues related with the agricultural sector.

2. DESCRIPTION OF CURRENT STATUS

2.1. Pilot area of Havgas - Milatos sub-basin

In the frame of project LIFE AgroClimaWater and within the administrative borders of Municipality of Agios Nikolaos, Havgas – Milatos sub-basin catchment area was selected for the implementation of the project after a two stage evaluation process applied in the frame of project's Action A.1. In particular the Municipality of Agios Nikolaos includes seven river basins, from which the area of Havgas – Milatos sub-basins, covering a total area of about 29 sq.km, was selected for the formulation and implementation of a water management adaptation to climate change strategy by Mirabello.

2.2. Water consumption and water sources utilized for abstraction

The water consumed by all the water uses within the catchment area of the pilot sub-basin of Havgas - Milatos is presented in Table 1, as it was estimated in the deliverable C2 "Identification and assessment of water efficiency in the three F.ORs before LIFE AgroClimaWater". The total volume of water consumed per year is 414.047 m^3. This quantity is allocated to potable (65.85%) and irrigation use (34.15%).

Table 10: Water consumption in Havgas - Mialatos sub-basin

POTABLE WATER	***Domestic***	***Enterprises***	***Touristic***	***Other uses***	***Sub-total***
Quantity (m^3/year)	159.491	44.985	62.706	5.453	***272.635***
Percentage (%)	58,50	16,50	23,00	2,00	***100,00***
IRRIGATION WATER	***Networks***		***Borehold/Wells***		***Sub-total***
Quantity (m^3/year)	0		141.413		***141.413***
Percentage (%)	0		100		***100***
TOTAL WATER CONSUMPTION	***Potable Water***		***Irrigation Water***		***Total***
Quantity (m^3/year)	272.635		141.413		***414.048***
Percentage (%)	65,85		34,15		***100***

The settlements that are located within the catchment area are presented in Fig. 1 and the sources utilized for abstraction of potable and irrigation water in Fig. 2. Within the catchment area, the potable water is provided by the Municipal Enterprise of Agios Nikolaos (DEYAN). Two boreholes that are utilized by DEYAN and two wells that are utilized by the Municipality of Ag. Nikolaos introduce water into the potable water in order to satisfy water demand for households, enterprises, tourism and other uses. Respectively, the area of Havgas-Milatos sub-basin is not covered neither by TOEB's nor the municipal irrigation network. As a result the irrigation water is abstracted from 10 boreholes, 7 of which are private and 3 are group owned, and 27 wells.

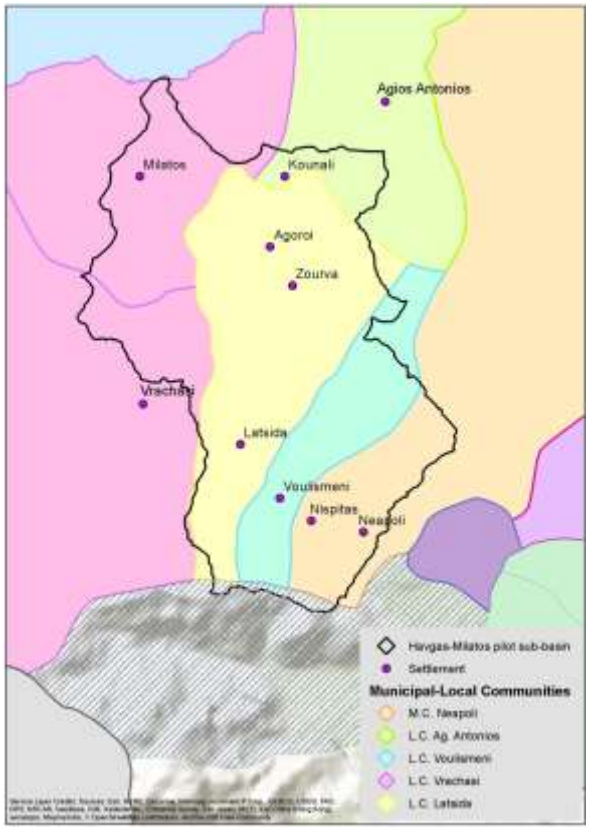
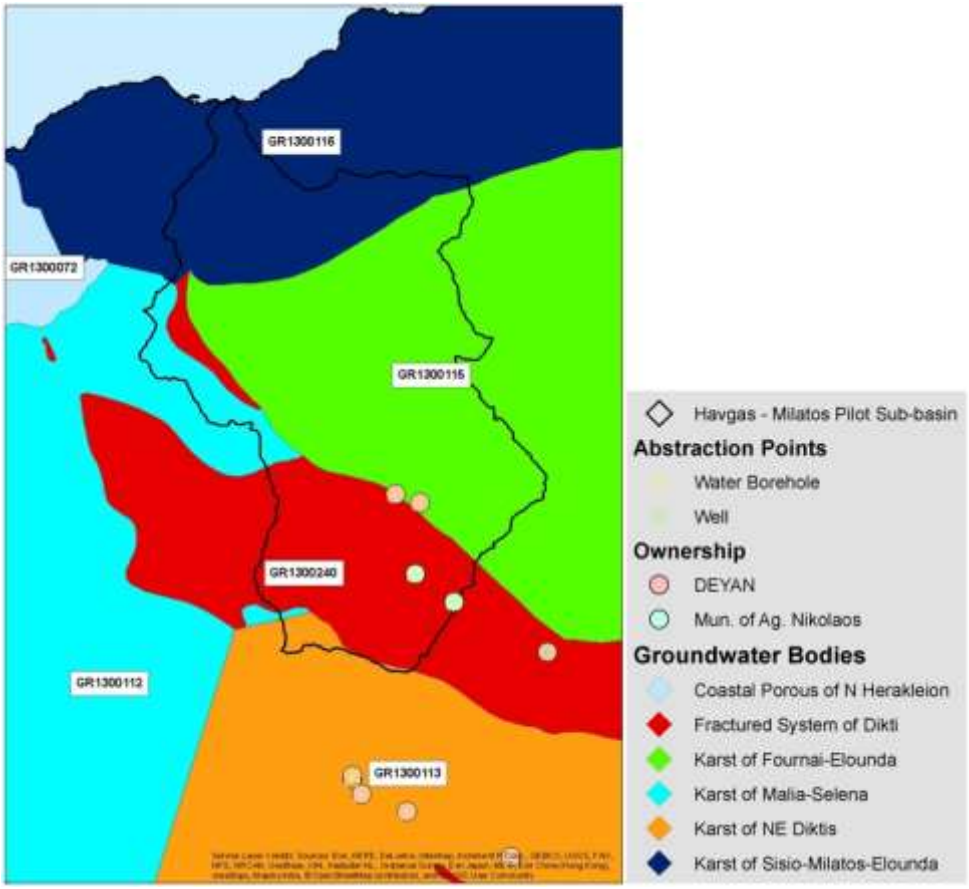


Fig. 6: Geodatabase Map Extract, depicting the settlements of Vrachassi and Neapoli Municipal Units located within the pilot basins



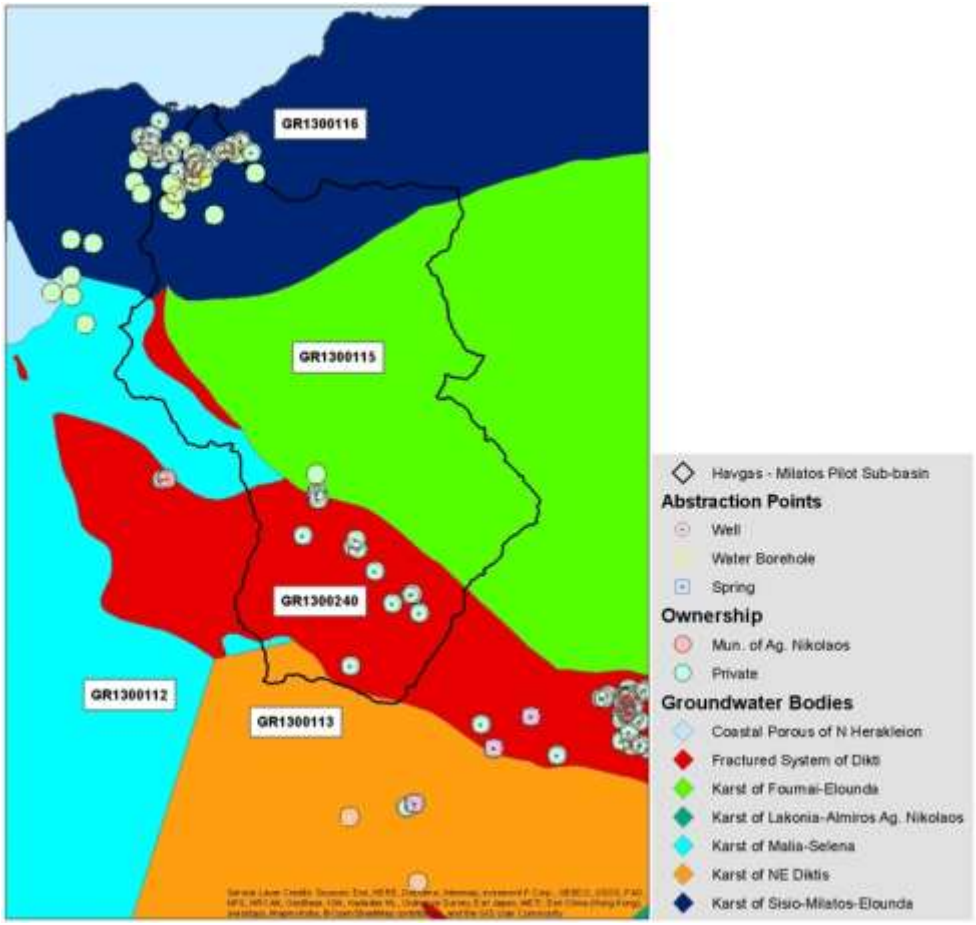


Fig. 7: Geodatabase Map Extract, depicting the abstraction points for potable (1st map) and irrigation (2nd map) use in Havgas - Milatos sub-basin based on the water usage legal permits issued

Regarding the use of irrigation water, data collected by the 1st AWMS form, revealed that 13 olive orchards are irrigated in a total of 101 orchards.

Actual irrigation water requirements are higher in Eastern Crete due to significantly lower precipitation as compared to the North-Western part of the island. A rough estimate, since there is no availability of experimental data, would be 300-330 mm of water, depending on climatic conditions, although there is a legislative limit of 300 mm per year set by the Decentralized Administration of Crete. According to farmers' interviews, the average annual application of irrigation water was 271 mm, but ranging from 60 to 625 mm. Application rates above 600 mm are definitely beyond the actual crop requirements. The application rate per irrigation event is considerably high (115 mm) and definitely beyond the water holding capacity of any type of soil, but the validity of this parameter should be further investigated. At high application rates, it is expected that a significant amount of water is lost to soil layers beyond the root zone of the trees and therefore not utilized by the crop. Based on the above, it seems that there is a significant potential for improving irrigation water use efficiency.

2.3. Use of agrochemicals

101 registered olive orchards that are located within Havgas - Milatos sub-basin participated in LIFE AgroClimaWater project.

From the 101 registered orchards in Mirabello the 10.9% are organic, the 89.1% are conventional and the 39.6% are fertilized. Also, 13% of the total orchards are irrigated, while the rest 87% are rainfed orchards.
A total of 7 PPPs are applied in the 32.67% of the registered olive orchards (or 33 out of 101). From these only 1 PPP (or 14.28%) is consisted of the substances "*Chlorpyrifos-ethyl*" and "*Naphthalene*", which have been characterized as "*priority substances*" according to the European legislation, and 2 other PPPs (or 28.56%) are consisted of "*Dimethoate*" and "*Copper*", which are "*specific pollutants*" according to the Greek National legislation (Table 2). Chlorpyrifos-ethyl and naphthalene are among the main components of RELDAN which is applied only in 3% (or 3 out of 101) of the registered olive orchards. Moreover, dimethoate is one of the components of Rogor L 40 EC, which is used as insecticide in 9.9% (or 10 out of 101) of the registered olive orchards, while copper which is contained in fungicides is used in 13.9% (or 14 out of 101) of the registered olive orchards.

Table 11: PPPs with priority substances and specific pollutants per crop in Mirabello area

	Commercial Name	**Application in olive orchards**
PPPs with chlorpyrifos-ethyl	RELDAN	3
PPPs with naphthalene	RELDAN	3
PPPs with dimethoate	Rogor L 40 EC	10
PPPs with copper	COPPER (Cu containing in fungicides	14

Table 3 represents the classification of the applied PPPs according to H-phrases and their application per crop. None of the PPPs which are used in Mirabello area is considered as either "very toxic to aquatic life" (H400) or "harmful to aquatic life with long lasting effects" (H412) or "may cause long lasting harmful effects to aquatic life" (H413). However, 3 out of 7 of the applied PPPs (or 42.9%), RELDAN, BULLDOCK and COPPER are "very toxic to aquatic life with long lasting effects" (H410) and they are applied in 19.8% (20 out of 101) of the total olive orchards. More specific, RELDAN is used in 3% (or 3 out of 101) of the registered orchards, BULLDOCK in 15.8% (or 16 out of 101) of the registered orchards and COPPER in 13.9% (or 14 out of 101) of the registered orchards. In addition, only 1 out of 7 PPPs (or 14.3%– ROUNDUP) is "toxic to aquatic life with long lasting effects" (H411) and it is used in the 9.9% (or 10 out of 101) of the total orchards.

Table 12: PPPs with H-phrases per crop in Mirabello area

	PPPs with h-phrases	**Orchards where PPPs with h-phrases are used**			**% of orchards in the registered area**
		Crop	**Number**	**%**	
H400	-	-	-	-	-
H410	RELDAN	Olive	3	3.0	19.8
	BULLDOCK		16	15.8	
	COPPER		14	13.9	
H411	ROGOR		10	9.9	9.9
H412	-	**-**	**-**	**-**	-
H413	-	**-**	**-**	**-**	-

As far as the fertilizers is concerned in Mirabello area 12 distinct types of fertilizers are applied (Table 4). The 83% of them (10 out of 12) are inorganic, while the rest of them (17% or 2 out of 12) are composite organic fertilizers. Also, from the total of 12 fertilizers half of them are compound/ multinutrient fertilizers (NP, NK or NPK) and the rest are straight fertilizers (N, P or K). In general the 58% (7 out of 12) of the applied fertilizers are characterized by low concentrations (less or equal to 20%) of primary and secondary nutrients. Borax was the only fertilizer used for the application of a micronutrient in high quantities, due to the importance of B in olive tree nutrition. It is applied in 1 out of 101 (1%) olive orchards and in small typical dosages. As a result the possible environmental risk linked to its use is relatively low.

Table 13: Type and mineral elements (%) of fertilizers used in Mirabello pilot area

Fertilizer	Mineral elements (%)							
	N	P_2O_5	K_2O	CaO	MgO	S/SO_3	Na_2O	B
Organic fertilizer 1	5	5	5					
Organic fertilizer 2	7	0	0					10
Calcium ammonium nitrate	26	0	0	8				
Ammonium sulphate	21	0	0			24		
Ammonium sulphate +B	21	0	0					0.2
Borax						15	16.5	11.5
Fertilizer 11-15-15	11	15	15					
Fertilizer 15-5-12	15	5	12		2			0.2
Fertilizer 40-0-0	40	0	0			14.5		
Fertilizer 20-10-10	20	10	10			9		
Fertilizer 11-0-43	11	0	43					
ENTEC perfect 14-7-17	14	7	17		2	9		0.02

Although the majority of the applied fertilizers are characterized by low nutrient concentrations and as a result with a low environmental risk, the excess fertilization can cause eutrophication of surface water bodies and specifically pollution caused by nitrates and phosphorus. Eutrophication results in the excessive growth of aquatic plant life, depletion of dissolved oxygen, thus suffocating fish and other animal life. The combination of the above and ANNEX VIII of WFD according to which substances which contribute to eutrophication (in particular, nitrates and phosphates) are considered to be Main Pollutants leads to the conclusion that all fertilizers utilized in the three pilot areas (as they contain nitrates and/or phosphorus) are considered as Main Pollutants. In groundwater, nitrates pollution causes the accumulation of high concentration of nitrates in water, compromising the quality of water and resulting in water not suitable for drinking.

The substances that are included in the fertilizers used in Mirabello are in most cases not hazardous for the aquatic environment, when utilized properly. The only exception is the Ammonium Sulphate, as this substance is toxic to aquatic life with long lasting effects (H411), which is applied only in 7.9% (or 8 out of 101) of the registered olive orchards.

2.4. Other agricultural practices applied

From the 101 olive orchards included (Table 5), 11 were organic (10.9%), while 13 were irrigated (12.8%).

Table 14: Indicative data collected through the 1st AWMS form, for 101 olive orchards in the pilot sub-basin of Havgas - Milatos

Parameter	All orchards	Conven-tional	Organic	Irrigated	Rainfed
Number of orchards	101	90	11	13	88
Soil cultivation applied (number of cases)	12	11	1	0	12
Weed mowing (number of cases)	46	39	7	10	36
Use of cover crops (number of cases)	6	5	1	0	6
Grazing (number of cases)	23	19	4	3	20
Pruning applied (number of cases)	74	65	9	10	64
Summer pruning (number of cases)	0	0	0	0	0
Burning of prunings (number of cases)	67	64	3	10	57
Shredding of prunings (number of cases)	2	1	1	0	2
Application of organic material from external sources (number of cases)	3	3	0	1	2

Soil cultivation was applied once per year or every 2 to 3 years to 12 orchards (11.9%). Apart from the fact that soil cultivation may have a negative impact on soil erosion and soil fertility, the periodical application may destroy the active part of the root system increasing tree water stress. Weed mowing was applied once per year in 46 orchards (45.5%), while the use of cover crops during winter was only applied in 6 orchards (5.9%). A positive fact is that chemical control of weeds was limited to 2 orchards (2%), while grazing by livestock was applied in a significant percentage of orchards (22.7%), in contrast with the typical situation in Western Crete.

A significant differentiation, as compared to Platanias area, is that pruning is only applied to 73.3% of the orchards, while in 39.6% of them pruning is applied periodically and not on an annual basis. In all cases, no summer pruning was applied in the area. Estimate of mean weight of pruning was at 2.83 tn/ha, which in the majority of the cases (67 out of 74 orchards, or more than 90%) was burned in the field. Shredding of pruned wood was reported in only 2 orchards (2%). Therefore, a potential source of organic material that could be used for mulching and increasing of soil organic matter is wasted in the vast majority of the orchards. Considering the application of organic material from external sources, this is also quite low, with manure applied in only 3 orchards. It is worth mentioning that manure was not applied in organic olive orchards.

2.5. The governance strategy of Mirabello

Effective F.ORs governance in relation to water management constitutes one of the major factors that has to be taken into account for the development of the water resources management strategy of each F.OR. This is also underlined by EWS Standard, according to which one out of the four principles is dedicated to water governance and aims at achieving equitable and transparent management of water resources. The current status of Mirabello's governance strategy was investigated and its readiness to take adaptive actions was assessed in the context of Action C2 by evaluating the responses in the 3rd form of the Agricultural Water Management System.

The overall readiness of Mirabello in relation to water governance directions indicated by the 4th principle of EWS was identified as low. More specifically, the main findings of the assessment are summarized below:

- The F.OR. of Mirabello has not established the appropriate procedures and documentation in order to ensure compliance with the legal requirements related to water management. Moreover there is no responsible person or department for the above.
- Mirabello has established relevant recording procedures in the context of the application of an Environmental Management System. These recordings are including water, energy and other inputs and they can be used in order to improve the water, energy and other inputs efficiency.
- The water efficiency increasing potential is considered as low, since water losses during irrigation are not estimated and there are no increasing water efficiency actions documented and implemented.
- There are no water related dissemination activities, either internal or external, implemented and also there are no actions documented and implemented related to the management of incidents. Therefore, the current degree of transparency on water management for Mirabello is considered as low.
- Mirabello is currently implementing some Best Management Practices (BMPs), mainly within the context of the already established Environmental Management Systems. Since the implementation performance of Good Agricultural Practices is not evaluated, the current potential of the F.OR. of Mirabello in order to ensure continuous improvement in water management is considered as medium.
- With regard to the economic transparency of water management the current readiness status is considered as low since the investments made for maintenance and improvement of the water management are not reported, while an environmental cost analysis has not been compiled yet.
- Currently, there is no water management strategy established, implemented and monitored.

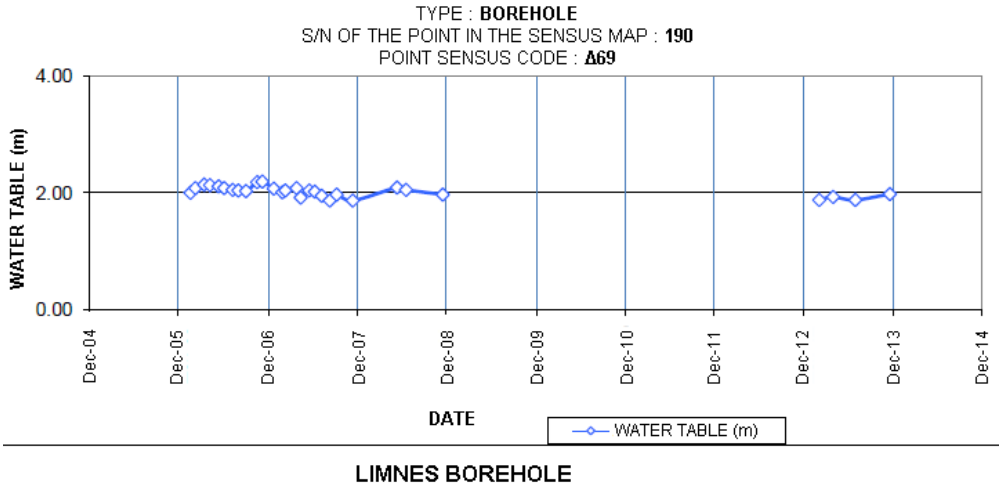
3. RESULTS OF IMPACT ASSESSMENT

3.1. Impacts on water quantity

As shown in Fig. 2, most abstraction points are located at the northern part of the Havgas-Milatos sub-basin, Northern of Milatos settlement and abstract water from the karstic aquifer of Sissio–Milatos-Elounda (GR1300116). In addition, water is also abstracted from the fractured system of Dikti (GR1300240) and in a less degree from the Karstic system of Fournai-Elounda (GR1300115).

According to the study on "The water status of groundwater bodies of Crete" (M. Kritsotakis, S. Pavlidou, 2013) as well as to the River Basin Management Plan of Crete (Special Secretariat for Water, 2015) the quantitative status of the particular water bodies is good. However, more information on the particular bodies has as follows:

- The fractured aquifer of Dikti (GR1300240) that has a low water capacity is locally overexploited thus prohibitive measures on a) the drilling of new boreholes, b) the abstraction and transfer of water quantities higher than the limits defined in the existing water permits and c) the alteration of the current situation of the existing water abstraction infrastructures (dredging, increasing the amount of water, etc. have been set by the water directorate of Decentralize Administration of Crete.
- The karstic aquifer of Sissio-Milatos-Elounda (GR1300116) presents high values of salinity due to the development of the karst in a negative altitude and its vicinity to the sea. In addition, the high values of electrical conductivity are also increased during summer.
- The karstic system of Fournai-Elounda (GR1300115) has a low water capacity/availability. The system is monitored by two stations (boreholes). In Fig. 8 the variation of water table as well of electrical conductivity are shown. The variation of water table is low in general but the increasing conductivity (possible salinization) during summer reveals that the source is locally over-exploited during summer.



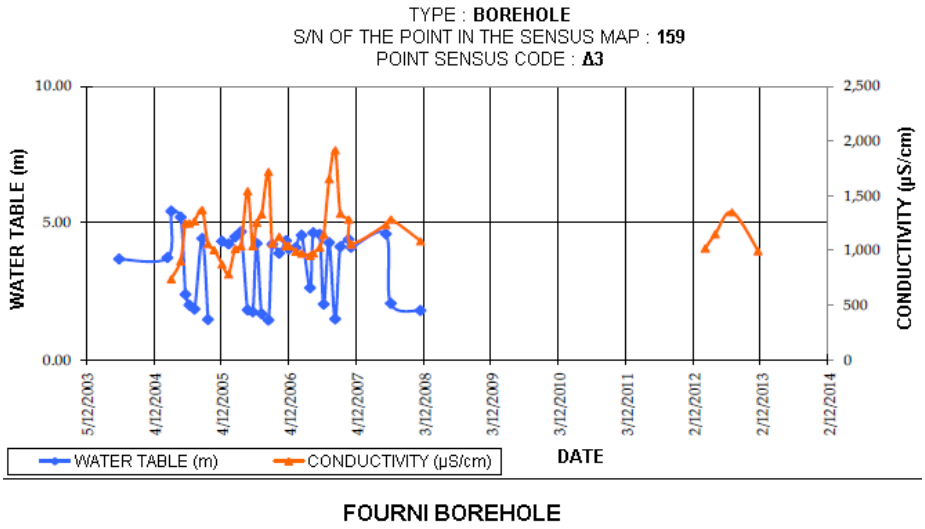


Fig. 8: Water table and conductivity variations in Karstic system of Fournai-Elounta (GR1300115) (source: "The water status of groundwater bodies of Crete" M. Kritsotakis, S. Pavlidou, 2013)

In addition, according to the River Basin Management Plan of Water District of Crete (Special Secretariat for Water, 2015), the quantitative water status of the groundwater water systems is assessed as good as presented in Fig. 8 with no increasing trend for further deterioration.

Table 15: Groundwater bodies in Havgas - Milatos sub-basin

Code	Name	Aquifer Type	Anthropogenic Pressures / Impacts	Natural Pressures / impacts	Quanti -tative Status	Comments	Increasing trend of pollutant
GR130 0116	Coastal karst of Sisi-Milatos-Elounda	karstic	No	Excess chloride values attributed to natural salinization (vicinity of the karst aquifer to the sea)	Good	Increased background values due to layers of gypsum	No
GR130 0115	Karst of Fourni - Elounda	karstic	Marginal local over-exploitation	-	Good	Local over - exploitation of low water capacity aquifers	No
GR130 0240	Fractured of Dikti	fractured	Local over-exploitation	-	Good	-	No

Based on the previous information on water status of groundwater bodies that has been characterized as good, no significant environmental and/ or socioeconomic impacts have been identified on them by anthropogenic pressures, including agriculture. However, local over exploitation is mentioned on two out of three of them (GR1300240, GR1300115).

According to the same study as above (M. Kritsotakis, S. Pavlidou, 2013), from the monitoring results of the water table of the Karstic system of Fournai - Elounda (GR1300115) for the period 2005 – 2014 (Fig. 8) derives that it is varied during the year but the annual water balance of the source is assumed stable. In addition, the water stress period is presented during the summer, resulting in an increase of salinization.

Considering the water consumed by all the water uses within the catchment area of the pilot sub-basin of Havgas – Milatos that is presented in Table 1, the total volume of water consumed per year is 414.047 m^3, out of which the 34,15% is used for irrigation and the rest for other uses. Thus, agriculture will have more potential impacts on water quantity only during the summer periods when the water needs are higher in comparison with the amounts that are required during the rest periods of the year and only on the fractured system of Dikti (GR1300240) and the Karstic system of Fournai-Elounda (GR1300115) that have been identified that are overexploited. Considering that the majority of abstraction points are located in the coastal karst of Sisi-Milatos-Elounda (Fig. 2), the degree of impacts from agriculture on GR1300240 and GR1300115 is not expected to be significant as only a small number of the abstraction points that are within Havgas – Milatos sub-basin are abstracted water from these groundwater bodies.

3.2. Impacts on water quality and affected destinations

The Havgas - Milatos sub-basin could be divided into 6 sub-basins based on the six surface water bodies that have been recognised in the area.

According to the risk assessment analysis, which is presented in the sub-deliverable C2.2 "Runoff, leaching and erosion risk assessment", 4 out of 6 sub-basins (HM-2, HM-3, HM-5 & HM-6), are characterized by high runoff risk potential and 2 (HM-1 & HM-3) by moderate potential. In addition, the registered orchards that are fertilized and in which PPPs are used and simultaneously are located in areas with runoff potential higher than moderate are equal to 38% and 33%, respectively. Also, only the 11% of the registered orchards is both irrigated and located in areas with such runoff potential.

As far as erosion potential is concerned, only 1 out of 6 sub-basins (HM-6), is characterized by high erosion risk potential, 4 sub-basins (HM-2, HM-3, HM-4, HM-5) by moderate and 1 sub-basin (HM-1) by very low erosion potential. In addition, the registered orchards that are fertilized and in which PPPs are used and simultaneously are located in areas with erosion potential higher than the moderate are equal to 27% and 24%, respectively.

The leaching potential is varied from very low to high, however, the average leaching potential for all the pilot area is low. The percentage of the register orchards in which fertilizers and PPPs are used and located in areas with leaching potential higher that moderate is equal to 6.9% and 4.9%, respectively.

In general, the 39.6% (or 40 out of 101) of the registered orchards are fertilized, while in the 32.7% (or 33 out of 101) of the registered orchards PPPs are used. Moreover, in the 23.8% of the registered parcels (or 24 out of 101), PPPs used contain specific pollutants (copper, dimethoate) and in the 3% of the registered parcels (or 3 out of 101), PPPs used contain a priority substance (Chlorpyrifos-ethyl).

In no registered orchard, located in the pilot area, PPPs classified as H400 are used. In 20 out of 101 registered orchards (or 19.8%), PPPs classified as H410 are used. The registered orchards in which such PPPs are applied in each sub-basin are 1 to 3 orchards per sub-basin with the only exception of HM-6 sub-basin in which such PPPs are applied in 14 registered orchards.

The 13 potentially affected destinations that are located within Havgas - Milatos sub-basin are depicted in Table 8 and they are presented in Table 16.

For only 1 out of 13 potentially surface affected destinations within Havgas-Milatos sub-basin it is known that its status is at least good. In particular, this is the HCV area of bathing waters of Milatos beach (GRBW139310032). For the rest surface affected destinations, their status is unknown.

As far as the 5 groundwater bodies is concerned, the qualitative status of all water bodies, Fractured of Dikti (GR1300240), Coastal karst of Sisi-Milatos-Elounda (GR1300116), Karst of Fourni – Elounda (GR1300115), Karst of NE Mount Dikti (GR1300113) and Karst of Malia – Selena (GR1300112) has been identified as good.

Table 16: Potentially affected destinations within Havgas - Milatos sub-basin

Code	Name	Type	Ecological Status	Chemical status	Qualitative Status	Quantitative status	Pressures/ Threats/ Impacts
-	HM-1	Stream	Unknown	Unknown	-	-	Unknown
-	HM-2	Stream			-	-	
-	HM-3	Stream			-	-	
-	HM-4	Stream			-	-	
-	HM-5	Stream			-	-	
-	HM-6	Stream			-	-	
GR1341C0009N	Coast of Malia Gulf	Shallow with sedimentary substratum	Good	Unknown	-	-	-
GRBW139310032	Bathing waters of Milatos Beach	-	-	-	Excellent	-	Wastes and sewage disposal from small private vessels and potential oil leakage
GR4320013	Farangi Selinari-Vrachasi	-	-	-		-	Fire, illegal hunting, use of poisoned baits
GR95341355	Latsidiani Kefala Dimou Neapolis	-	-	-	-	-	-
GR95341544	Anavlocho (Vrachasiou)	-	-	-	-	-	-
GR190	Mount Dikti	-	-	-	-	-	Agricultural intensification/expansion (high), burning of vegetation (high), firewood collection (medium), recreation/tourism (unknown)
GR4320002	Dikti: Oropedio Lasithioy, Katharo, Selena, Krasi, Selekanos, Chalasmeni Koryfi	-	Great variety of habitat types, rich flora in common species and in rare and vulnerable endemic species, rich fauna in endemic and rare	-	-	-	Fragile balance in danger due to overgrazing, fires, tourism activities, soil erosion due to the degradation of stabilizing vegetation caused by overgrazing, possible pollution of underground waters due to the general use of pesticides and of fertilization

			species, vineyards with old varieties of vines, caves with endemic fauna, scientificall y important fossils.				

It should be mentioned that none surface water body (river) has identified in the River Based Management Plan of Crete District (13), as they are streams whose surface flow lasts for almost 3 months and this category of streams is not included in the system which is used by the River Based Management Plan.
However, the project team has recognized 6 surface water bodies as presented in Table 8 whose ecological and chemical status is unknown. The agricultural activities that are applied within the catchment area of Havgas-Milatos covers an area of about 14.21 km^2. Based on the area of each sub-basin which is used for agricultural activities highly intensive activities are identified in HM-6 (8.71 km^2), rather intensive in HM-5 (2.23 km^2), HM-1 (1.23 km^2) and HM-2 (1.21 km^2) and not that intensive in HM-3 (0.32 km^2) and HM-4 (0.5 km^2).

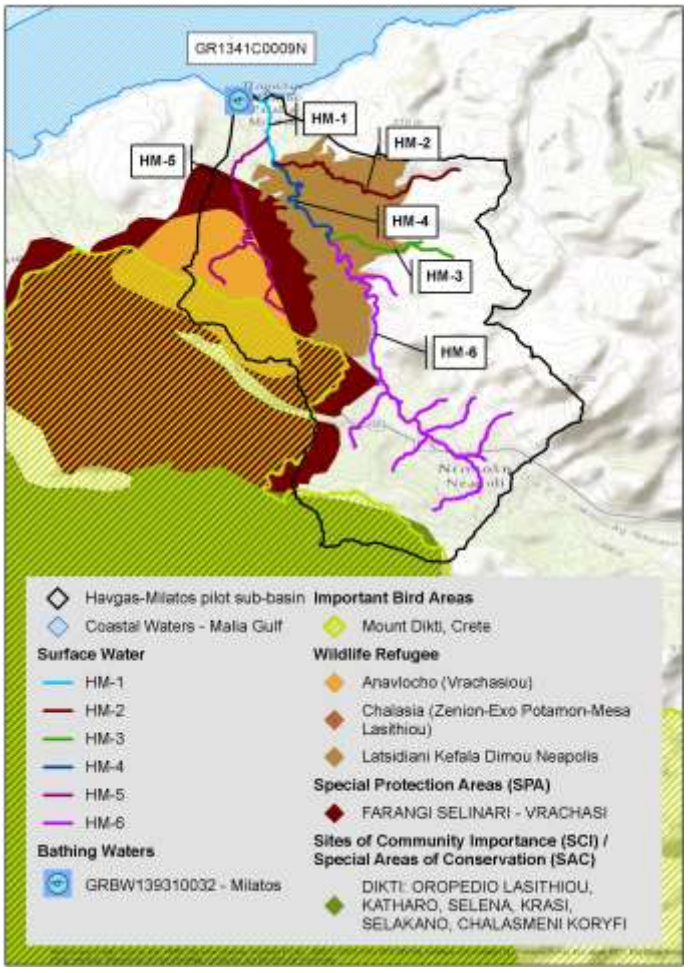


Fig. 9: Potentially affected surface water bodies and HCV areas in Havgas - Milatos sub-basin

Considering also the information that:

- the runoff and erosion risk potential for the entire basin is categorized higher than moderate
- Fertilizers and PPPs are used approximately in the half of the registered farms
- The PPPs that are used in the 19.8% of the registered orchards contain substances that are hazardous for the aquatic environment (H410) and the PPPs that are applied in the 23,8% of the registered orchards contain specific pollutants (Copper, Dimethoate).

It can be assumed that in cases where non good agricultural practices are applied, the agricultural activities can impose impacts on all the surface water bodies due to the runoff and erosion risk potential. But in the case of Havgas-Milatos the impacts will be lower than Voukolies and Havgas sub-basin because the majority of the farms are not irrigated and agrochemical are used only in the half of the registered orchards. Nevertheless, since the chemical status of all water bodies is unknown, there are no data to assess the impact impose to them by anthropogenic activities/pressures and agriculture particularly so far. The identification of their status is a demanding process and should be elaborated by the relevant authorities.

Regarding the impacts of agricultural activities on the HCV areas, they could not be also assessed since they interrelated with surface bodies with unknown ecological and chemical status. The only exception is the bathing water of Milatos as its status is excellent and it can be assumed that the agricultural activities have no impact on it in terms of its quality so far.

In reference to the groundwater bodies, according to the River Based Management Plan of Crete District (GR 13) the qualitative status of the qualitative status of the 5 groundwater bodies, located in the pilot area is good. Considering also the information presented above and in particular that:

- The agricultural activities that are applied are intensive
- The leaching potential is moderate
- The information on the used fertilizers and PPPs

it can be assumed the agricultural activities have no impact on the groundwater bodies in terms of their quality so far. In addition, the area has not designated as a Nitrate Vulnerable Zone (NVZ) for the purposes of the EU Nitrate Directive. However, it can be assumed that in cases where non good agricultural practices are applied, there is a moderate potential to be polluted by substances contained in the agrochemical used.

4. FORMATION OF WATER MANAGEMENT ADAPTATION STRATEGY OF MIRABELLO

The WMAS for Mirabello was formed taking into account the results of deliverable C3.1 "Proposal of farm specific Action Plans (GAPs and monitoring measurement equipment)" and C3.2 "Governance actions and floods and droughts action plan for the participant FORs" as well as the main measures that are relative to the agriculture and are included in the Programme of Measures of the River Basin Management Plan of Water District of Crete-G13 (Special Secretariat for Water, 2015) as they are briefly presented in the following sections.

4.1. Good Agricultural Practices for water efficiency enhancement

The Good Agricultural Practices (GAPs), proposed by the LIFE AgroClimaWater (Action C3, deliverable C3.1) project and will be implemented and monitored during the next period constitute a vital component of the water management strategy of Mirabello.
The main aim of these GAPs is to enhance water use efficiency during the cultivation process and to contribute to protection of the environment, of water resources and protected areas, as well as to protect crop productivity and farmers income in the view of climate change. The GAPs proposed are the following:

- **Reduction of water evaporation losses from soil surface**

This can be achieved through:

a) *Soil mulching*. This practice includes the weed mowing during the high water demand season (late spring and summer period). This practice can be implemented at least one (second half of spring – water demand season) or more times both in olives and citrus crops, while possible restrictions have to be considered for farms with high slopes.

b) *No weed control*. Based on this practice natural vegetation can remain on farm during rainy season (Oct – Apr). Additionally, sowing legumes in rainy season can also contribute to reducing water evaporation losses from soil surface as well as providing olive trees with nitrates during summer period after the weed mowing.

c) *Weed mowing*. This practice is expected to be the most applicable technique both on olive and citrus crops, while practicing the shredding of pruned wood is expected to enhance soil mulching too. Specifically, shredding pruned wood of small diameter can be applied on orchard surface late winter to early spring. This practice can be implemented on low land olives trees farms and with restrictions it may be applied to farms with high slopes. Finally, to reduce evaporation losses both in olive and citrus trees avoiding bare soil with no tillage is recommended.

- **Reduction of transpiration water losses through winter pruning and summer pruning**

Appropriate winter pruning can be applied in order to obtain the optimal balance between leaf area and yield. Moreover, summer pruning can be applied to reduce the transpiring leaves and reduce radiation competition; summer pruning can be implemented one time during July. These practices can be applied in olive trees while for citrus possible restrictions may be applied during summer pruning. In addition during this project the effectiveness of Kaoline for reducing the transpiration water

losses will be investigated. Kaoline will be applied on olive trees through spraying applications during summer period.

- **Reduction deep percolation water and nutrient losses**

This can be achieved through:

a) *Increasing organic matter.* Application of locally available organic matter could be used for improving the soil water holding capacity. In this way the rapid vertical movement of water along the soil profile can be reduced. This practice can be applied during autumn.

b) *Fertigation*. In irrigated orchards where there is the option of fertigation, fertilizers can be applied through this method in order to minimize nitrate losses to ground water (more applicable for citrus). The fertigation during spring and summer period may lead to 10 until 30% savings in water and nutrients compared to the quantities conventionally applied. The application of this practice in irrigated olives depending the infrastructure.

- **Reduction of surface runoff**

Based on this intervention the surface runoff can be minimized especially in sloppy areas. This can be achieved by physical reduction of surface runoff introduced along the contour lines in the orchard. The benefits of this practice could be more obvious for olive trees farms in high slope.

- **Measures in order to maximize the efficiency of irrigation**

Adjusting irrigation water application according to actual farm needs can significantly contribute to water saving. This can be achieved based on weekly bulletins that will be available on IOTSP on crop irrigation water requirements (meteorological conditions, soil type, crop) for irrigated olive trees and citrus. In addition, depending on the specific farm, a plan for irrigation network improvement and repair can be established. Based on this plan, a set of water-meters and volumetric valves can be introduced in each orchard, in order to provide farmers with the tools to precisely control the amount of irrigation water that is applied to the orchard. Establishing and checking the irrigation network in each farm and after the accurate estimation of evapotranspiration losses an application of regulated deficit irrigation could be of high priority for reducing water use up to 20-30% in olive trees and 10-15% in citrus, with no negative effects on yield quality and quantity.

- **Rationalization of fertilizers and agrochemicals utilized**

In order to minimize the risk for water pollution by agrochemicals, the principles of integrated management can be applied in the cultivation process. Moreover, a specific fertilizing schedule for each orchard has to be considered, in order to use the necessary quantity and minimize the risk of ground and surface water pollution by fertilizers. The fertilizing schedule may be applied in each farm based on soil and leaf nutrients analysis.

Ten pilot farms were selected based on a methodology presented in Deliverable "Proposal of farm specific Action Plans" (Action C3) in order to apply the GAPs presented above. The location of each pilot farm in the pilot sub-basins in illustrated in Figure 1, while the GAPs applied in each farm are listed in Table 1. More details about GAPs implementation can be found in the farm specific action plans compiled in the context of Deliverable "Proposal of farm specific Action Plans" (Action C3).

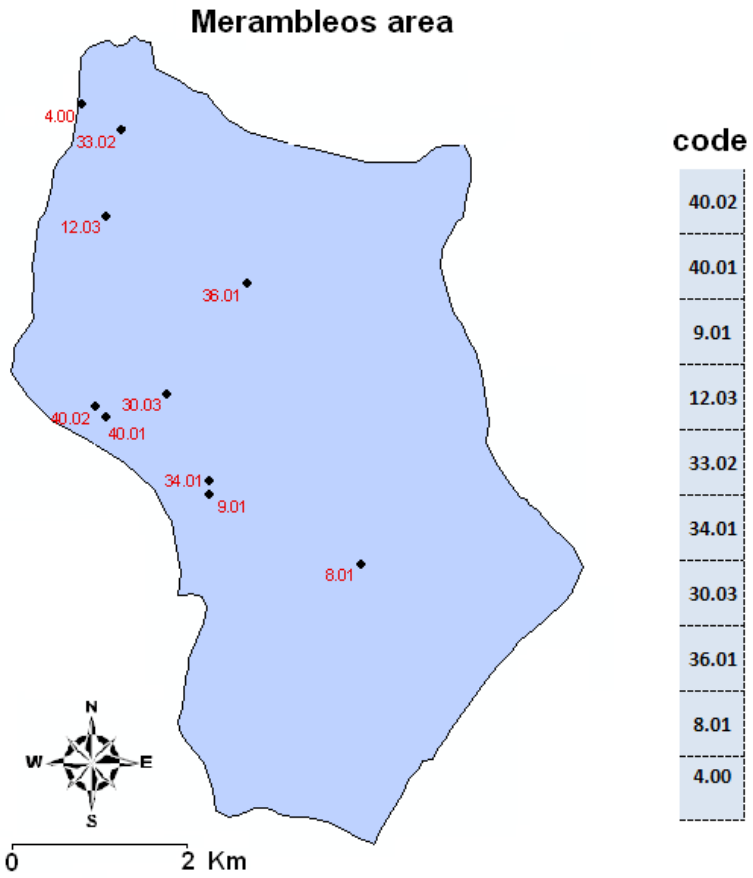


Fig. 10: The selected 10 pilot farms in Havgas - Milatos sub-basin with the corresponding codes

Table 17: GAPs scheduled to be applied in the 10 pilot farms located in Havgas-Milatos sub-basin

Code	Crop	Weed Mowing	No weed control during winter	Cover Crops	No soil tillage	Pruning Winter-summer	Shredding of prunings	Kaolin application	Organic material addition	Fertilizing scheduling/ Fertigation/ Foliar application of nutrients	Irrigation network improvement	Irrigation scheduling/ deficit irrigation	Physical reduction of surface runoff
40.02	Olive	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x / - / x**			
40.01	Olive	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x / - / x**			**x**
9.01	Olive	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x / - / x**			
12.03	Olive	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x / - / x**			**x**
33.02	Olive	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x / - / x**	**x**	**x / -**	
34.01	Olive	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x / - / x**	**x**		
30.03	Olive	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x / - / x**			
36.01	Olive	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x / - / x**			
8.01	Olive	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x / - / x**	**x**		
4.00	Olive	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x / - / x**	**x**	**x / x**	

4.2. Mirabello's Governance Actions for equitable and transparent water governance

Water governance within Mirabello FOR constitutes the framework under which efficient and sustainable water management can be achieved and therefore it is included as an integral part of the present strategy aiming at:

6. Ensuring conformance with water related legal requirements.
7. Identifying and managing interrelations of water with other resources used in agricultural sector.
8. Adaptive capacity building (information, training and raise public awareness).
9. Promoting the participation of the agricultural sector in decision making with respect to the management of the water basin.
10. Ensuring preparedness and response to environmental incidents on the area caused by eventual accidents and adverse weather conditions.

Therefore a set of actions was developed, described in detail in "Governance actions and floods and droughts action plan for the participant FORs" Deliverable (Action C3) accompanied by the corresponding procedures and documentation, which are summarized as follows:

- **Ensuring compliance with all legal requirements linked to water use**: A procedure is established for following up legal matters on water. Moreover, an assignment was created according to which a person or department is identified who will ensure compliance with legal requirements linked to water.
- **Linking water management to the management of other resources**: The quantitative relation of: a) water and energy use and b) water and other resources than energy has to be identified and optimized. Therefore, the appropriate recording system has been developed in order to quantify the aforementioned relations. The assessment of recording results can indicate improvement potential in water management in relation to energy and other resources.
- **Raising efficiency of water consumption**: Three specific actions are proposed in order for Mirabello to raise its efficiency of water consumption. The first action is related to the identification of water losses and their destination and therefore the appropriate methodology and documentation was developed. The second action is the planning, implementation and monitoring of measures that will enhance water efficiency. A set of measures are identified from the GAPs pool presented above which aim to improve water efficiency and more specifically: a) Calculation of evapotranspiration losses, b) Plan for farm irrigation network improvement and c) Deficit irrigation. The results of the above GAPs implementation are recorded and the year after year comparison can indicate the increasing water efficiency potential of each practice. The final action includes the calculation of total water consumption per unit of product.
- **Ensuring transparency on water management**: In the context of promoting and ensuring transparency on water management resources, F.OR. have to be devoted to ensure attentive communication with River Basin Committee. Thus, a person or -if possible- a department has to be defined which will represent and report on River Basin Committee activities and vice versa. The appropriate assignment has been created. Towards the internal dissemination of sustainable water management, the Water Steward of each F.OR. has to make sure that all the personnel of the F.OR. as well as the farmers are duly informed of F.ORs' water policy and the basic elements of WMAS, the objectives, the problems and drawbacks, the achievements, etc.

Moreover, promotional campaigns in topics related to irrigation scheduling, and GAPs implementation.

With regard to increasing the preparedness of Mirabello to efficiently cope with unexpected situations, floods and droughts action plans were developed, as these two situations are considered of major concern for Mirabello. A summary of floods & droughts action plans is provided in the next section.

- **Ensuring continuous improvement**: The pool of GAPs presented in the previous section can be considered as a robust basis for continuous improvement of water management within Mirabello. The improvement potential of each GAP is under investigation and more details about implementation, monitoring and evaluation are presented in detail in the corresponding deliverable developed in the context of the current action (Proposal of farm specific Action Plans). Moreover, taking into account the fact that such practices are not currently applied or there are sparsely applied, their implementation under a water management scheme can be considered as innovative.
- **Ensuring transparency on economic aspects of water management**: Two actions are proposed in order for Mirabello to maintain transparency on the economic aspect of water management. With regard to the first action, the investments related to maintenance and improvement of water management have to be reported. Concerning the second action, an environmental cost analysis has to be performed.

4.3. Floods & Droughts Action Plan for management of incidents

Under the scope of formulation of the adaptation strategy for F.ORs the "Floods and Droughts Action Plan" was developed by the LIFE AgroClimaWater (Action C3, deliverable C3.2) in order to ensure the preparedness and response of F.ORs to environmental incidents caused by the imminent climate change. Two are the main components of floods action plan:

- identification of flood risk and
- management of floods

The **river flood risk assessment** is based on the corresponding reports developed by Hellenic Special Secretariat for Water in compliance with Directive 2007/60/EC, and more specifically on preliminary flood risk assessment of Crete Water District and flood hazard and flood risk maps. According to the above, there is no high flood risk zone identified in Havgas-Milatos sub-basin and therefore the river flood risk is considered as low. With regard to flash floods risk assessment, which were based on the results of surface runoff potential estimation in the context of Action C2, overall the contribution of the agriculture activity developed in Havgas-Milatos basin to the development of flash floods is moderate to high, and this is mainly attributed to significant rainfalls experienced in the southern part of the basin and to the steep slopes of the topographic relief.

With regard to **flood management** and taking into account that there is no river flood risk identified in Havgas-Milatos sub-basin, several practices were proposed in order to increase flash floods mitigation potential. These practices were mainly selected from the pool described in the previous section, which are able to contribute (directly or indirectly) in runoff potential reduction (no weed control, no soil tillage, physical reduction of surface runoff), while some other practices were also included

(conservation buffers, avoidance of vehicle movements and wheel ruts on wet soil, avoidance to the best possible degree, of heavy machinery use within the farm).
In a similar manner, the droughts action plan was developed, which comprises of two main sections:

- the drought risk assessment section, in which the potential of drought occurrence is assessed and
- the drought risk management section, in which specific actions are proposed in order to enforce the drought preparedness level of the F.OR.
- According to the Water Resources Management Plan of Crete Water District the development of a strategic plan for the mitigation of water scarcity and droughts has been included in the list of measures that will be implemented (measure code: GR13SM02-01). Since this strategic plan is not existing, information about **drought risk assessment** were retrieved from alternative scientific sources. It is crucial to mention that summer period is normally dry for Crete according to the average climate conditions and therefore it cannot be considered as drought incident. Therefore, summer droughts cannot be considered of high risk for the agricultural production in Mirabello, since they constitute representative climate conditions during a critical time span of cultivation period. Prolonged droughts, on the other hand, is the major risk for agricultural production in Mirabello area, since water resources availability is decreasing. The results of drought indices application from several studies indicated that prolonged droughts frequency is of major concern for Mirabello and therefore drought management actions have to be proposed. With regard to **drought management**, the application of several GAPs selected from the pool presented above are proposed to be implemented, preventive and as operational actions, since the majority of them aim to water saving and therefore they can significantly contribute to droughts management.

4.4. Measures of River Basin Management Plan of Crete Water District (GR13) relative to Agriculture

The programme of measures consists part of the River Basin Management Plan of Crete Water District (GR13) (Special Secretariat for Water, 2015) and the "mechanism" for the achievement of the environmental goals that are mentioned in the plan.
The Programme of Measures is updated every six years, while any new or revised measure established under an updated programme shall be made operational within three years of their establishment.
According to the project's research team discretion (as none relevant categorization is applied in the River Basin Management Plan of Crete Water District) the measures that are related to the agricultural sector are presented as follows:

Basic Measures

- **Measures for the promotion of efficient and sustainable water use**

a) Establishment of strategic plan to deal with drought and water scarcity phenomena - GR13OM02-01: Development of a strategic plan to address extreme drought and water scarcity phenomena for Crete Water District, which will include mainly preventive measures (drought contingency planning), based on a combination of alternative solutions and measures to address the effects of water scarcity and drought.

b) Promotion of projects' planning and implementation related with maintenance and restoration of proper function of existing irrigation water pipelines - GR13OM02-03: Identification and registration of parts of irrigation water pipelines which over time have suffered from significant damages. Determination of priorities and preparation of replacement capacity study of existing open and tertiary irrigation pipes with pipes under pressure.

c) Determination of specifications and establishment of incentives for the sustainable management of rainwater - GR13OM02-05: The measure include the preparation of a manual with specifications in reference to rainwater collection and reuse, as well as the establishment of incentives for the construction of tanks for the collection of rainwater in greenhouse crops, livestock and tourist facilities, especially in areas with increased water demand or high altitudes.

d) Reduction of water abstraction for irrigation through the improvement of irrigation techniques - GR13OM02-10: Promotion of measures and incentives for the improvement irrigation techniques with water saving systems. Publication of relevant guidelines.

e) Encouragement of cultivation of traditional non-water consuming crops - GR130OM02-11: It is proposed the funding of specific programmes for the restructure of existing crops with new crops that are characterized as non-water consuming (eg. rainfed olive varieties, arid vegetable varieties etc.)

f) Encouragement and strengthening of the expansion of localized irrigation methods (drip irrigation) in cultivations in which such irrigation methods can be applied - GR13OM02-12: Expansion of drip irrigation in all irrigated tree crops and increase of the percentage of such systems on other crops (strawberry, asparagus, tree crops, etc.).

- **Measures for protection of water intended for potable water**

Prohibited activities in the protection zones where potable water abstraction works from groundwater aquifers are existed - GR13OM03-02: In these zones the installation and operation of new activities of high pollution is prohibited. The relevant activities are mentioned in the first category of Article 3 of N. 1650/1986 (OJ A'160), such as intensive agricultural crops with use of pesticides – agrochemicals, livestock facilities and general any similar activity which can be potential source of pollution for groundwater equal or greater than the above mentioned.

- **Measures for control of exploitation of surface and groundwater**

a) Rationalization of limits (minimum/maximum) of the necessary quantities of irrigation water in accordance with the climate conditions of Crete, the type of crop and the agricultural applied methods - GR13OM04-02: According to the JMC F16/6631/1989 the minimum and maximum limits of the necessary quantities of irrigation water for the sustainable use of water resources in irrigation per type of crop and Water District have been determined. These limits have been estimated per month for the period April-September and they are applied cumulative.

b) Record of water quantities from the abstraction points of surface water or/and groundwater for drinking, irrigation from organized networks (TOEB, GOEB), Municipalities, DEYA, other water services and large consumers - GR13OM04-04: This measure includes the establishment of recording systems (water meters, lever meters, etc.) at water abstraction points for drinking, irrigation and industrial use for the cover of needs of collective networks and the needs for irrigation and industry.

- **Measures for priority and other substances**

Register of pollution sources (emissions, discharges, losses) - GR13OM10-01: The Water Directorates of the Regions establish a list that includes maps, emissions, discharges and losses of all priority substances and pollutants listed in part A, Annex I of this Decision and their concentrations in sediment and biota, for each river basin or part of that area situated within their administrative boundaries. The register records the potential sources of pollution and it is the basis for the elaboration of those substances reduction action plan. Also, it should be investigated whether the increased concentrations of certain substances are due to anthropogenic causes or natural processes.

Supplementary Measures

- **Administrative measures**

Enforcement of necessary measures in order to tackle water scarcity problems or other emergencies - GR13SM02-01: The General Secretary of Decentralized Administration of Crete may adopt a decision in order to implement short-term measures in areas with intense problem in order to maintain the water "status" and to cover the water needs.

- **Measures for water abstraction control**

a) Definition of restriction zones for drilling of new boreholes for water uses and expansion of existing water use licenses in coastal groundwater bodies where phenomena or trends of salinization due to anthropogenic pressures or natural phenomena are observed - GR13SM04-02: In coastal groundwater bodies, which:

- are in poor qualitative status due to salinization by anthropogenic pressures (over-pumping)
- present local salinization due to anthropogenic pressures,
- present natural salinization (increased background values),

restrictive measures are adopted for new projects in reference to groundwater abstraction (boreholes, wells) and to expand the licenses of existing uses (eg increase pumping discharge, increase drilling depth, etc.).

Affected water bodies: GR1300112 & GR1300116

b) Specific protection measures in underground water bodies with a deficit over-annual input (enrichment) - output (receipts) balance and in groundwater areas with specific water uses (water supply, collective works) - GR13SM04-05: The construction of new abstracted projects from groundwater (boreholes, wells, etc.) for new water uses as well as expansion of existing water use licenses is prohibited as follows:

- In areas where the groundwater quantitate status is bad
- Within areas of collective irrigation networks from TOEB / Municipalities and within the aquifer water pumping fields for irrigation use.
- Within the protection zones (I and II) of drinking water abstraction projects
- Within groundwater aquifers which are in marginal quantitative status with the exception of water supply boreholes
- within the boundaries of settlements and approved city plans and expansions with the exception of abstraction intended for green irrigation, public areas and fire

Affected water bodies: GR1300240

- **Measures for codes of good agricultural practices**

Implementation of Codes of Good Agricultural Practices for the purpose of water economy, water protection and reduction of pollution caused by nitrates - GR13SM06-01: Information and awareness of farmers in reference to proper irrigation and

fertilization practices of different cultivations and promotion of other farming techniques that could reduce the water pollution from agricultural sources. Development of software/applications for easy identification of irrigation and fertigation doses per crop type and growth stage.

- **Measures for research, development and demonstration projects (best practises)**

Establishment and organization of pilot farms - GR13SM14-03: Integration of pilot farms into scientific and technical assistance programmes in reference to the organization and management of the farms, utilizing the latest technologies and techniques, applying exemplary various measures of Codes of Good Agricultural Practices (KOGP) and Cross Compliance, utilizing any funding program etc. In order to encourage also other farmers in the adoption and implementation of the same procedures and methods.

- **Educational measures**

Organization of information days, for new technologies, modern farming techniques, environmental protection, fertility of agricultural soils, etc. - GR13SM15-01: The proposed measure aims to increase the awareness of farmers and to encourage the adoption of best practices which will improve the productivity and efficiency of their cultivations, highlighting simultaneously the need for the protection of the agricultural environment and the maintain of the efficiency of agricultural land and the sustainable use of natural resources.

- **Measures for negotiated environmental agreements**

Agreements between public – agricultural sector - GR13SM16-02: Promotion of voluntary agreements between the public and the agricultural sector in reference to the monitoring of water use and pollution. These programmes try to persuade farmers (through education) for the advantages of good water management.

4.5. Water Management Adaptation Strategy for Mirabello

Taking into account the above mentioned Good Agricultural Practices, Governance actions and Flood and Drought action plan proposed in the frame of LIFE AgroClimaWater as well as some of the relative to agriculture measures of the River Basin Management Plan of Crete Water District (GR13) presented above, considering the ability Farmers' Organization to contribute to their implementation.

The water management adaptation strategy (WMAS) for Mirabello was developed in the context of the project LIFE AgroClimaWater.

The WMAS is structured in priority axes, measures and sub-measures which should be implemented by Mirabello and its farmers in order to enhance the sustainable management of water resources and to cope with the impacts of the prominent climate change.

In the following section the text of the WMAS for Mirabello is presented. The true copy of WMAS as it was signed by the board of directors of Agricultural Cooperative Partnership Mirabello Union S.A. is presented in APPENDIX I.

WATER MANAGEMENT STRATEGY AIMING TO THE ADAPTATION OF AGRICULTURE TO CLIMATE CHANGE –
AGRICULTURAL COOPERATIVE PARTNERSHIP MIRABELLO UNION S.A.

GENERAL | The proposed water management strategy focuses on the

DESCRIPTION	efficient management of water resources available to agriculture, in view of the potentially new climatic conditions resulting from climate change. The present draft proposal was developed in the context of the project LIFE AgroClimaWater for the partner AGRICULTURAL COOPERATIVE PARTNERSHIP MIRABELLO UNION S.A. (Mirabello), after assessment of the current status of its organization structure, the condition of the water bodies in its pilot area for the project, as well as the prevailing farming practices for the stone fruits in the pilot area.
VISION	To manage agricultural water in such a way as to ensure the protection of water bodies and the related ecosystems, the agricultural production and the balanced development in the pilot area.
STRATEGY OBJECTIVES	The proposed strategy will be addressed through the implementation of three cross cutting priority targets (axes), as follows: Target 1: The optimization of structure and function of farmers' organization in relation to water management in agriculture. Target 2: The introduction of water-related Good Agricultural Practices for the crops in the pilot area and specifically citrus and stone fruits. Target 3: The contribution of agriculture for the implementation of the River Management Plan of Crete (GR13).
CONTENT	In order to achieve the targets above, the proposed strategy focuses on measures to ensure compliance to the EU and national legislation for water, the identification and management of interactions of water with other resources used in agriculture, the development of adaptive capacity of farmers to climate change through training and awareness raising, encouragement of participation of Mirabello in the decision-making processes for the Havgas-Milatos river basin. Lastly, it proposes measures to ensure readiness for addressing environmental incidences caused by accidents or extreme weather. In addition, it proposes the implementation of actions/measures related to the minimization of water use, through the rationalization of irrigation, the reduction of water losses due to runoff, to percolation, to evaporation from soil and to transpiration by plants and by enhancement of water retention by soil. Also, it relates to the Good Agricultural Practice with regard to the use of agrochemicals (Fertilizers, Plant Protection Products, etc.). Finally, one more area of measures in the focus of the present strategy proposal is related to the contribution of the Farmer Organization to local authorities' efforts to implement the River Management Plan in the basin under question, as well as to the Management Plan for Floods and Droughts.
PRIORITY AXES	The proposed strategy is based on three Priority Axes (P.A.),

11 measures and 46 sub-measures, which are necessary for its implementation. Mirabello, with the assistance of the LIFE AGROCLIMAWATER partners will implement this strategy for a three-year period. The measures that refer to Farmers' Organization management and administration should be implemented by Farmers' Organization management (P.A. 1), whilst the ones referring to the farming practices (P.A. 2) will be implemented and recorded by the farmers – owners of the ten pilot farms of the project. Finally, as regards the P.A. 3, Mirabello should take into account the proposed, relevant to agriculture, measures in the River Management Plan and in the Flood and Drought Plan of Crete, in order to contribute, to the extent possible, to their implementation.

PRIORITY AXIS 1: ORGANIZATION AND MANAGEMENT FOR WATER USE IN AGRICULTURE

The objective of this axis is to achieve and maintain effective and transparent management of water resources through the implementation of suitable management and administrative tools in a Farmers' Organization level.

MEASURE 1.1: COMPLIANCE WITH WATER LEGISLATION

This measure focuses on the implementation of the appropriate procedures to ensure compliance with EU and national legislation for water management in the agricultural sector.

Sub-measure 1.1.1: "Assignment to a specific section or a person within the Farmers' Organization of the responsibility for the compliance to legislation as regards to water management"

Sub-measure 1.1.2: "Development, implementation and monitoring of processes to ensure compliance with the current legislation as regards to water abstraction and distribution, including issuance of the respective licenses"

MEASURE 1.2: RECORDING AND MONITORING OF THE USE OF WATER AND OTHER RESOURCES

This measure aims to improve the relation between usage of water and other resources in agriculture.

Sub-measure 1.2.1: "Measurement, recording and reporting of water usage and of its losses"

Sub-measure 1.2.2: "Recording, evaluation and optimization of the quantitative relationship between water and other resources used by agriculture, e.g. energy, fuels, fertilizers, Plant Protection Products, etc.)"

MEASURE 1.3: SUSTAINABLE WATER MANAGEMENT

This measure aims to abate the excessive consumption of the available water resources, through their rational management and the identification of alternative water resources that could be used.

Sub-measure 1.3.1 "Implementation and monitoring of the present strategy for the effective use and water saving in agriculture."
Sub-measure 1.3.2: "Introduction and implementation of novel measures and target-setting for the improvement of Farmers' Organization and river basin management."

MEASURE 1.4: TRANSPARENCE OF COST ISSUES IN THE WATER MANAGEMENT
This measure focuses on the recording, evaluation and dissemination of data and targets with regard to the investments on water management.
Sub-measure 1.4.1: "Recording and dissemination of the investments made for the maintenance and improvement of water management"
Sub-measure 1.4.2: "Evaluation of current and planned investments for the implementation of water management strategy"

MEASURE 1.5: DISSEMINATION OF INFORMATION AND PUBLIC AWARENESS RAISING ON WATER MANAGEMENT IN AGRICULTURE
The accurate and timely provision of information to the consumers and the interested stakeholders is a significant prerequisite for the sustainable use of water resources. So, this is the aim of the present measure.
Sub-measure 1.5.1: "Planning and implementation of training actions for farmers, with regard to the water management strategy and the measures adopted by the Farmers' Organization"
Sub-measure 1.5.2: "Provision of information and consultancy on the requirements for water, for nutrients and for plant protection, according to the crop, the growth stage, taking into account the development of technology"
Sub-measure 1.5.3: "Awareness raising and training of farming community for the Good Agricultural Practices for water management at a farm and at the area level"
Sub-measure 1.5.4: ""Provision of information and training of farmers for the mitigation of extreme weather events (e.g. prolonged drought) and water related accidents during the implementation of agricultural practices"
Sub-measure 1.5.5: "Participation of both Farmers' Organization and its farmers-members to the initiatives of local and regional authorities on the management and the protection of water resources"

MEASURE1.6: CERTIFIED WATER USE IN AGRICULTURE
This measure aims to prepare Farmers' Organization to

implement a water management plan according to the requirements of the EWS standard, as this has been described in the LIFE AgroClimaWater project. The utmost goal is to contribute to the EU target for sustainability of water resources use through the evaluation, the control and dissemination of appropriate practices. Mirabello will be supported in this by the other partners of the project.

Sub-measure 1.6.1: "Development by Mirabello of a water management system according to the EWS Standard"

Sub-measure 1.6.2: "Pilot implementation and monitoring of the systems' procedures during the life time of the LIFE project"

Sub-measure 1.6.3: "Revision of the procedures at the end of the LIFE project"

Sub-measure 1.6.4: "Evaluation of the preparedness of applying for certification to the competent certification body"

PRIORITY AXIS 2: IMPLEMENTATION OF GOOD AGRICULTURAL PRACTICES

The objective of this priority is the effective usage of water and to design the appropriate use of agrochemicals on crops, so as to improve, or at least maintain the current status of water resources and protected areas in Havgas-Milatos sub-basin. These specific measures will be implemented on the 10 pilot farms of the LIFE project, while all other farmers will be informed, so that they will be triggered to implement them on a wider area.

MEASURE 2.1: GOOD AGRICULTURAL PRACTICE FOR THE USE OF AGROCHEMICALS

Using fertilizers and Plant Protection Products (PPPs) is necessary for crop growth and health, but has to be adjusted to the soil properties and to the available technology and equipment, so as to avoid excessive use and the possibility to contaminate the water bodies.

Sub-measure 2.1.1: "Secure good growth conditions by balanced fertilization of the crops in the pilot farms"

Sub-measure 2.1.2: "Justified and well planned usage of fertilizers and PPPs, according to soil and weather conditions and crop needs"

Sub-measure 2.1.3: "Assessment of nitrogen and phosphorus balance by crop at field level, as a measure to avoid environmental impacts"

Sub-measure 2.1.4: "Adoption of specific measures for transport, storage and packaging disposal of agrochemicals to deter leakage risks"

Sub-measure 2.1.5: "Careful maintenance of fertilization and PPPs application equipment to also deter leakage risks"

MEASURE 2.2: EFFICIENT PLANNING AND

IMPLEMENTATION OF IRRIGATION

Farmers should take all necessary measures for the protection of the water bodies, -as a minimum contribution- for the maintenance of the ecological balance and the protection of the local society. Materialization of the present measure and of its sub-measures focuses on the proper irrigation planning with the objective to achieve the sustainable use of the available water resources and the minimization of losses by the farming activities.

Sub-measure 2.2.1: "Establishment of a system to measure, record and report the volume of irrigation water used and lost in the agricultural sector"

Sub-measure 2.2.2: "Determination of water need according to the growth stage of the crops and adjustment of water use to these needs when drafting the irrigation schedule"

Sub-measure 2.2.3: "Recording and monitoring of soil conditions and saturation status of soil-water for the determination of water availability and crop water needs"

Sub-measure 2.2.4: "Implementation of effective irrigation, by selection of the most appropriate method and timeliness of irrigation equipment"

Sub-measure 2.2.5: "Implementation of suitable measures, in order to reduce losses from the water distribution network and the irrigation equipment"

MEASURE 2.3: OTHER GOOD AGRICULTURAL PRACTICES FOR WATER MANAGEMENT

In the frame of Good Agricultural Practices, all the farming practices are included in relation to soil and crop management, with ultimate target the optimization of evapotranspiration, runoff and percolation, but also the stabilization of soil.

Sub-measure 2.3.1: "Implementation of appropriate farming practices for soil cover for reduction of losses due to evaporation"

Sub-measure 2.3.2: "Implementation of best practices for weed mowing and crop pruning, in order to minimize losses due to evapotranspiration"

Sub-measure 2.3.3: "Implementation of farming practices to increase water retention by soil and minimization of deep percolation"

Sub-measure 2.3.4: "Establishment of effective techniques and practices for containment of runoff and development of suitable structures for retardation of water movement and to increase soil moisture"

Sub-measure 2.3.5: "Use of annual cover crops, in order to stabilize soil and its structure as well as to increase its filtration capacity"

Sub-measure 2.3.6: "Evaluation and assessment of leaching potential, erosion and filtration potential at a farm or area

level"

PRIORITY AXIS 3: CONTRIBUTION TO THE IMPLEMENTATION OF THE RIVER MANAGEMENT PLANS IN THE BASIN

The objective of this priority axis is the contribution of the Farmers' Organization for the implementation of basic and supplementary measures contained in the River Management Plan and the Floods and Droughts Plan for the farming sector.

MEASURE 3.1: IMPLEMENTATION OF THE RIVER MANAGEMENT PLAN OF CRETE

In the frame of the River Management Plan of Crete (GR13) a number of basic and supplementary measures are proposed for farming. The contribution of Farmers' Organizations and their farmers-members is very important for their implementation.

Sub-measure 3.1.1: "Reduction of water abstraction for irrigation through the improvement of irrigation techniques - GR13OM02-10"

Sub-measure 3.1.2: "Encouragement of cultivation of traditional non-water consuming crops - GR13OM02-11"

Sub-measure 3.1.3: "Encouragement and strengthening of the expansion of localized irrigation methods (drip irrigation) in cultivations in which such irrigation methods can be applied - GR13OM02-12"

Sub-measure 3.1.4: "Activities that are prohibited in the protection zones where potable water abstraction works from groundwater aquifers are existed - GR13OM03-02"

Sub-measure 3.1.5: "Rationalization of limits (minimum/maximum) of the necessary quantities of irrigation water in accordance with the climate conditions of Crete, the type of crop and the agricultural applied methods - GR13OM04-02"

Sub-measure 3.1.6: "Record of water quantities from the abstraction points of surface water or/and groundwater for drinking, irrigation from organized networks (TOEB, GOEB), Municipalities, DEYA, other water services and large consumers - GR13OM04-04"

Sub-measure 3.1.7: "Register of pollution sources (emissions, discharges, losses) - GR13OM10-01"

Sub-measure 3.1.8: "Enforcement of necessary measures in order to tackle water scarcity problems or other emergencies - GR13SM02-01"

Sub-measure 3.1.9: "Implementation of Codes of Good Agricultural Practices for the purpose of water economy, water protection and reduction of pollution caused by nitrates - GR13SM06-01"

Sub-measure 3.1.10: "Definition of restriction zones for drilling of new boreholes for water uses and expansion of existing water use licenses in coastal groundwater bodies

where phenomena or trends of salinization due to anthropogenic pressures or natural phenomena are observed - GR13SM04-02"

Sub-measure 3.1.11: "Specific protection measures in underground water bodies with a deficit over-annual input (enrichment) - output (receipts) balance and in groundwater areas with specific water uses (water supply, collective works) - GR13SM04-05"

Sub-measure 3.1.12: "Establishment and organization of pilot farms - GR13SM14-03"

Sub-measure 3.1.13: "Agreements between public – agricultural sector - GR13SM16-02"

MEASURE 3.2: ADDRESSING EXTREME CLIMATIC CONDITIONS

Through this measure, Farmers' Organization has to adopt and contribute to the implementation of measures that will be included in the forthcoming Floods and Droughts Plans for Crete, so as to ensure their preparedness regarding the possible future extreme climatic conditions. In addition, practices that mitigate the impacts of such conditions should be implemented at a farm level.

Sub-measure 3.2.1: "Implementation of any measures that will be provided in the forthcoming Floods and Droughts plans for the agricultural sector"

Sub-measure 3.2.2: "Implementation of Good Agricultural Practices proposed in Priority axis 2, so as to assist for the mitigation of extreme weather impacts, e.g. reduction of runoff and evapotranspiration, increase of soil moisture"

Sub-measure 3.2.3: "Training of farmers for measures and practices for crop protection from extreme weather"

PART C - WATER MANAGEMENT ADAPTATION STRATEGY OF AFI

1. INTRODUCTION

The particular part presents the WMAS for Asso fruit Italia Società Cooperativa Agricola (AFI). Asso fruit Italia Società Cooperativa Agricola (AFI) was born in 2010, in Scanzano Jonico, Matera, Basilicata, Italy, as a result of a strategic collaboration of four major fruit and vegetable producers and immediately it became the most important association in the fruit and vegetable sector in the south of Italy. AFI includes 300 producers situated in Basilicata, Puglia, Calabria, Campania and Lazio, 46 of which are organic farms and 10 production warehouses. At this time, there are 3.000 hectares in production in 500 of which table grapes, strawberries, citrus fruits and stone fruits are cultivated.

Asso Fruit Italia plays an important economic role in planning and collecting the associates' products to satisfy the demands of a globalised market. AFI organizes many research projects the most important of which are the operational programmes through which the companies take part in the promotion as well as in the control of all agricultural practices, which are at the base of an improvement in quality standards of the grower's fruit and vegetable produce. Its technical support guarantees the correct application of the production guidelines through on-site assistance as well as a strict selection process in order to provide the consumer with a high quality, wholesome and controlled product that rigorously respects food standards. The work of AFI is to continually train and review its associates to support investments and technological upgrades. It also makes the producers aware of the need to respect the land, the environment and the people and guarantees a dialogue between the farms and the clients, and the producers and the consumers.

2. DESCRIPTION OF CURRENT STATUS

2.1. Pilot area of Agri sub-basin

In the frame of project LIFE Agroclimawater and within the administrative borders of Metapontino area and more specific the Region of Basilicata in Italy the Agri sub-basin catchment area was selected for the implementation of the project after a two stage evaluation process applied in the frame of project's Action A.1. In particular within Agri river basin, its lower part, "Agri sub-basin", covering a total area of about 305 sq.km were selected for the formulation and implementation of a water management adaptation to climate change strategy by AFI.

2.2. Water consumption and Water sources utilized for abstraction

The water consumed by all the water uses within the catchment area of the Agri pilot sub-basin is presented in Table 1, as it was estimated in the deliverable C2 "Identification and assessment of water efficiency in the three F.ORs before LIFE AgroClimaWater". The total volume of water consumed per year is 49.137.051 m^3. This quantity is equally allocated to potable (7.9%) and irrigation use (92.1%).

Table 18: Water consumption in Agri sub-basin from Monte Cotugno dam and Gannano weir

Monte Cotugno dam	***Potable Water***	***Irrigation Water***	***Sub-total***
Quantity (m^3/year)	3.867.051	23.360.000	27.278
Percentage (%)	14.2	85.8	100.0
Gannano weir	***Potable Water***	***Irrigation Water***	***Sub-total***
Quantity (m^3/year)	-	21.910.000	21.91
Percentage (%)	0	100.0	100.0
TOTAL WATER CONSUMPTION	***Potable Water***	***Irrigation Water***	***Total***
Quantity (m^3/year)	3.867.051	45.270.000	49.137.051
Percentage (%)	7.9	92.1	100.0

The settlements that are located within the catchment area are presented in Fig. 1 and the sources utilized for abstraction of potable and irrigation water in Fig. 2. Within the catchment area of Agri sub-basin, the potable water is provided only by Development Institute of Irrigation and land reclamation in Puglia, Lucania and Irpinia, (Ente per lo sviluppo dell'Irrigazione e la trasformazione fondiaria in Puglia, Lucania e Irpinia - EIPLI). The Monte Cotugno dam is utilized by EIPLI that introduced water into the potable water in order to satisfy water demand from households, enterprises, tourism and other uses. Respectively, the irrigation water is provided also by EIPLI utilizing both Monte Cotugno dam and Gannano weir.

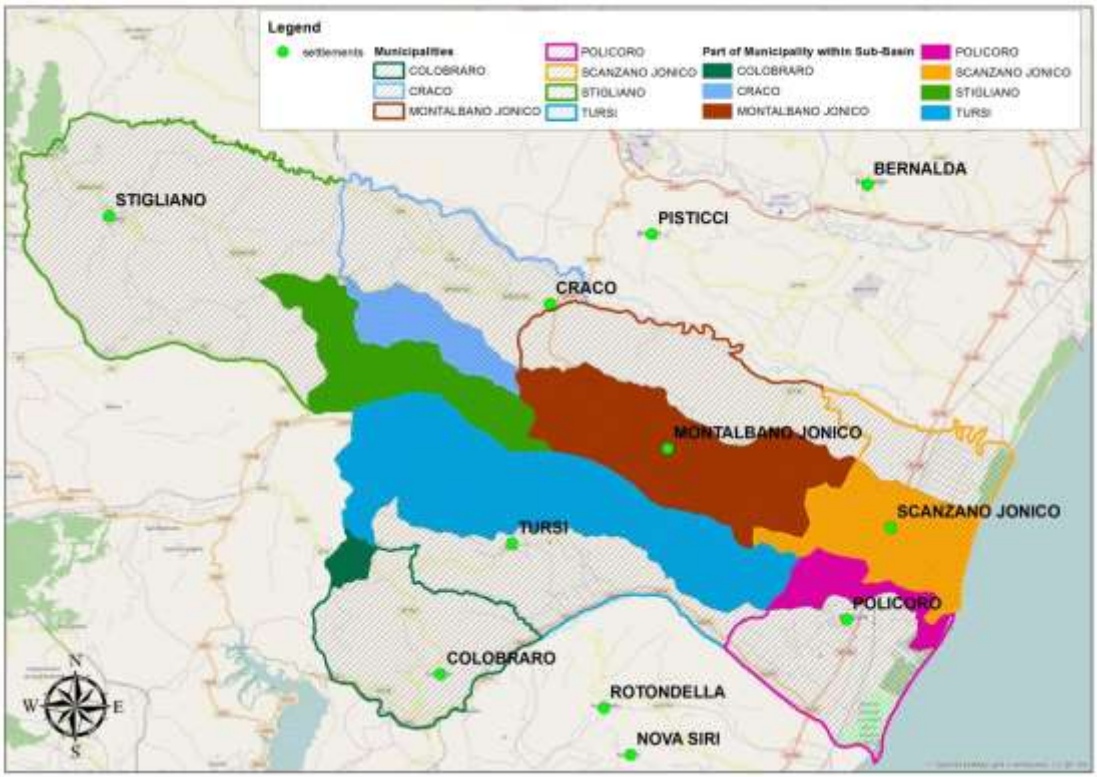


Fig. 11: Geodatabase Map Extract, depicting the settlements of Agri sub-basin municipal units located within the pilot sub-basin

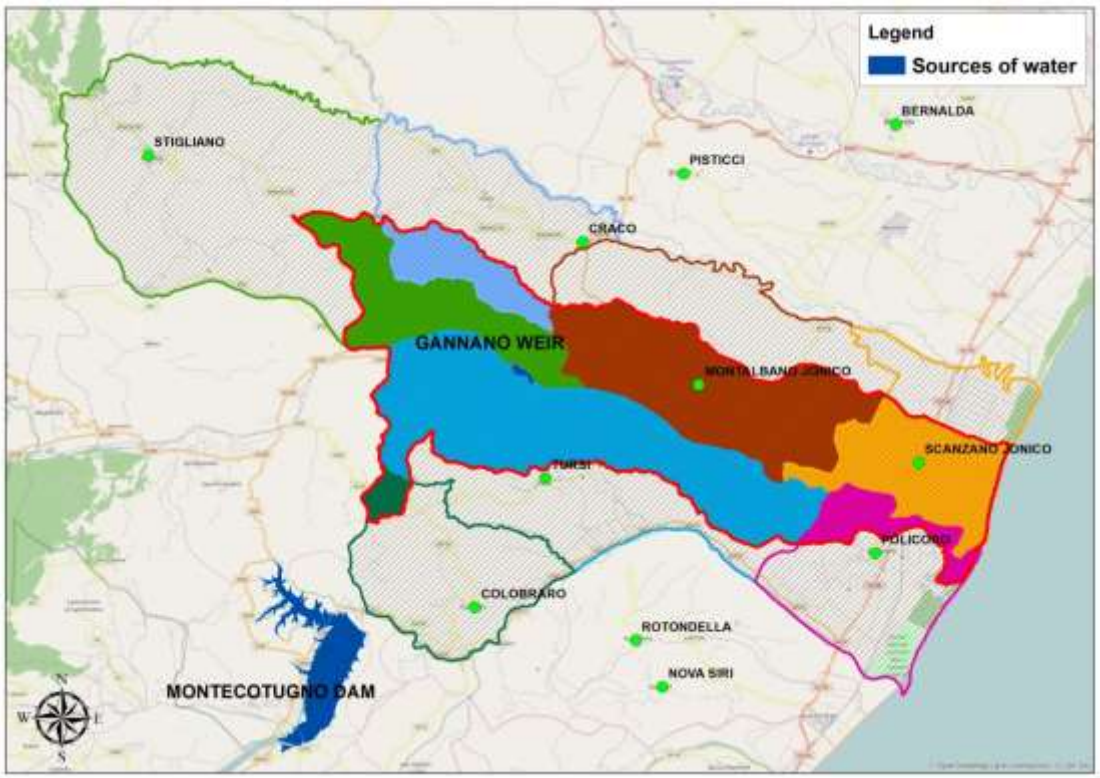


Fig. 12: Geodatabase Map Extract, depicting the water sources for multiple uses in Agri sub-basin

Regarding the use of irrigation water, data collected on the use of irrigation water by the 1st AWMS form revealed that 12 olive, 18 citrus, 48 peach and the 18 apricot orchards irrigated in a total of 100 orchards.

Concerning the irrigation of olive orchards, the mean volume of irrigation water used per year in the last 5 years for each olive parcel is 2,458 m^3/ha, with a minimum value of 900 and a maximum value of 4,500 m^3/ha. According to the production regulation "Disciplinare di produzione integrata" of Basilicata Region, in this case, almost 47% of the olive groves seems to be overirrigated, as compared to the typical olive water requirements (1000-2500 m^3/ha per year), while in no farms deficit irrigation is applied.

As far as the citrus orchards are concerned, the mean volume of irrigation water used per year in the last 5 years is 3,678 m^3/ha, with a minimum value of 2,333 and a maximum value of 5,833 m^3/ha. In the case of the registered orchards that are located within Agri sub-basin almost 5% of the citrus farms seems to be overirrigated, as compared to the typical citrus water requirements (3000-5000 m^3/ha per year), while in no farms deficit irrigation is applied.

The mean volume of irrigation water used per year in the last 5 years for each peach parcel is 4,036 m^3/ha, with a minimum value of 1,000 and a maximum value of 10,000 m^3/ha. According to the production regulation "Disciplinare di produzione integrata" of Basilicata Region, almost 17% of the peach farm located within Agri sub-basin seems to be overirrigated, as compared to the typical peach water requirements (3500-4500 m^3/ha per year), while in almost 38% of the farms deficit irrigation is applied. Based on these results, there is a medium potential risk for nutrient leaching in peach farms of Metapontino. In addition, irrigation is not carried out by means of the water taken from wells, for this reason there is no phenomena of water table drawdown and no risk of water salinization, even if the area is close to the sea.

Moreover, the mean volume of irrigation water used per year in the last 5 years for each apricot parcel is 3,300 m^3/ha, with a minimum value of 1000 and a maximum value of 5,000 m^3/ha. According to the production regulation "Disciplinare di produzione integrata" of Basilicata Region, in our case, only 4 farms seem to be overirrigated, as compared to the typical apricot water requirements (3000-3500 m^3/ha per year), while in almost 45% of the farms deficit irrigation is applied. Based on that fact, there is a medium/low potential risk for nutrient leaching in apricot farms of Metapontino.

2.3. Use of Agrochemicals

100 registered orchards that are located within Agri sub-basin participated in LIFE AgroClimaWater project. From these orchards 15 are olive orchards, 19 citrus orchards, 48 peach orchards and 18 apricot orchards.

From the 100 registered orchards in Metapontino area the 35% are organic, the 65% are conventional and almost all registered orchards (94%) are fertilized. Also, 96% of the total orchards are irrigated, while the rest 4% are rainfed orchards.

A total of 27 PPPs are applied in the 94% of the registered orchards (or 94 out of 100) and more specific the 14% are olive orchards, 18% citrus orchards, 45% peach orchards and 17% apricot orchards. From these PPPs the 7.4% (2 out of 27) contain priority substances (Chlorpyrifos-ethyl and Napthalene) and another 7.4% (2 out of 27) contain specific pollutants (Dimethoate and Copper) (Table 2). In 48% (or 48 out of 100) of the registered orchards 2 PPPs (ZELIG & RELDAN) which contain the priority

substance of chlorpyrifos-ethyl and naphthalene are applied while in 14% (or 14 out of 100) of the registered orchards 2 PPPs (ROGOR & COPPER) which contain the specific pollutants of dimethoate and copper are applied.

Table 19: PPPs with priority substances and specific pollutants per crop in Metapontino area

	Commercial Name	Application in:		
		Olive	Citrus	Apricot
PPPs with chlorpyrifos-ethyl	ZELIG & RELDAN	-	12	36
PPPs with naphthalene	RELDAN	-	7	36
PPPs with dimethoate	ROGOR	10	-	-
PPPs with copper	COPPER	14	-	-

Table 3 represents the classification of the applied PPPs according to H-phrases and their application per crop. In 35% (or 35 out of 100) of the registered orchards 2 PPPs (DELAN & SIGNUM) classified as "very toxic to aquatic life" (H400) are applied only in peach orchards. In almost all registered orchards (91% or 91 out of 100) in Agri sub-basin a total of 18 PPPs classified as "very toxic to aquatic life with long lasting effects" (H410) are applied. In addition, 3 PPPs (MOVENTO, TOPAS & ROUNDUP) classified as "toxic to aquatic life with long lasting effects" (H411) are used in the 69% (or 69 out of 100) of the total orchards. Moreover, 2 PPPs (NIMROD & NEEMIK) classified as "harmful to aquatic life with long lasting effects" (H412) and 1 PPPs which "may cause long lasting harmful effects to aquatic life" (H413) are used in the 64% and 65% of the registered orchards, respectively.

Table 20: PPPs with H-phrases per crop in Metapontino area

	PPPs with h-phrases	Orchards where PPPs with h-phrases are used			% of orchards in the pilot area
		Crop	Number	%	
H400	DELAN	Peach	7	14.6	35.0
	SIGNUM	Peach	34	70.8	
H410	CALYPSO	Apricot	17	94.4	91.0
		Peach	2	4.2	
	CHORUS	Apricot	16	88.9	
	LASER	Peach	44	91.7	
	CUPRAVIT	Apricot	11	61.1	
		Peach	38	79.2	
	DELAN	Peach	7	14.6	
	EPIK SL	Citrus	13	68.4	
	KARATE	Peach	35	72.9	
	Mezene	Peach	37	77.1	
	POLTIGLIA DISPERSS	Apricot	11	61.1	
	POMARSOL	Peach	38	79.2	
		Apricot	2	11.1	
	SIGNUM®	Peach	34	70.8	

	TREBON UP	Olive	4	26.7	
		Citrus	8	42.1	
		Apricot	14	77.8	
	VERTIMEC	Apricot	11	61.1	
		Citrus	14	73.7	
		Peach	1	2.1	
	ZELIG	Citrus	12	63.2	
	RELDAN	Peach	36	75.0	
		Citrus	7	36.8	
	PROTIL EC	Apricot	2	11.1	
	COBRE NORDOX	Citrus	2	10.5	
		Peach	7	14.6	
	PYRETHRUM NATURE	Olive	7	46.7	
		Peach	7	14.6	
		Citrus	2	10.5	
H411	MOVENTO	Citrus	15	78.9	69.0
		Peach	36	75.0	
	TOPAS	Peach	36	75.0	
	ROUNDUP	Olive	2	13.3	
		Apricot	15	83.3	
		Peach	37	77.1	
		Citrus	11	57.9	
H412	NIMROD	Apricot	17	94.4	64.0
		Peach	38	79.2	
	NEEMIK	Peach	7	14.6	
		Citrus	2	10.5	
H413	ROUNDUP	Peach	37	77.1	65.0
		Citrus	11	57.9	
		Apricot	15	83.3	
		Olive	2	13.3	

As far as the fertilizers are concerned in Metapontino area 21 distinct types of fertilizers are applied (Table 4). All the applied fertilizers (100% or 21 out of 21) are composite organic fertilizers. From the total of 21 fertilizers applied, 67% (or 14 out of 100) are compound/ multinutrient fertilizers (NP, NK or NPK), while 29% of them (or 6 out of 21) are straight fertilizers (N, P or K). In general, the 76% (or 16 out of 21) of the applied fertilizers are characterized by low concentrations (less or equal to 20%) of primary and secondary nutrients.

Table 21: Type and mineral elements (%) of fertilizers used in Metapontino pilot area

Fertilizer	Mineral elements (%)							
	N	P_2O_5	K_2O	CaO	MgO	S/SO_3	Na_2O	B

Nitrophoska Gold	15	9	15					
Fertilizer 20-20-20	20	20	20					
Calcium Nitrate	16	0	0	26				
Fertilizer 12-12-17	12	12	17					
Fertilizer 20-10-10	20	10	10					
Ammonium Sulphate	21	0	0					
Green Go	12	8	24	10				
Nov@ GR			5					
Urea Sulfate	29	0	0					
Stallatico	2	2	2			21		
Urea Phosphate	18	44	0			21		
Potassium Nitrate	13	0	46			21		
Nitrophoska Perfect	15	5	20		2	8		0.02
Green Go	12	20	30					
Stallatico	3	3	3			21		
Azocor 105	10.5	1.2	1			21		
Boroplus					11	21		
Nitrophoska® super 20+5+10	20	5	10		3	12.5		
Entec 20+5+10	20	5	10					
TIOFERTIL	10					44		
FERTIL 12,5	12.5							

All agrochemicals and fertilizers used in Agri sub-basin are allowed for use in each crop and the doses applied are in accordance with the Italian national legislation. Concerning the agrochemicals that are used, N, P and K contained in fertilizers are known as having a high risk of pollution for surface and ground water. In particular, the Metapontino area is considered as a nitrate vulnerable zone (NVZ) and, for this reason, it has specific allowed amount of nitrogen (that concerns mainly the spreading of organic manure and slurry in a specific period of the year).

Although the majority of the applied fertilizers are characterized by low nutrient concentrations and as a result low environmental risk, the excess fertilization can cause eutrophication of surface water bodies and specifically pollution caused by nitrates and phosphorus. Eutrophication results in the excessive growth of aquatic plant life, depletion of dissolved oxygen thus suffocating fish and other animal life. The combination of the above and ANNEX VIII of WFD according to which substances which contribute to eutrophication (in particular, nitrates and phosphates) are considered to be Main Pollutants leads to the conclusion that all fertilizers utilized in Metapontino pilot area (as they contain nitrates and/or phosphorus) are considered as Main Pollutants. In groundwater, nitrates pollution causes the accumulation of high concentration of nitrates in water, compromising the quality of water and resulting in water not suitable for drinking.

The substances that are included in the fertilizers used in Metapontino are in most cases not hazardous for the aquatic environment, when utilized properly. The only exception is the *Ammonium Sulphate*, as this substance is toxic to aquatic life with long lasting effects (H411). Ammonium Sulphate is applied only in citrus orchards and especially in 7% (or 7 out of 100) of the registered orchards.

2.4. Other Agricultural practices applied

From the 100 registered orchards included (Table 5), 17 were organic (17%), while almost all registered orchards in Agri sub-basin are irrigated (96 irrigated orchards and 4 rainfed orchards).

Table 22: Indicative data collected through the 1st AWMS form, for the registered orchards in Agri pilot sub-basin

Parameter	Olive	Citrus	Peach	Apricot
Number of orchards	15	18	48	18
Organic orchards	8	2	7	0
Irrigated	12	18	48	18
Soil cultivation applied (number of cases)	11	17	46	14
Weed mowing (number of cases)	4	17	46	14
Use of cover crops (number of cases)	12	0	0	0
Pruning applied (number of cases)	15	11	45	11
Shredding of prunings (number of cases)	15	19	45	11
Application of organic material from external sources (number of cases)	3	0	1	0

Considering the basic orchard management practices of olive orchards, one pruning intervention per year is performed in the 70 % of olive orchards, while the remaining perform pruning every two or three years. Weed control is practiced by tillage in 80% of olive orchards, increasing the potential of soil erosion while weed mowing is practiced in only 20% of olive orchards with a number of mowing interventions per year that range from 2 to 3. In all orchards in which pruning is applied, the thinnest pruned wood is shredded and spread on the soil surface, while the greater pruned wood is used for heating.

As far as the basic citrus orchard management practices are concerned, two pruning interventions (winter and summer pruning) per year are performed in 58 % of these orchards. Weed control is practiced by tillage in 89% of citrus orchards, increasing the potential of soil erosion, while weed mowing is practiced in most of citrus orchards with a number of mowing interventions per year that range from 3 to 4. In all citrus orchards in which pruning is applied, pruned wood is shredded and spread on the soil surface, increasing the soil organic matter (SOM).

Two pruning interventions (winter and summer pruning) per year are performed in the 94 % of peach orchards. Weed control is practiced by tillage in 96% of peach orchards, increasing the potential of soil erosion and in the same percentage, weed mowing is practiced with a number of mowing interventions per year that range from 3 to 4. In all peach orchards pruned wood is shredded and spread on the soil surface, increasing the soil organic matter (SOM).

Considering the basic apricot orchard management practices, two pruning interventions (winter and summer pruning) per year are performed in 61% of apricot orchards. Weed control is practiced by tillage in 78% of these farms, increasing the potential of soil erosion and in the same orchards weed mowing is also applied. Pruned wood is shredded and spread on the soil surface in 61% of apricot orchards.

Except for 3 olive orchards in which manure is applied and 1 peach orchards in which both manure and compost are applied, in the rest 96 registered orchards there is no use of organic materials like manure and compost, therefore the pollution risk from the use of chemical fertilizers is high.

2.5. The governance strategy of AFI

Effective F.ORs governance in relation to water management constitutes one of the major factors that has to be taken into account for the development of the water resources management strategy of each F.OR. This is also underlined by EWS Standard, according to which one out of the four principles is dedicated to water governance and aims at achieving equitable and transparent management of water resources. The current status of AFI's governance strategy was investigated and its readiness to take adaptive actions was assessed in the context of Action C2 by evaluating the responses in the 3rd form of the Agricultural Water Management System.

The overall readiness of AFI in relation to water governance directions indicated by the 4th principle of EWS was identified as low. More specifically, the main findings of the assessment are summarized below:

- AFI has not established the appropriate procedures and documentation in order to ensure compliance with the legal requirements related to water management. Moreover there is no responsible person or department for the above.
- None procedure and documentation are established that link water management to the management of other resources.
- The water efficiency increasing potential is considered as low, since water losses during irrigation are not estimated and there are no increasing water efficiency actions documented and implemented.
- There are no water related dissemination activities, either internal or external, implemented and also there are no actions documented and implemented related to the management of incidents. Therefore, the current degree of transparency on water management for AFI is considered as low.
- In the context of ensuring continuous improvement in water management, Good Agricultural Practices are implemented in a well-organized manner only by the farmers that adhere to GLOBALGAP standards.
- With regard to the economic transparency of water management the current readiness status is considered as low since the investments made for maintenance and improvement of the water management are not reported, while an environmental cost analysis has not been compiled yet.
- Currently, there is no water management strategy established, implemented and monitored.

3. RESULTS OF IMPACT ASSESSMENT

3.1. Impacts on water quantity

As it is shown in Fig. 2, the water stored in Monte Cotugno dam and regulated by Gannano weir is utilized for the provision of water to the multiple uses in the catchment area of the pilot Agri sub-basin. According to the approved River Basin Management Plan of South Apennine 2015-2021 the ecological status of Monte Cotugno (ITF_017_LW-ME-4-Monte Cotugno) and Gannano (ITF_017_LW-ME-2-Gannano) is totally unknown (Table 23). Thus, no conclusions on their quantitative status could be made from the particular information.

Table 23: Ecological Status of lakes in Agri sub-basin

EU_CD_LW	Name	Type	Ecological Status
ITF_017_LW-ME-4-Monte Cotugno	Monte Cotugno	Dam (ME-4)	Unknown
ITF_017_LW-ME-2-Gannano	Gannano	Dam (ME-2)	Unknown

However, an assessment on the quantitative status for the purposes of the LIFE AgroClimaWater could be made if the relation of the water available for use with the water consumed is considered.

Monte Cotugno dam has a maximum water capacity of 530 Mm^3 and provides almost the half of its water capacity to water consumers, an average of 275.27 Mm^3, while a quantity is stored as a reserve for the next year. In dry hydrological conditions the water is not ample to satisfy all the water needs and restricted measures is taken by the managing authority of the reservoir. Special attention is given to measures related with irrigation water. Regarding Gannano weir, its main operation is the regulation of water volumes released from Pertusillo and Cotugno dams, thus its storage water capacity is only 2.6 Mm^3. Therefore, the quantity of water provided for irrigation from Gannano weir depends on the quantities released by the two dams and the water collected from the upper streams. Thus the quantitative status of Gannano weir is expected to be degraded on one hand during summer, drought periods as the water released from Pertusillo and Cotugno dams in this period of the year and also the water inflows in the weirs due to meteorological conditions is less than the rest period of the year and on the other hand when the managing authority of the weir decides to empty the weir at the end of each year.

Considering the water consumed by all the water users within the catchment area of the pilot basin of Agri that presented in Table 1, the total volume of water consumed per year is 49.14 Mm^3, out of which the 92.1% is used for irrigation and the rest for other potable uses. Thus, agriculture might impose more impacts on water quantity than potable use.

Regarding Monte Cotugno dam the 54,56 % of water consumption is irrigational for the entire area both Basilicata and Puglia while for the area of Bailicata the amount of the water provided to agriculture is 124.96 Mm^3 out of the 133.04 (93.93%). Thus the pressure might impose by the agriculture on the dam is severe especially during the dry years and the summer period. As far as Gannano weir is concerned neither impacts nor pressures are expected to be imposed by water abstraction as water from the weir is used for irrigation only if it is in excess.

Regarding the use of irrigation water, data collected on the use of irrigation water by the 1st AWMS form revealed that 96 orchards irrigated in a total of 100 orchards. More in particular, the 47% of the olive orchards seem to be over irrigated, while in no

orchards deficit irrigation is applied. The 5% of the citrus orchards seems to be over irrigated while in no one deficit irrigation is applied. The 17% of the peach orchards seems to be over irrigated, and in almost 38% of them deficit irrigation is applied. Finally, only 4 apricot orchards seem to be over irrigated, while in almost 45% of the farms deficit irrigation is applied.

3.2. Impacts on water quality and affected destinations

The Agri sub-basin could be divided into 14 sub-basins based on the 14 surface water bodies that have been recognised according to the River Basin Management Plan of Hydrographic district of the Southern Apennines 2015-2021 (Distretto Idrografico dell'Appennino Meridionale, 2016). Only 6 out of 14 sub-basins (Agri3, Agri4, Agri5, Agri8, Agri9 and Agri10) are included in the following analysis as only in these sub-basins registered orchards are located.

According to the risk assessment analysis that is presented in sub-deliverable C2.2 "Runoff, leaching and erosion risk assessment" the 5 out of 6 sub-basins are characterized by moderate runoff risk potential and only Agri10 sub-basin by low runoff potential. In addition, the orchards that are fertilized and in which PPPs are applied and they are located in areas with runoff potential higher than moderate are equal to 51% and 53%, respectively.

As far as erosion potential is concerned it are varied from very low to moderate with the largest part of Agri's sub-basins to be characterized by very low erosion potential. More specific, 5 out of 6 sub-basins are characterized by very low erosion potential and only Agri3 sub-basin is characterized by moderate erosion potential. In addition, the orchards that are fertilized and in which PPPs are applied and they are located in areas with erosion potential higher than moderate are equal to 2% and 3% of the total registered orchards, respectively.

The leaching potential in the pilot area demonstrates a wide range of variations, with the largest part characterized by low to moderate potential.

The leaching potential in the pilot area demonstrates a wide range of variations, with the largest part to be characterized by low to moderate leaching potential. As far as the leaching potential for both groundwater bodies is concerned it presents a wide range of variation (from very low to high), thus indicating significant leaching potential variability. On the average, leaching potential for both groundwater bodies is estimated to be moderate. The percentage of the registered orchards in which fertilizers and PPPs are used and located in areas with higher that moderate leaching potential is equal to 53% for both categories.

In general, the 91% (or 91 out of 100) of the registered orchards are fertilized while in the 94% (or 94 out of 100) of the registered orchards PPPs are used. Moreover, in the registered parcels, there are no PPPs used that contain specific pollutants, but the percentage of registered parcels that use PPPs with priority substances is 48%. More specific, in the 12% of the registered parcels, PPPs used contain the priority substance of Chlorpyrifos-ethyl and in the 43% of the registered parcels, PPPs used contain the priority substance of Naphthalene.

In 35 registered orchards (35%) PPPs classified as H400 are used. The percentage of orchards in which such PPPs are applied in each sub-basin is varied from 0% the minimum in sub-basins Agri 3, Agri 4 and Agri 5, to 85.7% the maximum (or 12 out of 14) in Agri 10 sub-basin. As far as PPPs classified as H410 are consented they are

used in 94 registered orchards (94%). The percentage of orchards in which such PPPs are applied varied from 75% to 100% in all sub-basins.

The 20 potentially affected destinations (surface water bodies and HCVAs) that are located within Agri sub-basin are mentioned in the following Table 8 and they are presented in Fig. 4. For the 2 out of 3 surface water bodies (AGRI 1 and AGRI 2) the only available information that is related to their ecological status shows that it is sufficient. The chemical status for the 3 surface water bodies is unknown. Also for the 9 out of 17 HCVAs it is known that their qualitative status is excellent. Particularly, these are the bathing waters that are described in Table 8. For the rest HCVAs their status is unknown. As far as the two groundwater bodies is concerned the both qualitative and quantitative status of both water bodies, Alluvial aquifer of Agri River (T17BAGR) and Metaponto plain (IT17DPMET) has been identified as not good, but with no increasing trend of pollutants.

Table 24: Potentially affected destinations within Agri sub-basin

Code	Name	Type	Ecological Status	Chemical status	Qualitative Status	Quantitative status	Pressures/ Threats/ Impacts
ITF_017_RW-16SS03T-AGRI 1	AGRI 1	River	Sufficient	Unknown	-	-	-
ITF_017_RW-18SS03T-AGRI 2	AGRI 2	River	Sufficient	Unknown	-	-	-
ITF_017_RW-16EF07T-F.SO VALLE	F.SO VALLE	River	Unknown	Unknown	-	-	-
ITF_017_LW-ME-2-Gannano	Gannano	Dam	Unknown	Unknown	-	-	-
ITF_017_CW-C3_FLUV-Policoro	Piana di Policoro	Coastal water systems	-	-	-	-	
ITF_017_CW-F3_FLUV-Cavone	Piana del Cavone	Coastal water systems	-	-	-	-	
IT017077031002	CANALE BUFALORIA - 100 MT. MARGINE NORD	Bathing waters			Excellent	-	-
IT017077031003	CANALE BUFALORIA - 100 MT. MARGINE SUD	Bathing waters	-	-	Excellent	-	-
IT017077021006	FOCE AGRI - 1500 MT. MARGINE SUD	Bathing waters	-	-	Excellent	-	-
IT017077031004	FOCE AGRI - 250 MT. MARGINE NORD	Bathing waters	-	-	Excellent	-	-
IT017077021003	FOCE AGRI - 250 MT. MARGINE SUD	Bathing waters	-	-	Excellent	-	-
IT017077031006	IDROVORA SCANZANO ION.-100 MT.MARG. NORD	Bathing waters	-	-	Excellent	-	-

IT017077031007	IDROVORA SCANZANO ION.-100 MT.MARG. SUD	Bathing waters	-	-	Excellent	-	-
IT017077021005	IDROVORA TORRE MOZZA-150 MT. MARGINE SUD	Bathing waters	-	-	Excellent	-	-
IT017077021004	IDROVORA TORRE MOZZA-150 MT.MARGINE NORD	Bathing waters	-	-	Excellent	-	-
IT9220080	Costa Ionica Foce Agri	SCI	-	-	-	-	-
IT9220095	Costa Ionica Foce Cavone	SCI	-	-	-	-	-
46037	Fiume Agri da intermedio alla foce	Water Bodies to support fish life and shellfish	-	-	-	-	-
-	-	Vulnerable Nitrate Zones	-	-	-	-	-
IBA 196	Calanchi della Basilicata	Important Bird Area	-	-	-	-	-

Taking into account the information presented above and especially:

- The runoff risk potential for the entire basin is categorized higher than moderate,
- The intensive agricultural practices applied, where 91 out of 100 registered orchards use fertilizers and 94 out of 100 registered orchards use PPPs that are very toxic to the aquatic environment with long lasting effects (H400 & H410),
- 48% of the registered orchards use PPPs with priority substances (naphthalene, chlorpyrifos-ethyl)

It can be assumed that in cases where non good agricultural practices are applied, the agricultural activities can impact all the surface water bodies due to the runoff risk potential considering also the fact that the 95% of the registered orchards are irrigated. Nevertheless, since the chemical status of all water bodies is unknown, there are no data to assess the impacts impose to them by anthropogenic activities/pressures and agriculture particularly so far. The identification of their status is a demanding process and should be elaborated by the relevant authorities.

In relation to the impacts of agricultural activities in 8 out of HCV areas (ITF_017_LW-ME-2-Gannano, ITF_017_CW-C3_FLUV-Policoro, ITF_017_CW-F3_FLUV-Cavone, IT9220080, IT9220095, 46037, IBA 196 and NVZ), they could not be also assessed since they are interrelated with surface bodies with mostly unknown ecological and chemical status. However, given all the above it is concluded that these 8 HCV areas that are included within Agri sub-basin are expected to be affected by agricultural activity. As far the impacts on the 9 bathing waters are concerned, as their status is excellent it can be assumed that the agricultural activities have no impact them in terms of their quality so far.

In reference to the groundwater bodies, according to the approved River Basin Management Plan of South Apennine 2015-2020 the qualitative and quantitative status of the 2 groundwater bodies, P-AGR (IT17DPAGR) and P-MET (IT17DPMET) located in the pilot area is not good.

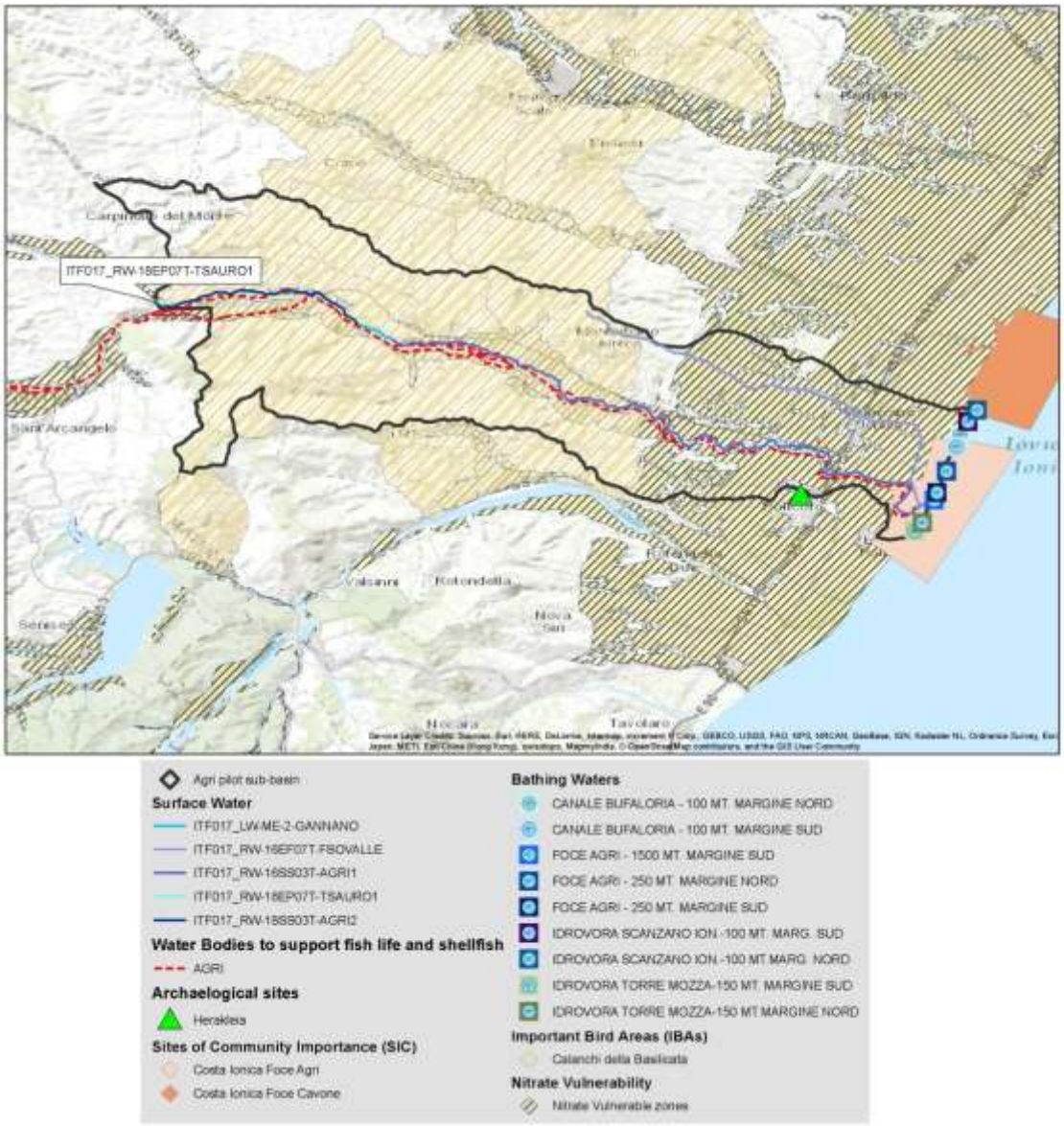


Fig. 13: Potentially affected surface water bodies and HCV areas in Agri sub-basin

Considering also the information presented above and in particular that:

- The agricultural activities that are applied are intensive.
- The average leaching potential is moderate
- The information on the used fertilizers and PPPs

It can be assumed the anthropogenic activities and in particular the agricultural activities have an impact on the environment in general and specifically the groundwater bodies. Furthermore, the area has been designated as a Nitrate Vulnerable Zone (NVZ) for the purposes of the EU Nitrate Directive, due to the high concentrations of chlorides and nitrates to both the groundwater bodies respectively. As a result, the Italian National Legislation is imposing measures and limits as far as

the use of PPPs and Fertilizers is concerned. Thus, in cases where non good agricultural practices are applied, there is a very high risk of further polluting water bodies irreversibly.

4. FORMATION OF WATER MANAGEMENT ADAPTATION STRATEGY OF AFI

The WMAS for AFI was formed taking into account the results of deliverable C3.1 "Proposal of farm specific Action Plans (GAPs and monitoring measurement equipment)" and C3.2 "Governance actions and floods and droughts action plan for the participant FORs" as well as the main measures that are relative to the agriculture and are included in the Programme of Measures of the River Basin Management Plan of Hydrographic district of the Southern Apennines 2015-2021 (Distretto Idrografico dell'Appennino Meridionale, 2016) as they are briefly presented in the following sections.

4.1. Good Agricultural Practices for water efficiency enhancement

The Good Agricultural Practices (GAPs), proposed by the LIFE AgroClimaWater (Action C3, deliverable C3.1) project and will be implemented and monitored during the next period constitute a vital component of the water management strategy of AFI.
The main aim of these GAPs is to enhance water use efficiency during the cultivation process and to contribute to the environmental protection of water resources and protected areas, as well as to protect crop productivity and farmers income in the view of climate change. The GAPs proposed are the following:

- **Irrigation management**

a) *Irrigation system setup:* A set of water-meters and volumetric valves can be introduced in each orchard, in order to provide farmers with the tools to precisely control the amount of irrigation water that is applied to the orchard.

b) *Soil characterization:* Chemical-physical and hydrological characteristics of the soil can be investigated in order to know the capacity to retain water, define the wilting point (WP) and the field capacity and the optimal threshold for the crop.

c) *Compiling a daily water balance calibrated on the need of the crop in relation to the climatic conditions:* In order to define the irrigation volumes a spreadsheet can be compiled with environmental data (ET0, rainfall…), soil characteristics and orchard information (irrigation system, K_C).

d) *Deficit irrigation*: During the post-harvest period, a regulated deficit irrigation scheme can be applied in the farm, based upon meteorological data, monitoring sensors and the use of crop coefficients (K_C =0.5).

- **Soil management and Nutrition**

a) *No soil tillage:* This practice can contribute to the reduction of evaporation losses because of avoiding bare soil.

b) *Spontaneous cover crops*: Mowing of cover crops (in a reduced soil portion of 20 cm, compared to the control, 80 cm) can be applied during the periods of high competition for nutrient, water and light between the main crop and the cover crops.

c) *Shredding of prunings*: Pruning residues can be shredded into the demonstration plot.

d) *Application of organic material*: Organic matters (compost, manure) can applied during winter. Application of locally available organic matter could be used for improving the soil water holding capacity. In this way the rapid vertical movement of water along the soil profile can be reduced.

e) *Nutritional Balance*: Assessment of orchard input (fertilizers, chopped pruning material and weeds) and output (plant nutritional request) for nutritional balance.

- **Canopy management**

a) *Winter pruning:* Winter pruning can be applied in order to obtain the optimal balance between leaf area and yield.

b) *Summer pruning:* UNIBAS research group will evaluate each year the need for pruning during pre or post harvest. Pre-harvest pruning improves light penetration and, therefore, standardizes the quality of fruits in different zones of the canopy. Any interventions in post harvest will aim to reduce the transpiration, avoiding the shaded areas in the canopy and then increase the WUE.

Ten pilot farms were selected based on a methodology presented in Deliverable "Proposal of farm specific Action Plans" (Action C3) in order to apply the GAPs presented above. The location of each pilot farm in the pilot sub-basins in illustrated in Fig. 14, while the GAPs applied in each farm are listed in Table 25. More details about GAPs implementation can be found in the farm specific action plans compiled in the context of Deliverable "Proposal of farm specific Action Plans" (Action C3).

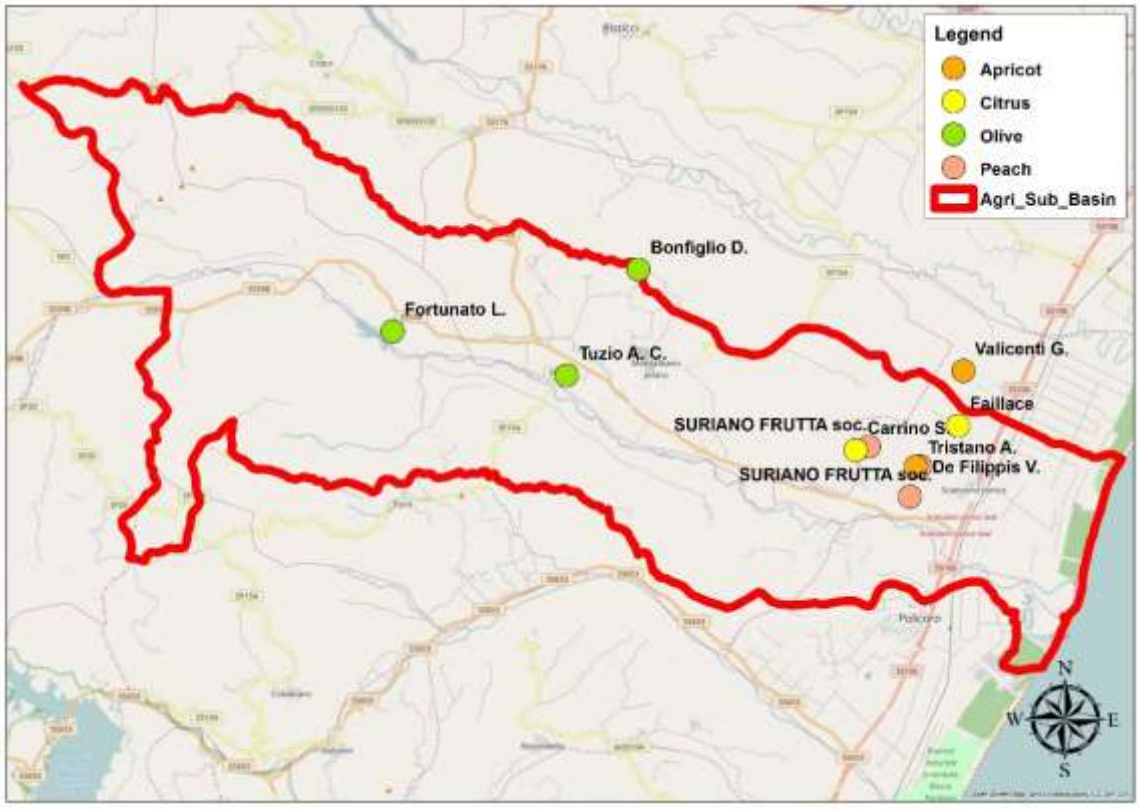


Fig. 14: The selected 10 pilot farms in Agri sub-basin with the corresponding codes

Table 25: GAPs scheduled to be applied in the 10 pilot orchards of AFI

Code	Crop	Weed Mowing	Cover Crops	No soil tillage	Pruning Winter-summer	Shredding of prunings	Organic material addition	Nutritional Balance	Irrigation network setup	Irrigation scheduling/ deficit irrigation
29	Apricot	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x / x**
79	Apricot	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x / x**
63	Citrus-Orange	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x / x**
44	Citrus-Clementine	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x / x**
110	Peach	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x / x**
84	Peach	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x / x**
85	Peach	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x / x**
107	Olive	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x / x**
101	Olive	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x / x**
97	Olive	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x**	**x / x**

4.2. AFI's Governance Actions for equitable and transparent water governance

Water governance within AFI constitutes the framework under which efficient and sustainable water management can be achieved and therefore it is included as an integral part of the present strategy aiming at:

1. Ensuring conformance with water related legal requirements.
2. Identifying and managing interrelations of water with other resources used in agricultural sector.
3. Adaptive capacity building (information, training and raise public awareness).
4. Promoting the participation of the agricultural sector in decision making with respect to the management of the water basin.
5. Ensuring preparedness and response to environmental incidents on the area caused by eventual accidents and adverse weather conditions.

Therefore a set of actions was developed, described in detail in "Governance actions and floods and droughts action plan for the participant FORs" Deliverable C3.2 (Action C3) accompanied by the corresponding procedures and documentation, which are summarized as follows:

- **Ensuring compliance with all legal requirements linked to water use**: A procedure is established for following up legal matters on water. Moreover, an assignment was created according to which a person or department is identified who will ensure compliance with legal requirements linked to water.
- **Linking water management to the management of other resources**: The quantitative relation of: a) water and energy use and b) water and other resources than energy has to be identified and optimized. Therefore, the appropriate recording system has been developed in order to quantify the aforementioned relations. The assessment of recording results can indicate improvement potential in water management in relation to energy and other resources.
- **Raising efficiency of water consumption**: Three specific actions are proposed in order for AFI FOR to raise its efficiency of water consumption. The first action is related to the identification of water losses and their destination and therefore the appropriate methodology and documentation was developed. The second action is the planning, implementation and monitoring of measures that will enhance water efficiency. A set of measures are identified from the GAPs pool presented above which aim to improve water efficiency and more specifically: a) Calculation of evapotranspiration losses, b) Plan for farm irrigation network improvement and c) Deficit irrigation. The results of the above GAPs implementation are recorded and the year after year comparison can indicate the increasing water efficiency potential of each practice. The final action includes the calculation of total water consumption per unit of product.
- **Ensuring transparency on water management**: In the context of promoting and ensuring transparency on water management resources, FOR have to be devoted to ensure attentive communication with River Basin Committee. Thus, a person or -if possible- a department has to be defined which will represent and report on River Basin Committee activities and vice versa. The appropriate assignment has been created. Towards the internal dissemination of sustainable water management, the Water Steward of each F.OR has to make sure that all the personnel of the F.OR as well as the farmers are duly informed of F.ORs' water policy and the basic elements of WMAS, the objectives, the problems and drawbacks, the achievements, etc. Moreover,

promotional campaigns in topics related to irrigation scheduling, and GAPs implementation.

With regard to increasing the preparedness of AFI FOR to efficiently cope with unexpected situations, floods and droughts action plans were developed, as these two situations are considered of major concern for AFI FOR. A summary of floods & droughts action plans is provided in the next section.

- **Ensuring continuous improvement**: The pool of GAPs presented in the previous section can be considered as a robust basis for continuous improvement of water management within AFI FOR. The improvement potential of each GAP is under investigation and more details about implementation, monitoring and evaluation are presented in detail in the corresponding deliverable developed in the context of the current action (Proposal of farm specific Action Plans). Moreover, taking into account the fact that such practices are not currently applied or there are sparsely applied, their implementation under a water management scheme can be considered as innovative.
- **Ensuring transparency on economic aspects of water management**: Two actions are proposed in order for AFI FOR to maintain transparency on the economic aspect of water management. With regard to the first action, the investments related to maintenance and improvement of water management have to be reported. Concerning the second action, an environmental cost analysis has to be performed.

4.3. Floods & Droughts Action Plan for management of incidents

Under the scope of formulation of the adaptation strategy for F.ORs the "Floods and Droughts Action Plan" was developed by the LIFE AgroClimaWater (Action C3, deliverable C3.2) in order to ensure the preparedness and response of F.ORs to environmental incidents caused by the imminent climate change.

Two are the main components of floods action plan:

- identification of flood risk and
- management of floods

The **river flood risk assessment** is based on the corresponding reports developed by the Italian Governmental Authorities in compliance with Directive 2007/60/EC. The results demonstrated that a very high hydraulic hazard area was identified along the Agri river course. Concerning flood risk, a very high risk area was identified on the lower part (near the mouth of the river) of the Agri sub basin and along the Agri river course (on the left–hand side). The same area is classified as of very high damage. With regard to flash floods risk assessment, which were based on the results of surface runoff potential estimation in the context of Action C2, overall the contribution of the agriculture activity developed in Agri sub-basin to the development of flash floods is low to moderate.

With regard to **flood management**, actions and measures proposed to be implemented were divided into two categories having in mind to mitigate: a) flash floods and b) river floods. The 1st category includes practices that aim to reduce farms contribution to flash floods. Therefore, several practices from the pool identified in the previous section were proposed that can contribute (directly or indirectly) in runoff potential reduction (no weed control, no soil tillage, physical reduction of surface runoff), while some other practices were also included (conservation buffers, avoidance of vehicle movements and wheel ruts on wet soil, avoidance to the best

possible degree, of heavy machinery use within the farm). Concerning river flood management several measures and practices were proposed that can be implemented both by FOR Management and FOR Members categorized as actions and measures applied before flood, during flood and after flood.
In a similar manner, the droughts action plan was developed, which comprises of two main sections:

- the drought risk assessment section, in which the potential of drought occurrence is assessed and
- the drought risk management section, in which specific actions are proposed in order to enforce the drought preparedness level of the FOR.

According to the Water Resources Management Plan (WRMP) of Hydrographic district of the Southern Apennines (2010, 2015 - 2021) a drought management plan has not been developed yet. Since this strategic plan is not existing, information about **drought risk assessment** were retrieved from alternative scientific sources. Basilicata Region as well as other Southern Italy's regions are affected by the desertification issue where soil degradation - depends on more and more arid climatic conditions, exceptional rainfall of increasing intensity, excessive water withdrawals at certain period of the year, fires characterized by high frequency, etc. According to Interregional River Basin Authority of Basilicata, Basilicata region, though rich in water resources, is an area exposed also in drought and desertification phenomena, primarily linked to the characteristics of the meteorological regime in the area, such that in the last few years extreme climatic events have been occurred increasingly often. With regard to **drought management**, the application of several GAPs selected from the pool presented above are proposed to be implemented, preventive and as operational actions, since the majority of them aim to water saving and therefore they can significantly contribute to droughts management.

4.4. River Basin Management Plan of Hydrographic district of the Southern Apennines relative to agriculture

The Programme of Measures consists part of the River Basin Management Plan of Hydrographic district of the Southern Apennines and the "mechanism" for the achievement of the environmental goals that are mentioned in the plan.
The Programme of Measures is updated every six years and it presents a set of measures, both structural and non-structural character, that are split up in the following subject areas:

- Water resources quantity and connected physical-environmental system - surface and underground water bodies;
- Quality of water resources and connected physical-environmental system – surface and underground water bodies;
- Morphology-hydraulic-environmental system - river and coastal region;
- Water system, sewerage and treatment plants (supply systems, use, treatment and management) - irrigation system - industrial System

At the framework of the measures, above mentioned, have been associated structured programming framework defined by:

- Framework agreements program Government-Region;
- 2007-2013 Regional Programming
- Area Plans Programming;
- Specific program agreements.

Following the new organization of measures to:

- General actions/measures (AG)
- General and specific measures (MG and MS)
- Additional measures for different sectors (MU)

The measures which have been proposed in the River Basin Management Plan of Hydrographic district of the Southern Apennines are divided into two categories, basic and supplementary measures.

All measures are based on the type of water body and the sector of use. In addition, it is made explicit the link with both the actions connected with the Risk Management Plan Floods and the pilot actions already carried out by the Basin.

The detection of punctual measures whether basic or supplementary, will be defined in the implementation phase of the concert plan with the regions, in view of the possible availability of more detailed information regarding the pressures, the risk, the exemptions and the finalization of the 2014-2020 programming period.

According to the categorization that is applied in the River Basin Management Plan of Hydrographic district of the Southern Apennines the measures that are related to the agricultural sector are presented as follows:

Basic Measures

- **General measures**

a) Concerted redefinition of surface and groundwater bodies identified within the Water Protection Plans and the Water Management Plan - AG.01

b) Definition of the criteria for the evaluation of the water balance / average annual water balance (under D.M.28/07/04 and D.vo 30/2009) - AG.02

c) Definition of the criteria for the determination and regulation of the water releases for the maintenance of the ecological flow (Minimum Vital Outflow) - AG.03

d) Stipulation of inter-regional agreements for transferring the water resources - AG.05

e) Identification and regulation of alternative drinking water sources to overcome water crisis or severe water shortages - AG.07

f) Regulation and control of samples (water, aggregates, etc.) and effluent (water and others), and the fight to illegal actions - AG.08

g) Identification of actions for different sectors aiming the protection of water resources policies - AG.09

h) Implementation of the Public Participation path, even though information, training and participation projects of "Environmental Laboratory" - AG.10

i) Proactive management/proposals: Programme agreements and arrangements for the protection and restoration of water and land systems, environmental and cultural related, as well as the correlation of the flood risk mitigation - AG.11

j) Reorganization of the autonomous sources of water supply and its regulation - AG.12

k) Reordering of management systems for civil, irrigation and industrial sectors - AG.13

l) River contracts - AG.14

m) Guidelines for use and protection of adjacent strips to surface water bodies - AG.15

n) Management plans of Natura 2000 network - AG.17

o) Actions to manage public lands - AG.18

p) Guidelines for use of groundwater resources in industrial agglomerations - AG.19

q) Planning and coordinated joint planning and for the integrated protection of soil water resources and environment - AG.20

r) Adaptation of the directives plans and programs: Sector plans (energy, transport, waste, mining, industrial, agricultural, forestry, irrigation systems, fisheries, tourism) - AG.22

s) Application of the measures provided by the Action Plan and by Legislative Decree 150/2012 on the sustainable use of plant protection products at Regional scale - AG.24

t) Application of Ministerial Decree 180/2015, even in areas not subject to cross-compliance according to the Regulation 1306/2015 - AG.25

u) Encourage the correlation between the regulations on the transposition of the Nitrates Directive and the implementation of the Water Framework Directive (WFD) through permanent technical meetings between institutions for sharing the update of the status of water bodies and all the basic data - AG.26

v) Coordination Basin Authorities/Regions in the frame of the implementation of the Management Plan activities through setting-up a special agriculture's working table as a place of confrontation for the implementation of agricultural and environmental policies for the water component - AG.27

w) Implementation of action programs required for the protection and restoration of waters against pollution caused by nitrates from agricultural sources by the defaulting regions and according to the current legislation - AG.28

x) Use of environmentally friendly integrated systems and the best sustainable technologies in order to capture or remove the nutrients - AG.29

y) Application of the article. 46 of EU Regulation 1305/2013 also for those companies, associations of farmers, farmer who do not benefit by European funding - AG.30

z) Encourage the coordination between institutions in order to support the implementation of the Water Management Plan through the proper preparation of agricultural and environmental policy measures for the water component - AG.31

aa) Application of the decrees of the national reference standards with particular reference to D.M. April 3, 2006 on livestock manure - AG.32

bb) Implementation of consumption accounting system according to DM 31.07.2015 "Approval of the guidelines for the regulation, by Regions, of the measuring systems of irrigation consumption" - AG.34

cc) Analysis and possible review of the ecological state on the basis of the updated methods for classification, with particular reference to the fish fauna - AG.36

dd) Adjustment of evaluation methods of the chemical and quantitative status of the GW with current guidelines - AG.40

ee) Define and implement at district scale a uniform methodology for the assessment of the qualitative and quantitative trends for the purpose of GW classification - AG.41

ff) Define and implement at district scale a uniform methodology for assessing the impact of the values for the GW classification - AG.42

- **Measures for surface water bodies – rivers**

a) Ecological flow (Minimum Vital Outflow) updating - MG.F.03

b) Updating /redefinition of the water bodies quality status - MG.F.05

c) Cadastre of discharges into surface water bodies - MG.F.06

d) Monitoring of surface water bodies - MG.F.08

e) Programs for the protection, retraining and proper use of river and coastal regions area - MG.F.09

f) Database and Territorial Information System (TIS) of surface waters - MG.F.10

- **Measures for surface water bodies – lakes**

a) Reorganization of the system of concessions for the equilibrium of the water balance - MG.L.02

- **Measures for surface water bodies – coastal seawater bodies**

a) Upgrade the quality status of water bodies - MG.M.03

b) Monitoring of coastal marine water bodies - MG.M.05

c) Realization of monitoring sediment transport networks - MG.M.06

- **Measures for surface water bodies – underground water bodies**

a) Redefinition/Update of the chemical status in accordance with Legislative Decree 30/09 - MG.S.04

b) Redazione di carte dei suoli - MG.S.06

c) Soil monitoring - MG.S.07

d) Updating of vulnerable areas based on new monitoring data MG.S.09

e) Drafting of addresses for the use of the soil with the aim to reduce the waterproofing and for increasing in the infiltration of recharge areas of aquifers - MG.S.10

f) Monitoring the diffuse sources of nutrients outside of Nitrate Vulnerable Zones, at farm scale - MG.S.13

g) Monitoring, at farm scale, with regard to diffuse sources of pesticides - MG.S.14

h) Monitoring, at farm level, with regard to diffuse sources of organic and microbiological contamination pollution - MG.S.15

- **Measures for surface water bodies – rivers**

a) Creation and implementation of ecological/environmental fluvial networks - MS.F.04

b) Identification of water bodies affected by water salinization and implementation of the related mitigation programs - MS.F.05

c) Verification, control and reduction actions of the discharged hazardous substances and the use of plant protection products - MS.F.06

d) Protection actions of wetlands - MS.F.10

e) Promote the restoration of the environmental quality of the protected areas, of the free and degraded and vulnerable areas within the river landscapes - MS.F.11

f) Implementation of programs aiming to knowledge, analysis, assessment the interaction between waters, environmental, archaeological, historical and architectural heritage - MS.F.14

g) Monitoring, survey and analysis of the cultural heritage (archaeological, historical, architectural, landscaping) connected to the water resource system - MS.F.15

h) Protection of areas belonging to surface water bodies with maintenance of natural vegetation in adjacent waterways areas, as well as conservation of biodiversity - MS.F.16

i) Creation of buffer areas along the river areas - MS.F.17

j) Encouraging the increase of wooded areas within urban, river and coastal areas also for the adaptation to climate change - MS.F.18

- **Measures for water bodies – lakes**

a) Interventions for the removal of nutrients and the mitigation of eutrophication of lakes and reservoirs - MS.L.02

b) Protective actions and recovery of the lake habitats to stop the loss of biodiversity - MS.L.03

- **Measures for underground waters bodies**

a) Definition or redefinition of the water balance/average annual water balance - MS.S.01

b) Definition or redefinition of the water balance/average annual water balance or Assessment of evolutionary trend of piezometric levels of plain areas - MS.S.02

c) Definition of aquifer vulnerability (intrinsic and/or integrated) - MS.S.08

d) Define and/or redefine the Nitrate Vulnerable Zones in accordance with D.L.vo 152/06 (all.7) - MS.S.09

e) Define and/or redefine the Vulnerable Zone of Pesticides in accordance with D.L.vo 152/06 (all.7) - MS.S.10

f) Control and monitoring of the application of good agricultural practice and environmental measures - MS.S.18

g) Definition or redefinition of the chemical status of water bodies - MS.S.19

h) Actions designed to improve the quality of the surface water body - MS.S.20

i) Programs aiming at knowledge, analysis and assessment interaction water, environment,
archaeological, historical and architectural heritage - MS.S.21

j) Action programs to reduce the spread of nitrates deriving by agricultural sources - MS.S.22

k) Action programs to reduce the spread of pesticides - MS.S.23

l) Action programs to mitigate desertification and land degradation - MS.S.25

m) Monitoring the implementation of organic crops or crops that use low-polluting fertilizers - MS.S.26

n) Actions with the aim to mitigate the vulnerability of aquifers - MS.S.27

o) Encourage the increase of wooded areas to tackle desertification and promote the natural water retention - MS.S.29

p) Apply good agricultural practice, even outside of vulnerable areas also providing education and training for farmers - MS.S.30

q) Realization of cover crops and break crops, in order to capture nutrients and pesticide residues - MS.S.31

Supplementary Measures

- **Measures for irrigation sector**

a) Database and Territorial Information System (TIS) of the irrigation systems - MU.A.01

b) Monitoring of water uses and assessment of water losses - MU.A.02

c) Modernization, rationalization, upgrading and strengthening of the irrigation systems - MU.A.03

d) Adaptation of crop systems to water availability - MU.A.04

e) Maintenance plan of drainage/reclamation channels - MU.A.05

f) Optimize irrigation distribution networks and possible interconnections of the main networks and the existing reservoirs - MU.A.06

- **Measures for water treatment plants sector**

a) Modernization, adaptation and strengthening of water treatment plants also for the water reuse - MU.D.03

b) Encourage the water treatment with specific ecosystems (phytoremediation in agriculture, livestock and small villages or urban areas) - MU.D.05

- **Measures for drinking sector**

a) Database and GIS of drinking water supply systems - MU.P.01

b) Leak detection network - MU.P.02

c) Modernization, rationalization, adaptation and upgrading of water supply systems - MU.P.03

4.5. Water Management Adaptation Strategy for AssoFruit

Taking into account the above mentioned Good Agricultural Practices, Governance actions and Flood and Drought action plan proposed in the frame of LIFE AgroClimaWater as well as some of the relative to agriculture measures of the River Basin Management Plan of Hydrographic district of the Southern Apennines presented above, considering the ability Farmers' Organization to contribute to their implementation. The water management adaptation strategy (WMAS) AFI was developed in the context of the project LIFE AgroClimaWater.

The WMAS is structured in priority axes, measures and sub-measures which should be implemented by AFI and its farmers in order to enhance the sustainable management of water resources and to cope with the impacts of the prominent climate change.

In the following section the text of the WMAS for AFI is presented. The true copy of WMAS as it was signed by the board of directors of Asso fruit Italia Società Cooperativa Agricola is presented in APPENDIX I.

WATER MANAGEMENT STRATEGY AIMING TO THE ADAPTATION OF AGRICULTURE TO CLIMATE CHANGE – ASSOFRUIT-METAPONTINO

GENERAL DESCRIPTION	The proposed water management strategy focuses on the efficient management of water resources available to agriculture, in view of the potentially new climatic conditions resulting from climate change. The present draft proposal was developed in the context of the project LIFE AgroClimaWater for the partner ASSOFRUIT (AFI), after assessment of the current status of its organization structure, the condition of the water bodies in its pilot area for the project, as well as the prevailing farming practices for the crop in the pilot (citrus and stone fruits).
VISION	To manage agricultural water in such a way as to ensure the protection of water bodies and the related ecosystems, the agricultural production and the balanced development in the pilot area.
STRATEGIC OBJECTIVES	The proposed strategy will be addressed through the implementation of three cross cutting priority targets (axes), as follows: Target 1: The optimization of structure and function of AFI in relation to water management in agriculture. Target 2: The introduction of water-related Good Agricultural Practices for the crops in the pilot area. Target 3: The contribution of agriculture for the implementation of the "River Management Plan" of the Metapontino area.

CONTENT

In order to achieve the targets above, the proposed strategy focuses on measures to ensure compliance to the EU and national legislation for water, the identification and management of interactions of water with other resources used in agriculture, the development of adaptive capacity of farmers to climate change through training and awareness raising, encouragement of participation of AFI in the decision-making processes for the local basins. Lastly, it proposes measures to ensure readiness for addressing environmental incidences caused by accidents or extreme weather.

In addition, it proposes the implementation of actions/measures related to the minimization of water use, through rationalization of irrigation, the reduction of water losses due to run-off, to percolation, to evaporation from soil and to transpiration by plants and by enhancement of water retention by soil. Also, it relates to the Good Agricultural Practice with regard to the use of agrochemicals (Plant Protection Products, fertilizers).

Finally, one more area of measures in the focus of the present strategy proposal, is related to the contribution of AFI to local authorities' efforts to implement the River Management Plan in the basin under question, as well as to the Management Plan for Floods and Droughts.

PRIORITY AXES

The proposed strategy is based on three priority axes (PA), 11 measures and 46 sub-measures. AFI, with the assistance of the projects' partners will implement this strategy for a three-year period. The measures that refer to AFI's management and administration will be implemented by AFI's management (PA 1), whilst the ones referring to the farming practices (PA 2) will be implemented and recorded by the farmers – owners of the ten pilot farms of the project. Finally, as regards the PA 3, AFI should take account the proposed, relevant to agriculture, measures in the river management plan and in the flood and drought plan of Hydrographic district of the Southern Apennine in order to contribute, to the extent possible, to their implementation.

PRIORITY AXIS 1: ORGANZATION AND MANAGEMENT FOR USE OF WATER IN AGRICULTURE

The objective of this axis is to achieve and maintain effective and transparent management of the water resources through the implementation of suitable management and administrative tools of AFI.

MEASURE 1.1: COMPLIANCE WITH WATER LEGISLATION.

This measure focuses on the implementation of the appropriate procedures to ensure compliance with EU and national legislation for water management in agricultural sector.

Sub-measure 1.1.1: "Assignment to a specific section or a person within AFI of the responsibility for the compliance to legislation as regards water management"
Sub-measure 1.1.2: "Development, implementation and monitoring of processes to ensure compliance with the current legislation as regards water abstraction and distribution, including issuance of the respective licenses"

MEASURE 1.2: RECORDING AND MONITORING OF THE USE OF WATER AND OTHER RESOURCES.
This measure aims to improve the relation between usage of water and other resources in agriculture.
Sub-measure 1.2.1: "Measurement recording and reporting of water usage and of its losses"
Sub-measure 1.2.2: "Recording, evaluation and optimization of the quantitative relationships between water and other resources used by agriculture, e.g. energy, fuel, fertilizers, Plant Protection Products etc"

MEASURE 1.3: SUSTAINABLE WATER MANAGEMENT
The measure aims to abate the excessive consumption of available water resources, through their rational management.
Sub-measure 1.3.1 "Implementation and monitoring of the present strategy for the effective use and water savings in agriculture"
Sub-measure 1.3.2: "Introduction of novel measures and target- setting for the improvement of water management by AFI in the river basin of the pilot"

MEASURE 1.4: TRANSPARENCE OF COST ISSUES IN THE WATER MANAGEMENT.
The measure focuses on the recording, evaluation and dissemination of data and targets with regard to the investments on water management.
Sub-measure 1.4.1: "*Recording of the investments made for the maintenance and improvement of water management*"
Sub-measure 1.4.2: "Evaluation of current and planned investments for the implementation of water management strategy"

MEASURE 1.5: DISSEMINATION OF INFORMATION AND PUBLIC AWARENESS RAISING ON WATER MANAGEMENT IN FARMING.
The accurate and timely provision of information to the consumers and the interested stakeholders is a significant prerequisite for the sustainable use of water resources. So, this is the aim of the present measure.
Sub-measure 1.5.1: "Planning and implementation of

training actions for farmers, with regard to the water management strategy and the measures adopted by AFI"

Sub-measure 1.5.2: "Provision of information and consultancy on the requirements for water, for nutrients and for plant protection, according to the crop, the growth stage, taking into account the development of technology"

Sub-measure 1.5.3: "Awareness raising and training of farming community for the Good Agricultural Practices for water use at the farm and at the area level"

Sub-measure 1.5.4: "Provision of information and training to farmers for the mitigation of extreme weather events (e.g. prolonged drought) and water related accidents"

Sub-measure 1.5.5: "Participation of AFI and its farmers-members to the initiatives of local and regional authorities on the management and the protection of water resources"

MEASURE 1.6: CERTIFIED WATER USE IN AGRICULTURE

This measure aims to prepare AFI to implement a water management plan according to the requirements of the standard EWS, as this has been described in the LIFE project AgroClimaWater. The utmost goal is to contribute to the EU target for sustainability of water resources use through the evaluation, the control and the dissemination of appropriate practices. AFI will be supported in this by the other partners of the project.

Sub-measure 1.6.1: "Development by AFI of a water management system according to the EWS"

Sub-measure 1.6.2: "Establishment of a pilot project and attendance of the systems procedures, during the deployment of the project"

Sub-measure 1.6.3: "Reviewing and -where necessary- revision of the procedures of the project at the final stage of its implementation"

Sub-measure 1.6.4: "Evaluation of the preparedness of AFI to apply for EWS certification"

PRIORITY AXIS 2: IMPLEMENTATION OF GOOD AGRICULTURAL PRACTICE

The objective of this priority axis is the effective usage of water and to design the appropriate use of agrochemicals on crops, so as to improve, or at least maintain the current status of water resources and protected areas in the pilot area, taking in account though that the designed measures will be implemented on the 10 pilot farms of the project. However, all the farmers in the basin will be informed, so that they will be triggered to implement them as well on as wider area as possible.

MEASURE 2.1: GOOD AGRICULTURAL PRACTICE (GAP)

FOR THE USE OF AGROCHEMICALS.

Using fertilizers and Plant Protection Products (PPPs) is necessary for crop growth and health, but has to be adjusted to the soil properties and to the available technology and equipment, so as to avoid excessive use and the possibility to contaminate the water bodies.

Sub-measure 2.1.1: "Secure good growth conditions by balanced fertilization of the crops in the pilot farms"

Sub-measure 2.1.2: "Justified and well planned usage of fertilizers and PPPs, according to soil and weather conditions and crop needs"

Sub-measure 2.1.3: "Assessment of nitrogen and phosphorus balance by crop at field level, as a measure to avoid environmental impacts"

Sub-measure 2.1.4: "Adoption of specific measures for the transport and storage of agrochemicals to deter leakage risks."

Sub-measure 2.1.5: "Careful maintenance of fertilization and PPP application equipment to also deter leakage risks"

MEASURE 2.2: EFFICIENT PLANNING AND IMPLEMENTATION OF IRRIGATION.

Farmers should take all necessary measures for the protection of the water bodies, -as a minimum contribution- for the maintenance of the ecological balance and the protection of the local society. Materialization of the present measure and of its sub-measures focuses on the proper irrigation planning with the objective to achieve the sustainable use of the available water resources and the minimization of losses by the farming activities.

Sub-measure 2.2.1: "Establishment of a system to measure, record and report the volume of water used and lost by the farming sector"

Sub-measure 2.2.2: "Determination of water needs according to the growth stage of the crops and adjustment of water use to these needs when drafting the irrigation schedule"

Sub-measure 2.2.3: "Recording and monitoring of soil conditions and saturation status of soil-water, for determination of water availability and crop water needs"

Sub-measure 2.2.4: "Implementation of effective irrigation, by selection of the most appropriate method and timeliness of irrigation"

Sub-measure 2.2.5: "Implementation of suitable measures, in order to reduce losses from the water distribution network and the irrigation equipment"

MEASURE 2.3: OTHER GOOD AGRICULTURA PRACTICES FOR WATER MANAGEMENT.

In the frame of Good Agricultural Practice, all the farming practices are included in relation to soil and crop management, with ultimate target the optimization of evapotranspiration, runoff and percolation, but also the stabilization of soil.

Sub-measure 2.3.1: "Implementation of appropriate farming practices for soil cover for reduction of losses due to evaporation"

Sub-measure 2.3.2: "Implementation of best practices for weed mowing and crop pruning, in order to minimize losses due to evapotranspiration"

Sub-measure 2.3.3: "Implementation of farming practices to increase water retention by soil and minimization of deep percolation"

Sub-measure 2.3.4: "Establishment of effective techniques and practices for containment of runoff and development of suitable structures for retardation of water movement and to increase soil moisture"

Sub-measure 2.3.5: "Use of annual cover crops, in order to stabilize soil and its structure as well as to increase its filtration capacity"

Sub-measure 2.3.6: "Evaluation and assessment of leaching potential, erosion and filtration potential in fields or area level"

PRIORITY AXIS 3: CONTRIBUTION TO THE IMPLEMENTATION OF THE RIVER MANAGEMENT PLANS IN THE AGRI SUB-BASIN

The objective of this priority axis is the contribution of AFI for the implementation of basic and supplementary measures contained in the River Management Plan and in the flood and drought plan for the farming sector.

MEASURE 3.1: Implementation of River Management Plan for the area of Hydrographic district of the Southern Apennines

In the frame of the River Management Plan of Hydrographic district of the Southern Apennines (Competent Authority: ITADBR171 – Interregional River Basin Authority of Basilicata, Unit of Management: ITR171 – Basento, Cavone and Agri River Basins) a number of basic and supplementary measures is proposed for farming. The contribution of the farmers' organizations like AFI, and their farmers-members is very important.

Sub-measure 3.1.1: "Database and Territorial Information System (TIS) of the irrigation systems - MU.A.01"

Sub-measure 3.1.2: "Monitoring of water uses and assessment of water losses - MU.A.02"

Sub-measure 3.1.3: "Modernization, rationalization, upgrading and strengthening of the irrigation systems -

MU.A.03"

Sub-measure 3.1.4: "Adaptation of crop systems to water availability - MU.A.04"

Sub-measure 3.1.5: "Maintenance plan of drainage/reclamation channels - MU.A.05"

Sub-measure 3.1.6: "Optimize irrigation distribution networks and possible interconnections of the main networks and the existing reservoirs - MU.A.06"

Sub-measure 3.1.7: "Monitoring, at farm scale, with regard to diffuse sources of pesticides - MG.S.14"

Sub-measure 3.1.8: "Monitoring, at farm level, with regard to diffuse sources of organic and microbiological contamination pollution - MG.S.15"

Sub-measure 3.1.9: "Apply good agricultural practice, even outside of vulnerable areas also providing education and training for farmers - MS.S.30"

Sub-measure 3.1.10: "Realization of cover crops and break crops, in order to capture nutrients and pesticide residues - MS.S.31"

MEASURE 3.2: ADDRESSING EXTREME CLIMATIC CONDITIONS

Through this measure AFI has to adopt the generic measures that has been prepared by the respective authorities and contribute to this effort, as well as to assist farmers to adopt suitable practices at farm level to mitigate the impacts of extreme weather.

Sub-measure 3.2.1:"Implementation of any measures that will be set forward for addressing floods and draughts"

Sub-measure 3.2.2: "Implementation of Good Agricultural Practice proposed in Priority axis 2 to assist the mitigation of extreme weather impacts, e.g. reduction of run-off and of evapotranspiration, increase of soil moisture)"

Sub-measure 3.2.3: "Training of farmers for measures and practices for crop protection from extreme weather"

REFERENCES

- BEWARE (National research project), 2002-2005. Best Water Use Innovative Practices towards a Sustainable Water Resources Management. Crete Innovative Region (CRINNO).
- Distretto Idrografico dell'Appennino Meridionale (2016). Piano Di Gestione Delle Acque Ciclo 2015-2021 (Direttiva Comunitaria 2000/60/CE, D.L.vo 152/06, L. 13/09). Relazione Generale
- Doupis G., Bertaki M., Psarras G., Kasapakis I., Chartzoulakis K. 2013. Water relations, physiological behavior and antioxidant defense mechanism of olive plants subjected to different irrigation regimes. Sci. Hort., 153: 150-156.
- Joint Ministerial Decision (JMD) 31095/2716/15.12.2015 (OJ B'2055)
- Kritsotakis M. & Pavlidou S., 2013. The water status of groundwater bodies of Crete. Hellenic Republic. Decentralized Administration of Crete. Directorate General for Spatial and Environmental Policy. Water Directorate.
- Special Secretariat for Water, 2015. River Basin Management Plan of G13. [pdf] Athens: Special Secretariat for Water. Available at: http://wfd.ypeka.gr/index.php?option=com_content&task=view&id=113&Itemid=19

APPENDIX I: SIGNED WATER MANAGEMENT ADAPTATION STRATEGIES