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

Deliverable C3.2: Governance actions final text

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
AFI	Assofruit Italia Società Cooperativa Agricola
EWS	European Water Stewardship
FAO	Food and Agriculture Organization of the United Nations
F.OR	Farmers Organization
GAP	Good Agricultural Practice
KEDHP	Platanias Municipality Development Enterprise
RBMP	River basin management plan
UNESCO	United Nations Educational, Scientific, and Cultural Organization
WFD	Water Framework Directive
WMO	World Meteorological Organization

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INTRODUCTION - SUMMARY

The current deliverable aims to addresses issues that promote water management adaptation on a strategic level for the three F.ORs included in the project's partnership and propose actions focused on the achievement of equitable and transparent water governance, as required by the 4th EWS Standard Principle. The actions proposed below are based on findings reported at "Evaluation of the organizational structure and operational practices of the three F.ORs" completed in C2 and aim to contribute to the accomplishment of the following:

1. **Ensuring compliance with all legal requirements linked to water use**: A procedure is proposed to be established for following up legal matters on water, accompanied by an assignment in which a person or department is identified who will ensure compliance with legal requirements linked to water.
2. **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 are proposed to be identified and optimized. Therefore, the appropriate recording system has been developed in order to quantify the aforementioned relations.
3. **Raising efficiency of water consumption**: Three specific actions are proposed in order to raise efficiency of water consumption of the three F.ORs. 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 in C3.1 Deliverable, aiming to improve water efficiency. The final action includes the calculation of total water consumption per unit of product.
4. **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, an assignment that designates the person or the department that will represent and report on River Basin Committee activities and vice versa, was compiled. 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 are proposed. With regard to increasing the preparedness of the three F.ORs to efficiently cope with unexpected situations, floods and droughts action plans were developed, as these two situations are considered of major concern for the three F.ORs.
5. **Ensuring continuous improvement**: The pool of GAPs accompanied by an implementation and monitoring schedule has been developed for each F.OR within the context of Deliverable C3.1 that can be considered as a robust basis for continuous improvement of water management within the three F.ORs.
6. **Ensuring transparency on economic aspects of water management**: Two actions are proposed in order for the three F.ORs 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.

PART A –GOVERNANCE ACTIONS FOR KEDHP F.OR

1. CURRENT STATUS

The current status of KEDHP F.OR governance strategy was investigated in the context of Action C2 by evaluating the responses in the 3rd form of the Agricultural Water Management System.

The overall readiness of KEDHP F.OR in relation to water governance directions indicated by the 4th principle of EWS was identified as low. More specifically:

- Except from maintaining a list of the applicable water legislation, KEDHP F.OR has not established the appropriate procedures and documentation in order to ensure compliance with the legal requirements related to water management.
- There are no procedure and documentation established that link water management to the management of other resources.
- 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 while there are no actions documented and implemented related to the management of incidents. Therefore, the current degree of transparency on water management for KEDHP F.OR is considered as low.
- Since there is no documented and evaluated implementation of Good Agricultural Practices, the current potential of KEDHP F.OR in order 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.

Considering the above, a specific set of actions are presented below aiming to improve water governance in KEDHP FOR.

2. ENSURING COMPLIANCE WITH ALL LEGAL REQUIREMENTS LINKED TO WATER USE

The following actions are proposed in order to ensure compliance with all legal requirements linked to water use:

1. **Identify a person or department** who ensures compliance with legal requirements linked to water. In the context of this action, an assignment has been developed (Form KED-1) which has to be signed by the F.ORs management.
2. **Establish a procedure** for following up legal matters on water. This procedure (KED-PL) aims to ensure that legal and other e.g. contractual, requirements are not overlooked, and that their implementation is controlled, monitored and reported to the Management. It is provided in Annex I and it is accompanied by Form KED-L.

3. 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. Taking into account the above the following actions are proposed:

1. **Quantify the aforementioned relations**: The appropriate documentation and forms were created for recording by the farmers (Form 4.3, for primary data, Annex I) and for processing them by the Water Steward (Form 4.3a). They contain information both on water and energy use per parcel, in relation to the various activities in the parcel. Such activities are pruning, mechanical cultivation, mechanical weed control and harvesting. The corresponding results are to be used for improving the energy efficiency. Form 4.3 provides also the means to calculate water consumption per unit of product which has to be calculated according to indicator 4.4.4.

KEDHP		FORM KED-4.3 ACIVITY DIARY PER PARCEL												v1 13.11.2016
Parcel (Code)	Date	Pruning (Yes/No)	Mechanical Cultivation (Yes/No)	Mechanical weed control (Yes/No)	Harvesting (Yes/No)	Wages payed for activity (€/parcel)	Farmer's time spent on activity (Hr/parcel)	Energey used for activity (Lit oil or kWh)	Energey used for activity (Lit petrol or kWh/parcel)	Energy cost / activity (€/parcel)	Other costs / activity (€)	Yield (Kg/Parcel)	Estimated yield losses (%)	Notes
Farmer					**Signature**					Completed for year yyyy dd/mm/yyyy				

KEDHP		FORM KED-4.3a CUMULATIVE ACTIVITY SPENDING														v1 13.11.2016
	Irrigation		Irrigation (energy)		Pruning (energy)		Fertilization			Cultivation(energy)		Plant Protection			Harvest (energy)	
Parcel (Code)	m3/Ha	m3/Kg	kWh or Lit/m3	kWh or Lit/Kg	Lit/Kg	Lit/m3 water	Lit/Kg	Lit/m3 water	Kg N-P-K/m3 water	Lit/Kg	Lit/m3 water	Lit/Kg	Lit/m3 water	Kg a.i.s/m3 water	Lit/Kg	Lit/m3 water
Water Steward							**Signature**					Completed for year yyyy dd/mm/yyyy				

The following instructions can be given to the farmers in order to fill in Form 4.3:

- Parcel code: Write down the code of the parcel
- Date: Date that the activity took place (not the date of filling the form)
- Pruning: Write YES if the activity against the given date was irrigation, and NO if it was not.
- Do the same for the next three columns. If you did more than one activity in one day, use two sequential lines with the same date.
- Write down in the eighth column the labour cost in € paid for the activity on that date.
- Write down the time in hours, spent by the farmer on the same activity, the energy consumption in liters of oil (diesel) and in liters of petrol, then the cost in € of the fuel that was used and any other costs (just the €, not the items).
- Last, write down the yield in Kg that was obtained from this parcel (presumably, this is going to be written down when you will have written

YES in the seventh column) and your estimation of the % of yield lost for any reason.

- Note 1: You should try to fill the same form every day (until it is full, so you start a new one). No matter if the parcels will be mingled. The water steward will separate them, later.
- Note 2: Do not forget to write down -in raw form- the correct amounts per whole parcel. Never proceed to calculations in order to express the input e.g. per hectare.

The reason for asking each farmer to fill this 'diary' is that it will allow the Water Steward to have a measure of the efficiency of the used inputs, by collecting all the inputs for each parcel and compiling Form KED-4.3a and then compare the efficiency between parcels.

2. **Improve water management in relation to energy and other resources**: The results of Form KED-4.3a can indicate improvement potential in water management in relation to energy and other resources. Therefore the Water Steward can analyze the corresponding data, identify parcels of low efficiency and propose improvement actions. Moreover, the pool of GAPs planned to be implemented in the pilot farms, which are described in detail in Deliverable C3.1, are also contributing to the improvement of water management in relation to energy and other resources.

4. RAISING EFFICIENCY OF WATER CONSUMPTION

In accordance to EWS standard, three specific actions have to be considered in order for KEDHP F.OR to raise its efficiency of water consumption. The first action is related to the identification of water losses and their destination. Water losses are defined as the applied water that does not return to its source. For example, when irrigation water source is an aquifer and an amount of the applied water turns into surface runoff then this amount of water is considered as lost. If the amount of water lost through surface runoff was draining into the aquifer, it would not be considered as lost.

Potential destinations of water losses are: a) the atmosphere, when water is lost though evaporation, b) the adjacent surface water body, when water is lost through surface runoff and c) the underlying aquifer, when water is lost through drainage.

Water losses in agriculture cover a significant portion of water used. Sometimes water losses may be higher than 50% of irrigation water abstractions. Therefore, there is always a significant potential for water saving by identifying and reducing water losses. Irrigation process can be divided into three components:

a) the **distribution-conveyance component**, which corresponds to the distribution and transportation of irrigation water from the source to the field,

b) the **on-farm application component**, which corresponds to the application of irrigation water in the field with an irrigation system-method.

c) the **storage component**, which corresponds to the special constructions (such as dams), in which irrigation water is collected prior to the distribution in the farms.

Water distribution systems in agriculture are categorized into surface and piping systems. With regard to surface systems, water losses are mainly attributed to evaporation from water surface and water percolation along the system. Some indicative average conveyance efficiencies are 70% and 85% for well maintained-operated earthen channels and lined canals, respectively, while the corresponding efficiency for piping systems is 95%. Please keep in mind that accidental leakages may also be

occurred in distribution systems because of system failures (such as broken pipes), resulting in water losses through surface runoff, drainage or evaporation.
With regard to the on-farm application of irrigation water, the water losses potential is significantly different depending on the irrigation system applied (surface irrigation, sprinkler irrigation, drip irrigation). For surface irrigation, such as furrow irrigation, evaporation, surface runoff and drainage are the three major water loss mechanisms. In terms of sprinkler irrigation, except from evaporation, wind drift and spray losses are also considered. Indicative field application efficiencies of irrigation are 60%, 75% and 90% for surface, sprinkler and drip irrigation, respectively. Except from the above, on-farm conveyance losses have to be considered because of accidents or not well-maintained irrigation systems resulting in water losses through surface runoff, drainage or evaporation. Moreover, the application of irrigation water above the crop requirements may result in significant water losses, mainly through evaporation, surface runoff and drainage.
Like an open water body, the irrigation water storage constructions are exposed to the evaporation process. Depending on the climate conditions, water losses from the storage construction through evaporation may be significant.
All the above, as well as the estimation procedure of water losses during the irrigation process are summarized in Form 4.4. It has to be mentioned that the appropriate considerations have to be made, depending on the irrigation water source and water loss destination. Therefore, total water loss has to be properly adjusted. Moreover, accidental water loss have to be considered when such incidents are happening and are significantly affecting water losses.

KEDHP	**FORM KED 4.4 – WATER LOSSES ESTIMATION**					
Distribution – conveyance water losses (%)						
Type of water distribution system	Evaporation [1]		Deep percolation [2]			Total water distribution losses [3]=[1]+[2]
Open canals						
Piping system	-					
On-farm water application losses (%)						
Type of irrigation system	Water Distribution System [4]	Surface runoff [5]	Deep Percolation [6]	Soil & Canopy evaporation [7]	Wind drift [8]	Total on-farm water application losses [9]=[4]+…+[8]
Furrow					-	
Sprinkler						
Drip		-		-	-	
Water storage losses (%)						
Type of storage system	Evaporation [10]		Deep Percolation [11]			Total water storage losses [12]=[11]+[12]
Reservoir or dam						
TOTAL IRRIGATION WATER LOSSES (%) 13=[3]+[9]+[12]						

The second action is the planning, implementation and monitoring of measures that will enhance water efficiency. A set of measures are presented in the corresponding farm specific action plans which aim to improve water efficiency. The monitoring schedule as well as the measurement equipment are also presented. Such measures include:

- Calculation of evapotranspiration losses: This measure can lead to a more accurate calculation of crop water needs and therefore to avoid irrigation water excess and the corresponding water losses.
- Plan for farm irrigation network improvement: Repairs of the farm irrigation network are included. Moreover, a set of water-meters and volumetric valves will be introduced in selected orchard, in order to provide farmers with the tools to precisely control the amount of irrigation water that is applied to the orchard.

- Deficit irrigation: This measure includes application of regulated deficit irrigation may reduce water use by 20-30% in olive trees and 10-15% in citrus, with no negative effects on yield quality and quantity.

By comparing data recorded in Form KED-4.3 year after year and according to the measures and practices applied, the Water Steward of the organization has to fill-in the results in the following table KED-4.3b and compare the increasing water efficiency potential of the applied practices. It has to be mentioned that the compared periods have to be of the same extent.

The final action includes the calculation of total water consumption per unit of product (fruits in this case), which can be conducted by the data collected in Form KED 4.3 by dividing consumed water to the crop yield. It has to be mentioned that the term "consumed water" is defined as the water abstracted from a specific water sources.

KEDHP			FORM KED 4.3b-MONITORING WATER EFFICIENCY			v1 13.11.2016
Parcel code	Initial water consumption period	Initial water consumption (m3/Ha)	Measures taken	Current water consumption period	Current consumption (m3/Ha)	Water savings (m3/Ha)
Water Steward			**Signature**		**Completed for year**	

5. 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. This person will be responsible to inform the management of F.OR for any updates of the River Basin's Water Resources Management Plan, and make it available in F.OR's premises. Assignment of the person above is facilitated by the Form KED-1.2 (Annex I) for assignment of roles and responsibilities.

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. According to the management system of each F.OR, internal communication can be accomplished by e.g. circulation of internal memos, by introducing a thematic issue in the agenda of formal personnel meetings, by using social media, etc. The activities selected should be recorded, e.g. in a quarterly report on WMAS. Verification of the efficacy of the measures selected can be part of the internal audit of the F.OR's management system e.g. by interviewing a sample of the F.OR's personnel and a sample of farmers.

According to EWS Standard, a report with information on operational water management has to be available to customers, to the local community and the authorities (both, for water and for agriculture). This report shall include basic information on water management (for example water abstractions and their distribution on to the several crops) and other information such as actions and achievements linked to sustainable water management, definition of water-related risks and preventive measures implemented. Since KEDHP F.OR is not performing the operational water management, such a report is not mandatory. However, as the issue is quite novel for the Greek agriculture each F.OR will consider the usefulness it could have for its image in the area and proceed to design such a report, even as an alert to the innovation EWS brings and to stress the focal position of the F.OR as a local 'ambassador' of EWS. The contents may be selected among:

- Informal, awareness-raising about the consequences of forthcoming regulation.
- A brief presentation of findings, evaluation of practices tested, objectives update etc.
- Problems, especially the ones that may systematically affect other farmers in the basin.
- News on the expansion of implementation of EWS,
- Major events related to the implementation of the EWS in addition to the events related to the AgroClimaWater project.
- Brief reports on international appraisal of climate change news related to water issues.
- News on technology and science on irrigation water management e.g. under conditions of drought.

Depending on the availability of information and of human resources, the report could be either annual or every six months.

Cooperation between the three F.ORs could prove fruitful, especially capitalizing on the cross country element.

As a third action, promotional campaigns have to be organized and implemented on topics related to water. For agriculture, such campaigns may be related to irrigation (scheduling, methods, deficit irrigation, irrigation system maintenance) and GAPs that promote the sustainable water management from both the quantitative and qualitative point of view. The campaigns may be aligned with the milestones of the AgroClimaWater project, or with local agricultural nature festivities in each area, fairs and other major events related to agriculture. This action may well be combined with the edition of the report mentioned above, at least as much as the topics of reference are concerned.

The F.OR has also to be prepared in order to efficiently manage accidents, emergency situation and disasters. Therefore two action plans dealing with floods and droughts were compiled in which the corresponding risk, as well as management and mitigation actions are proposed. These action plans are found in the last chapter of this part of the deliverable. With regard to other incidents that could significantly affect the agricultural activity in KEDHP FOR, such as fire, it is proposed for the F.OR to stay in contact with the Independent Civil Protection Office and Fire Station of Chania Municipality and ask to be informed in case of emergency situations. With regard to irrigation system breakdown, KEDHP F.OR have no direct intervention right. Therefore, when system breakdown is occurred, the Water Steward should contact the water supplier and ask for a plan on when the system is going to recover.

6. ENSURING CONTINUOUS IMPROVEMENT

Currently, there are no GAPs applied under an organized scheme in KEDHP FOR. Therefore, a pool of GAPs has to be established, which will be implemented depending on the specific needs of each farm. The performance of those GAPs has to be evaluated. The pool of GAPs that contributes to the continuous improvement is established from the GAPs proposed to be implemented in the ten pilot farms. The GAPs are summarized in Table 1, while their implementation, monitoring and evaluation processes are presented in detail in the Deliverable C3.1. 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.

Table 1: Good agricultural practices (GAPs) proposed to be implemented in the pilot farms

Aim	Practice	Description
Reduction of water evaporation losses	Soil Mulching	Weed mowing during the high water demand season
	No weed control	Natural vegetation will remain on farm during rainy season
	Shredding of pruned wood	Pruned wood of small diameter will be shredded on orchard surface
	No soil tillage	Avoid bare soil to reduce evaporation losses
Reduction of transpiration water losses	Winter pruning	Appropriate winter pruning will be applied to obtain the optimal balance between leaf area and yield
	Summer pruning	Will be applied to reduce the transpiring leaves and reduce radiation competition
Reduction of surface runoff	Increase organic matter	Application of locally available organic matter (improving the soil water holding capacity)
	Fertigation	Apply fertilizers through irrigation
Maximizing the efficiency of irrigation	Calculation of evapotranspiration losses	Weekly bulletins (will be available on IOTSP) on crop irrigation water requirements (meteorological conditions, soil type, crop)
	Plan for farm irrigation network improvement	Repairs of the farm irrigation network. A set of water-meters and volumetric valves will 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
	Deficit irrigation	Application of regulated deficit irrigation may reduce water use by 20-30% in olive trees and 10-15% in citrus, with no negative effects on yield quality and quantity

	Rationalization of fertilizers and agrochemicals	A more environmental friendly agricultural practices policy

7. ENSURING TRANSPARENCY ON ECONOMIC ASPECTS OF WATER MANAGEMENT

Two actions are proposed in order for KEDHP F.OR 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. These investments may include capital investments, granting, loans etc. Special attention should be paid in order to identify the relation between investments made for sustainable water management and the total investments made for water management. Moreover, money saving potential could be identified from the water saving investments implemented.

Concerning the second action, an environmental cost analysis has to be performed. The cost included in the above analysis may include all environmental management costs such as:

1. Personnel employed for education and training.
2. External services for environmental management.
3. External certification of environmental management systems.
4. Personnel for general environmental management activities.
5. Research and development.
6. Investments in water saving programs and measures.
7. Other environmental management costs.
8. Environmental charges as percentage of water tariff.

8. WATER MANAGEMENT STRATEGY

An operational water management strategy has to be in place in which the following have to be addressed:

1. Include stakeholder concerns.
2. Incorporate all 4 EWS principles. It is important to make a clear link between the strategy and the 4 principles of EWS, and if possible with the indicator(s) addressed.
3. Identify and assess risks related to water use.
4. Incorporate preventive measures to mitigate impacts of water use and discharge.
5. Establish a monitoring scheme (frequency and method and report and follow-up on outcomes of monitoring).
6. Develop a water efficiency strategy.
7. Person or department in charge of implementation and monitoring of the strategy. An special assignment is presented in Form KED 1.3 (Annex I) Moreover, a responsible person or department that will cope with the legal matters of water and a responsible person or department for the River Basin's Committee has to be defined as mentioned earlier.
8. Give effort to insure the continuous improvement in water management.

9. FLOODS AND DROUGHTS ACTION PLAN

9.1 Floods Action Plan

9.1.1 Introduction

A large number of flood definitions exists. According to WMO & UNESCO (2012) floods can be defined as "rises, usually brief, in the water level of a stream or a water body to a peak from which the water level recedes at a slower rate". There are three types of floods which can potentially affect the agricultural sector: river floods, flash floods and coastal floods. River floods occur when river water system capacity is exceeded and therefore river water is not able to be channeled through the river course. Flash floods are developed from localized, intense rainfalls and can occur anywhere in the basin, while coastal floods constitutes the result of increased sea level rise caused by storm surges driven by tropical storms or strong windstorms. According to Morris et al. (2010), flood development consists of three major components: the sources, the pathway and the receptor. Flood sources are the extreme rainfall events and/or the sudden snow-cover melt, while pathway is considered as the land and the hydrological system which transfer the water to the receptor. Finally, flood receptor is where flooding occurs. Agricultural land can serve either as pathway or receptor.

Since the agricultural sector is fully exposed to floods and their impacts, either as flood pathway or as flood receptor, the necessity for floods action plans development is high. Taking into account climate change projections, according to which floods frequency is expected to increase, the necessity for compilation of floods action plans becomes even higher.

Floods action plan constitutes a part of the F.ORs governance actions/strategy and more specifically contributes to EWS Standard indicator 4.5.5: Management of incidents:

1) Procedures are established, implemented and monitored to respond to accidents, security incidents, emergency situations, disasters and the like. 2) The impacts of such an occurrence to the environment, employees, the regional population and communities of the affected region are described or estimated. A specific methodology was established for the development of flood action plans by the three F.ORs participating in AgroClimaWater partnership. This methodology is implemented individually for each one of them and therefore one action plan per F.OR was compiled.

9.1.2 Flood action plan development methodology

The methodological framework followed in order to establish the flood action plan is presented in Fig. 1; Two are the main steps that each F.OR has to follow in order to compile it: a) identify the areas characterised by high flood risk and b) compile a flood management strategy by identifying actions, measures and practices that will lead to reduction of agricultural activity contribution to surface runoff and mitigation of the corresponding floods' impact.

Floods risk assessment can be based on reports, data and information developed within the context of Directive 2007/60/EC. More specifically, every EU Member State has to be conform to Directive 2007/60/EC on the assessment and management of flood risks. Conformation to this Directive includes:

1. Preliminary flood risk assessment.
2. Development of flood hazard and flood risk maps.
3. Development and configuration of flood risk management plans for the areas that are potentially at any flood risk.

The milestones established towards the implementation of Directive 2007/60/EC are presented in
Table 2. Concerning the current implementation status of Greece, flood hazard and flood risk maps have been developed for most of Water Districts, while the compilation of flood risk management plans has been finalized only for Water District GR012 (Thrace-NE Greece).

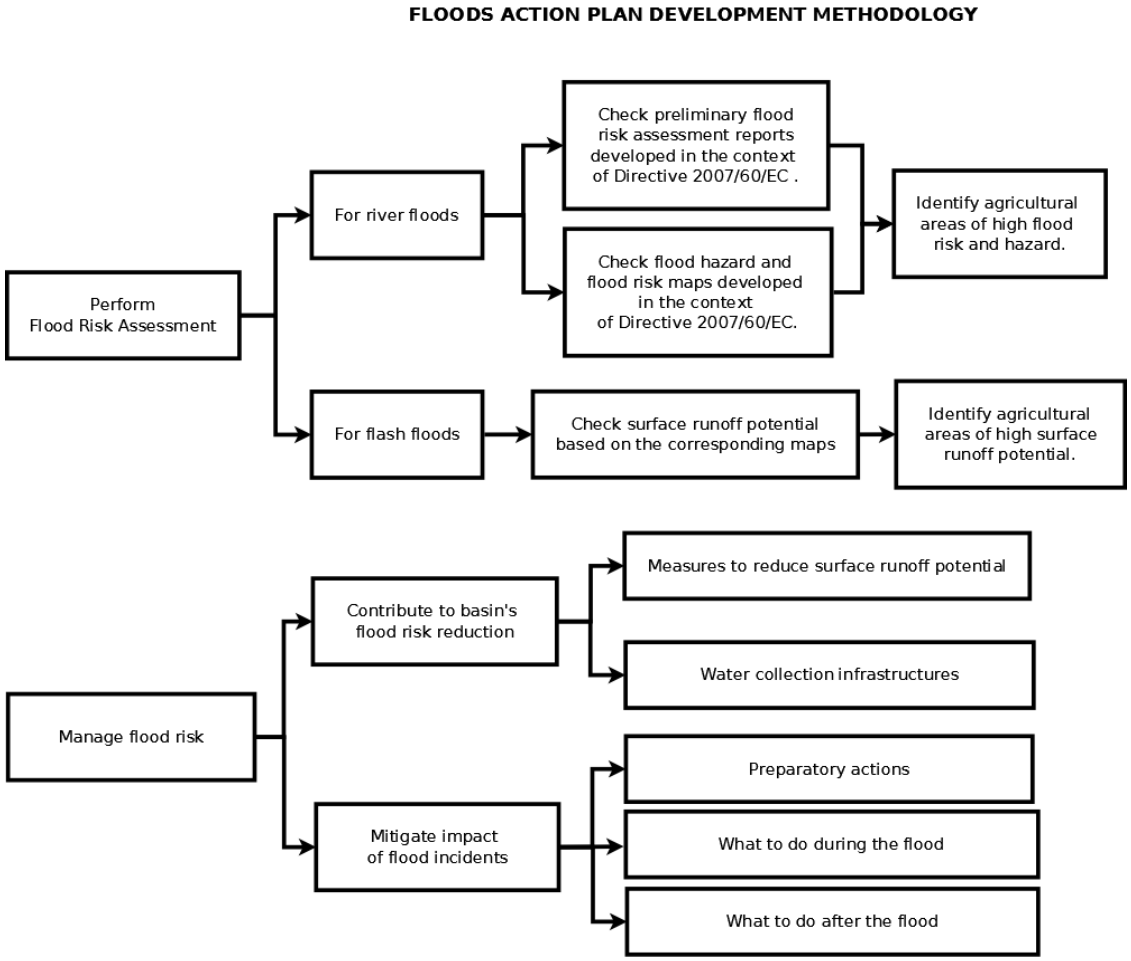

Fig. 1: Diagram of floods action plan development methodology

The results of preliminary flood risk assessment for Greece are provided in the following URL: http://www.ypeka.gr/Default.aspx?tabid=252. The user can find the corresponding report and maps as well as, GIS data (shapefiles and "kmz" files) for zones of potentially high flood risk, historic floods and significant historic floods. From preliminary flood risk assessment, the user can identify whether there are zones included in his area of interest which have been designated as being at high flood risk.
The flood risk and hazard maps accompanied by the corresponding maps can be accessed through the following URL: http://floods.ypeka.gr/. For each of the zones of potentially high flood risk the following information can be gathered by the corresponding maps:

1. Spatial distribution of maximum flood depth with return periods of 50, 100 and 1000 years.
2. Spatial distribution of maximum flood velocity with return periods of 50, 100 and 1000 years.

3. Spatial distribution of flooded areas with return periods of 50, 100 and 1000 years.
4. Spatial distribution of flood impact assessment with return periods of 50, 100 and 1000 years.
5. Spatial distribution of soil erosion vulnerability.

Table 2: Milestones towards the implementation of Directive 2007/60/EC (source: http://ec.europa.eu/environment/water/flood_risk/implem.htm)

Issue	Deadline	Reference
Entry into force	26.11.2007	OJ L 288, 6.11.2007 Art 18
Transposition	26.11.2009	Art 17
Reporting format Preliminary Flood Risk Assessment	22.12.2009	Art 11
Administrative arrangements to be in place and to be notified to the Commission	26.5.2010	Art 3
Cut-off date transitional measure (availability of existing tools)	22.12.2010	Art 13
Preliminary flood risk assessment	22.12.2011	Art 4 & 5
Public participation process starts (publication of mechanism and timetable for consultation)	22.12.2012	Art 9.3 & 10
Flood hazard and risk maps	22.12.2013	Art 6
Flood risk management plans	22.12.2015	Art 7
2nd Preliminary Flood Risk Assessment, specific requirement on climate change	22.12.2018	Art 14.1 & 4
Commission's first implementation report due.		
2nd Flood hazard and risk maps	22.12.2019	Art 14.2
End of 1st flood risk management cycle	22.12.2021	Art 14.3 & 4
2nd Flood Risk Management Plans, specific requirement on climate change.		
3rd Water Framework Directive River Basin Management Plans.		

It has to be mentioned that soil erosion potential has been investigated in the context of Action C2. Based on the above information, every participating F.OR can identify the river flood zones and investigate the potential flood hazard and flood risk for this zones. With regard to flash floods, in which agricultural land can be considered to serve as flood pathway, the surface runoff potential maps developed according to the methodology presented in the corresponding deliverable of Action C2 can be used in order to identify the surface runoff potential of each farm participating in every F.OR and therefore the risk for flash floods to occur.

Concerning flood risk management, actions, mechanisms and practices have to be identified in order to:

- Reduce the contribution of farms that indicate high surface runoff potential. These actions, measures and practices are also contributing to the mitigation of flash floods impacts both in the farm and the basin scale. They can be divided into two major categories including: a) measures that are applied on farm and aim to reduce surface runoff potential and therefore flash flood risk and b)

infrastructures in which surface runoff can be collected and therefore flash floods impact can be mitigated, while these infrastructures may also contribute to mitigate river floods.

- Mitigate the impacts of river floods before their occurrence (i.e act in a preventive maner), during them and after them. The actions, mechanisms and practices identified in the basin's flood risk management plans (in case that it is existing) which are related to F.OR activities, have to be incorporated into the current flood risk management plan.

9.1.3 Flood risk assessment

With regard to KEDHP F.OR and concerning river floods, a high flood risk zone was identified (GR13RAK0010) which is presented in Fig. 2. This zone is located in the southern half of Tavronitis basin, and is mainly identified along Tavronitis main river courses, as well as in the northern plain part of the basin. Four recorded historic flood events were identified in Tavronitis River basin, based on the Preliminary Floods Risk Assessment report, while several other flood events were identified in the surrounding area (Fig. 2). As stated in Preliminary Floods Risk Assessment report (Hellenic Special Secretariat for Water 2012), floods in the high flood risk zone are accompanied by damages in the agricultural areas according to KEDHP Municipality information.

The flood risk assessment results are presented in Fig. 3. The major part of the flood zone is covered by agricultural land, while two education facilities, one sport facility, two livestock farms and three water supply boreholes are included in the infrastructures that can potentially be affected by a river flood in Tavronitis basin. With regard to the population affected three settlements of less than 500 inhabitants each are identified.

The potential flood impact for recurrence intervals of 50, 100 and 1000 years is presented in Fig. 4. For recurrence periods of 50 and 100 years, potential flood impact is predicted to be low or very low. Even for recurrence interval of 1000 years, potential flood impact can be overall considered as low, except from the northern part of the basin in which a moderate impact zone is identified and Voukolies village in which a high impact zone is foreseen.

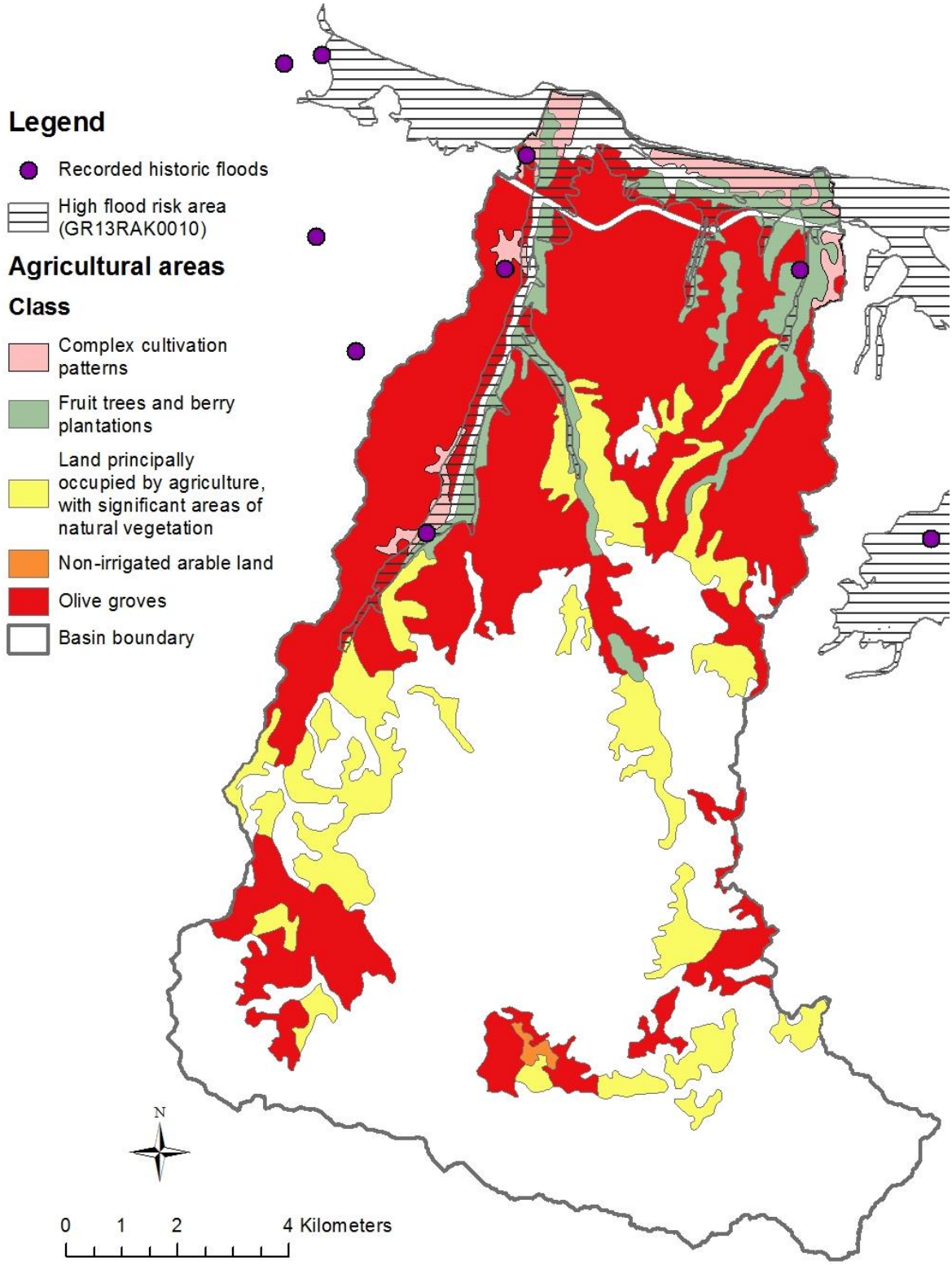

Fig. 2: High flood risk areas and historic floods in Tavronitis basin, as identified in the Hellenic Preliminary Floods Risk Assessment report

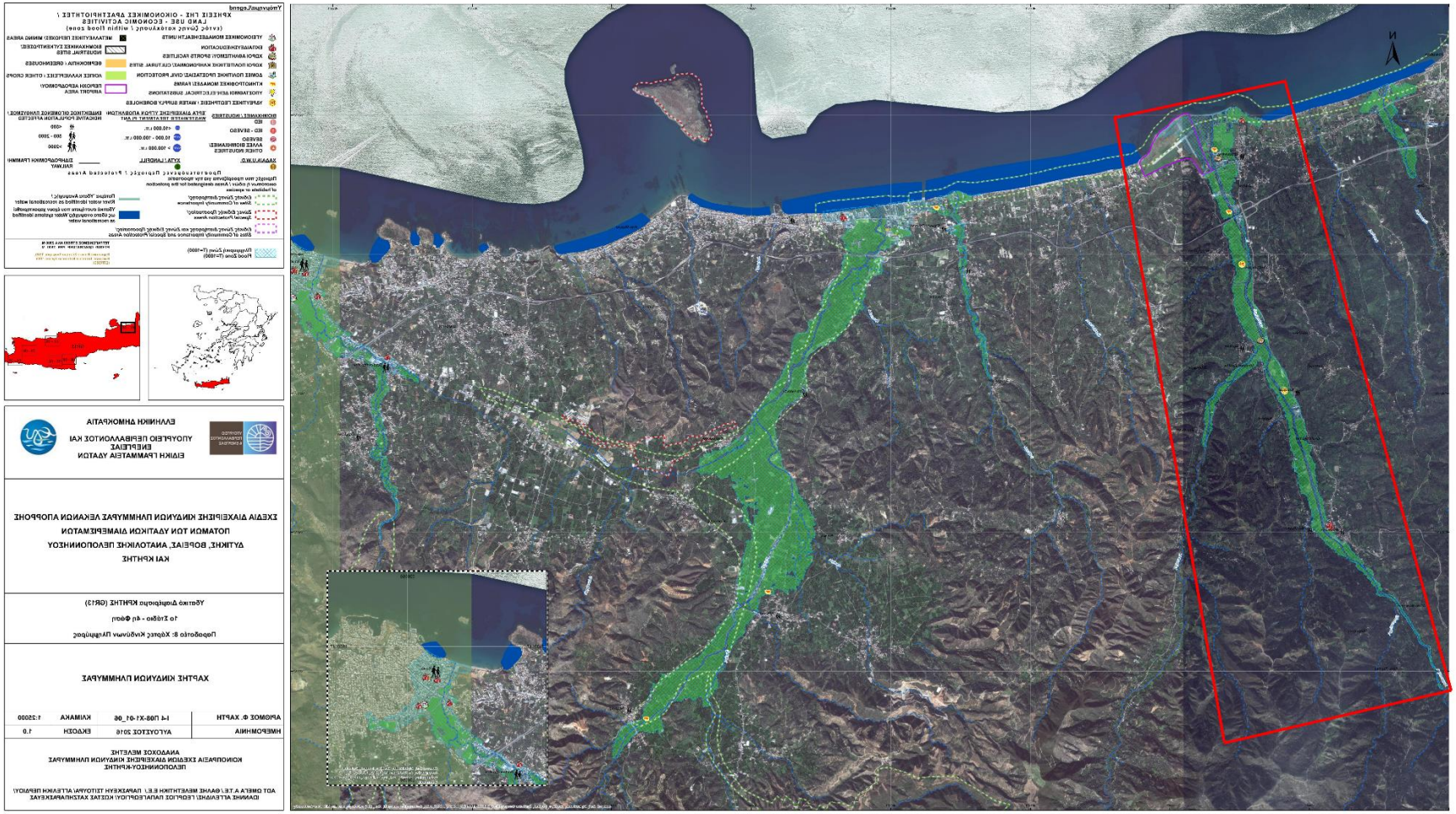

Fig. 3: Flood risk map. The area of interest is enclosed in the red polygon. Source: Special Secretariat for Water (2016)

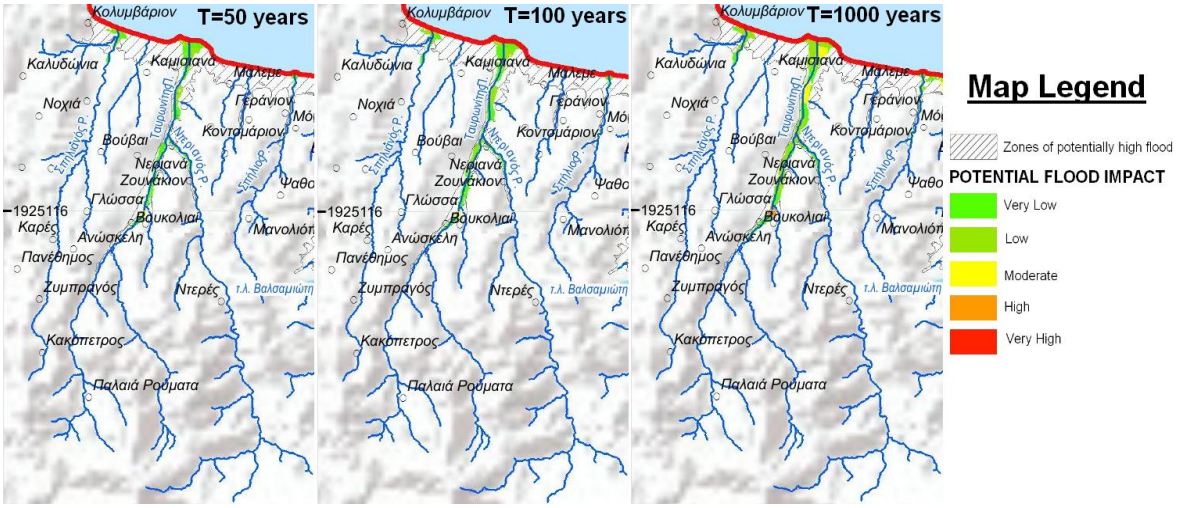

Fig. 4: Potential flood impact spatial distribution in Tavronitis basin for 50, 100 and 1000 years recurrence intervals. (Fig.s modified after Hellenic Special Secretariat for Water (2016))

With regard to flash flood risk assessment, the results of surface runoff potential as estimated in the context of Action C2 are used, which are presented in Table 3. The average runoff potential for all agricultural areas ranged from moderate to high. The lowest average runoff potential was calculated for fruit trees and berry plantations (1.59-Moderate), while the highest runoff potential was calculated for land principally occupied by agriculture, with significant areas of natural vegetation (2.52-Very high). Especially for olive groves, which constitute the dominant land cover for Tavronitis basin (32.34%), the average runoff potential was 2.06 and it is considered as high, while the corresponding range of variation was 0.88 (Low) – 2.75 (Very High), thus indicating a significant degree of runoff potential variation. Considering the above, it can be concluded that 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.

Table 3: Surface runoff potential statistics for the agricultural lands of KEDHP basin

Land Cover Code	Land Cover Description	Area		Minimum		Maximum		Average	
		(km²)	(%)	Score	Class	Score	Class	Score	Class
221	Non-irrigated arable land	0.26	0.16	1.51	Moderate	2.51	Very High	2.00	High
222	Fruit trees and berry plantations	7.86	4.76	0.85	Low	2.33	High	1.59	Moderate
223	Olive groves	53.41	32.34	0.88	Low	2.75	Very High	2.06	High
242	Complex cultivation patterns	2.95	1.79	1.05	Low	2.45	Very High	1.58	Moderate

243	Land principally occupied by agriculture, with significant areas of natural vegetation	17.08	10.34	1.15	Low	2.84	Very High	2.52	Very High

With regard to coastal floods risk and according to the Hellenic Special Secretariat for Water (2016), the estimated sea level rise is not expected to significantly affect human activities and pose risk for life and therefore coastal floods scenarios were not developed.

9.1.4 Floods risk management

9.1.4.1 Reducing farms contribution to floods

The actions presented below aim to contribute to surface runoff potential reduction and therefore to directly reduce the contribution of agricultural activity to flash floods. The direct reduction of flash floods may reduce (depending on the incident) the contribution of agricultural activity to river floods. A wide range of practices are proposed in the literature which aim to contribute to surface runoff reduction from crop covered land. The actions practices and measures presented below are chosen from the pool of practices that are to be implemented in the context of the project as well as other actions applicable to the specific case of Tavronitis basin.

The practices implemented within the context of the project that directly or indirectly contribute to surface runoff potential reduction are the following:

- No weed control: According to this practice, natural vegetation is preserved during the wet season. Therefore, soil is covered during the rainy season resulting in surface runoff potential decrease. This practice is similar to the establishment of cove crops.
- No soil tillage: Despite the fact that this practice was incorporated with a view to reduce evaporation losses, according to Aina (1993) other benefits such as storm runoff reduction and improved infiltration capacity can be expected by its application.
- Physical reduction of surface runoff: Surface runoff can be reduced by introducing physical materials along the contour lines.
- Other practices and measures that are well known to be effective in reducing surface runoff potential from the farms are the following:
- Conservation buffers: This practice includes the development and/or maintenance of small areas or strips of permanent vegetation. There are several versions of this practice applied such as riparian buffers, filter strips and grassed waterways.
- Avoidance of vehicle movements and wheel ruts on wet soil.
- Avoidance to the best possible degree, of heavy machinery use within the farm. Heavy machines are contributing to soil compaction, which reduces water infiltration capacity thus increasing surface runoff potential.

Water collection infrastructures can contribute to flood impacts mitigation and serve as water saving infrastructures that will provide water during the peak water demand periods. The F.OR has to upgrade and maintain collaboration with the local authorities and mainly with the local Technical Services Division and the Water Directorate,

Decentralized Administration of Crete in order to perform a feasibility study for the construction of water collection infrastructures and identify potential funding tools such as the National Strategic Reference Framework (NSRF). With regard to Tavronitis basin, Kourgialas et al. (2015) applied a hydrologic model and indicated several possible locations for the construction of small hydraulic structures (dam and/or reservoir).

9.1.4.2 Actions before the flood

A set of actions can be taken in order to ensure sufficient preparation for the flood. These action includes:

- Ask the Independent Civil Protection Office and Fire Station of Chania Municipality (https://www.chania.gr/katoikoi/politikhprost/politikh-prostasia.html) about how you will be informed when a flood event is expected to occur.
- Inform the farmers about the expected flood incident.

The following directions have to be given to the farmers:

- Avoid applying fertilizers and plant protection products prior to the flood, since the possibility for water bodies' pollution from runoff or leaching is high.
- In case that electricity supply is available in your farm make sure that it is turned off and secured.
- In case that a groundwater pumping well or borehole exists in or near the farm, it has to be sealed properly in order to avoid runoff water entering through the annulus.
- A list of the existing on-farm machinery and equipment has to be drawn.
- Make sure that potentially hazardous substances, such as fertilizers, plant protection products and fuels are not exposed in the farm. These should be securely stored in appropriate infrastructure at the field or removed to such a place off the farm.
- Update the list of available F.OR member farmers' machinery that can be set at the disposal of the authorities to serve during the flood and/or alleviate its impacts. This list that is originally drawn and maintained by the F.OR administration, is notified to the Independent Civil Protection Office.
- Secure or remove heavy/hazardous equipment and machinery from the farm.

9.1.4.3 Actions during the flood

A set of actions can be taken in order to ensure sufficient preparation for the flood. These action includes:

- Get informed about the flood status. Information can be retrieved by the local media.
- Stay in touch with the Independent Civil Protection Office and Fire Station of Chania Municipality as well as the Department of Rural Economy and Veterinary of Chania Prefecture. Report the availability of F.OR member farmers' machinery to help in case this is needed.

The following directions are proposed to be given to the farmers:

- Avoid being on the farm or any other exposed location during the flood. Find a safe place to stay and do move without any specific scope. Do not use flooded bridges or river/creek passages.

9.1.4.4 Actions after the flood

The set of actions that could be taken after the flood can be divided into those that can be implemented by the F.OR and those that can be applied by the farmers. Concerning the F.OR actions, the following are proposed:

- Get informed about the impacts of the flood and follow the directions of Independent Civil Protection Office and Fire Station of Chania Municipality. Also communicate with the Department of Rural Economy and Veterinary of Chania Prefecture since it is responsible for providing information of farmers for the protection of agricultural properties according to the Preliminary Flood Risk Assessment report (Hellenic Special Water Secretariat 2012).
- Communicate the information to the farmers.
- Ask farmers if fertilizers of plant protection products have been applied in the farm before the flood and relay this information to the Water Directorate of Crete.

Concerning the actions that can be applied by the farmers, the following are proposed:

- Be careful when trying to approach your farm in order to avoid injury.
- Compare the list of your equipment compiled before flood in order to identify damages or losses.
- Check the overall status of your farm before and after the flood.
- Stay in touch with the F.OR in order to guide you for the next steps.
- In case that fertilizers of plant protection products have been applied in the farm before the flood, communicate this information to the FOR.
- Report loss of any agrochemical, piece of equipment or machinery and any changes to the soil cover at your farm.

The most significant impacts of floods in a farm are deposition of sediment of productive land, agricultural soil erosion and soil nutrient losses. In order to mitigate the above mentioned impacts the following practices could be applied by the farmers:

- Try to incorporate the sediment excess into the field by tillage. In case that this is not feasible the sediment has to be removed from the farm and disposed off in a designated site. By no means should this sediment be disposed off next to the course of a creek, torrent or river.
- Try to rehabilitate soil erosion with appropriate tillage. In case that this is not feasible, try to fill the erosion gaps with material from other sites. Take all precautions to use appropriate soil for this purpose (adjacent site, consult an agronomist, etc).
- Check the nutrient concentrations of the soil in the farm and properly adjust. Cover crops application has been found to significantly contribute to soil recovery after flooding.

9.2 Droughts Action Plan

9.2.1 Introduction

Drought constitute one of the more severe hazards with adverse economic, social and environmental impacts. According to the European Commission, (http://ec.europa.eu/environment/water/quantity/about.htm) *Droughts can be considered as a temporary decrease of the average water availability due to e.g. rainfall deficiency*. The usual types of droughts are presented in Fig. 5. A meteorological drought occurs when the actual rainfall in an area is significantly less than the long-term average rainfall observed in this area. Agricultural droughts happen when the available water is

not sufficient to cover crop water needs during the crop cultivation period. Agricultural droughts are linked to either meteorological or hydrological droughts, since specific characteristics of meteorological or hydrological droughts are linked to impacts in agriculture. Hydrological droughts occur when there is evident low water availability in steams, reservoirs and aquifers and usually, they constitute the result of prolonged periods of meteorological droughts. In contrast to meteorological droughts, the duration and recovery of which are usually short, both the development and the recovery of hydrological droughts are usually lasting much longer.

Since agriculture is directly exposed to climate variability, the impacts of droughts in agriculture are also direct. Therefore, agriculture constitutes one of the most drought vulnerable productive sectors and subsequently the necessity for proper response in order to alleviate impacts is very high. Water scarcity and droughts constitutes one of the major water-related concerns of European Commission which was recognized in the Communication "Addressing the challenge of water scarcity and droughts" at 2007 [COM(2007)414]. The necessity for drought management has been also recognized in Directive 2000/60/EC, according to which, when and where needed, a specific "drought management (sub) plan" should be included in the WFD RBMP (art. 13.5).

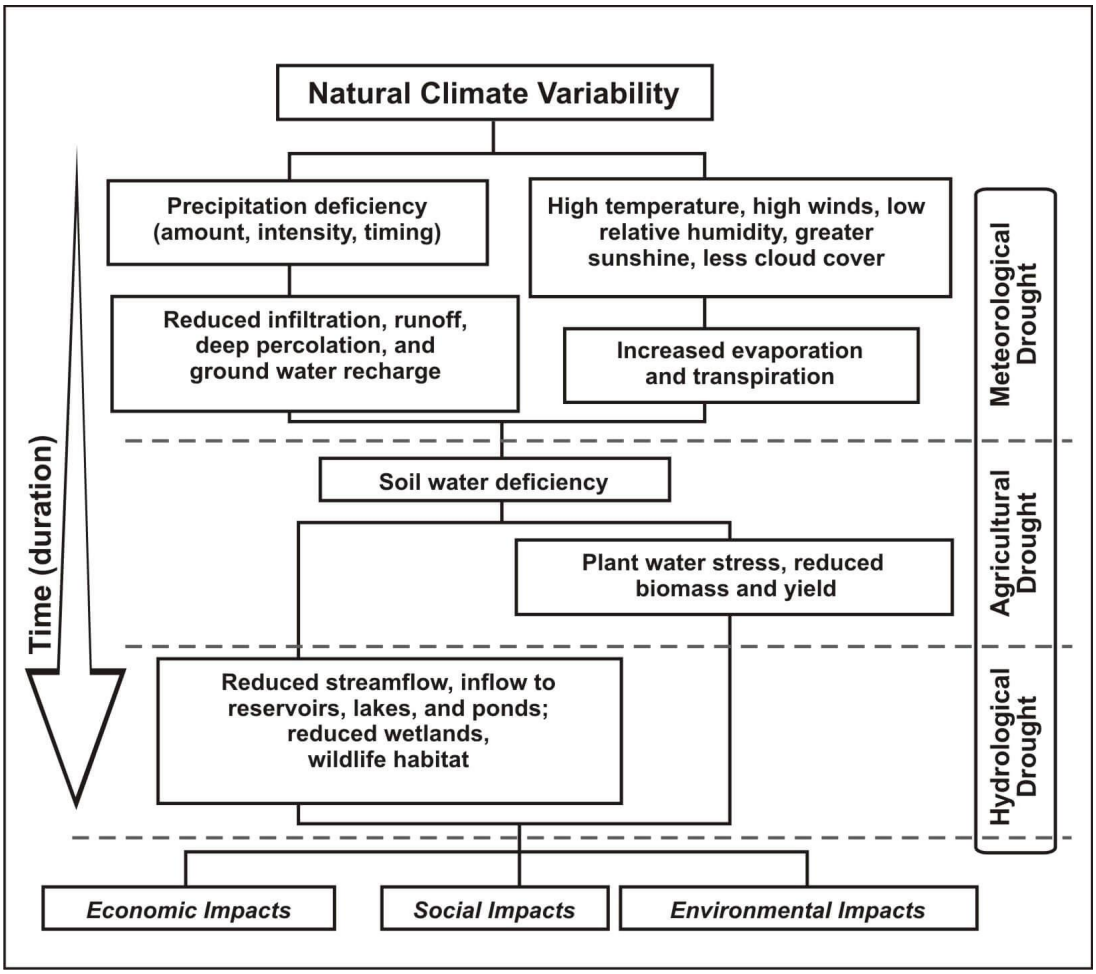

Fig. 5: Types of drought (Source: National Drought Mitigation Center, University of Nebraska-Lincoln, U.S.A., http://drought.unl.edu/DroughtBasics/TypesofDrought.aspx)

9.2.2 Drought action plan development methodology

Drought management constitutes a very complex processes, since a wide variety of sectors (e.g. agriculture, industry, tourism, environment, socioeconomical aspects) are interacting in a complicated way. Therefore drought management plans are commonly compiled at national and regional level for which a management procedure can be established in a common basis. Subsequently, compiling a drought action plan only for a specific sector (agriculture) and for a very specific area (area of farmers organization) constitutes a very tricky and demanding task.

Considering the above, the compilation of F.OR specific drought action plans have to be strongly connected to the regional drought management plans that in turn have to be compiled for drought vulnerable areas, in accordance to Directive 2000/60/EC (art. 13.5). In regional drought management plans, each F.OR can identify specific drought management directions, identify its role as a water user in the basin, as well as the interactions with the other water users and sectors.

The drought action plan development methodology described below 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 FOR. Drought risk assessment section aims to identify, analyze and evaluate drought risk. Based on drought risk assessment results, specific actions are proposed, according to which the F.OR is getting prepared to deal with droughts.

9.2.2.1 Drought risk assessment

According to the Guidelines for preparation of the Drought Management Plans in the context of the EU Water Framework Directive (Global Water Partnership Central and Eastern Europe 2015), drought risk assessment may include the flowing processes:

- risk identification – finding, recognizing, and describing risks
- risk analysis – determining the level of risk (i.e. the quantitative estimation of the probability of occurrence and severity of potential drought impacts)
- risk evaluation – evaluating the significance of the drought risk

Since the development of drought risk assessment including the aforementioned information requires specialized knowledge and expertise, it is proposed to retrieve this information from the drought management plan in case that such a plan exists for the specific Water District or the basin. Alternatively, other related scientific information resources may be gathered either from the local authorities or web sources. Moreover, internal information on drought occurrence and impact could be retrieved in case that such information is available within the FOR. Since drought constitutes a major hazard for agriculture, there is strong possibility for the F.OR to have recorded severe drought incidents, as well as their impacts on crop production.

9.2.2.2 Drought management

Before establishing the risk management plan, the F.OR has to consider the degree of its influence in local water resources management status and identify its role as a water user in relation to the other users located in the basin. For example, the direct degree of influence in water resources management status of a F.OR that own a wide number of private groundwater wells could be considered as higher compared to a FOR, the agricultural water needs of which are supplied by other authorities, such as Land Reclamation Organizations in Greece. In the first case, F.OR will be directly connected to the public authority that coordinates drought management in the basin, while for the

latter case, F.OR will probably get specific drought management directions from water supplier.

According to the EU Guidelines for preparation of the Drought Management Plans in the context of the EU Water Framework Directive (Global Water Partnership Central and Eastern Europe 2015), the following categories could be used in order to classify the actions that could be applied in the case of F.ORs:

- Preventive actions: These actions aim to increase drought resistance and mitigate potential drought risk and impacts on the economy, society, and they are implemented under normal periods.
- Operational actions: This kind of actions are designed to be implemented during a drought period.

The core of drought management actions that can be potentially implemented by a F.OR is water saving. Therefore a number of specific actions and practices must be proposed and implemented, when necessary, in order to enhance drought mitigation potential of F.ORs. Most water saving actions and practices could be either applied as preventive or operation actions, since the majority of them can contribute to drought resistance increase during normal periods and to drought impacts mitigation during drought periods. Nevertheless, a specific threshold based on rainfall distribution and crop type can be specified in order to trigger the necessity for operation actions implementation.

9.2.3 Drought action plan of KEDHP FOR

9.2.3.1 Drought risk assessment

According to the Water Resources Management Plan of Crete Water District (Hellenic Special Secretariat for Water, 2015) a drought management plan has not been developed yet. More specifically, 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). Therefore, the necessity for the development of a regional drought management plan has been recognized in the Water Resources Management Plan.

Given the absence of a regional drought management plan, information about drought risk assessment were retrieved from alternative sources. An important notice about drought risk in Crete Water District comes from the Water Resources Management Plan, according to which, the lack of rainfall during summer, combined to high air temperature and evapotranspiration are resulting in a drought conditions, usually lasting from June to September. Subsequently, the above mentioned 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 of KEDHP FOR, 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 KEDHP FOR, since water resources availability is decreasing. As the agricultural activity of the Platanas F.OR is focused on trees, providing trees with sufficient amounts of water throughout the year is essential to achieve sufficient production. According to FAO (2016a), water deficit during winter can cause reduced twig growth and defoliation in olive trees leading to a large percentage of imperfect flowers during spring, while flowering is also retarded.

Koutroulis et al. (2011) investigated the spatiotemporal characteristics of meteorological droughts in Crete based on the calculation of Standardized Precipitation Index (SPI) and its normalized version (SN-SPI) for the period 1973-2004. Especially for Tavronitis

basin, the results indicated that the period 1988-1996 was identified to be a prolonged drought period. Moreover, the calculation of the above mentioned indices based on Regional Climate Models data for the period 2010-2100, presented a decreasing trend both in SPI and SN-SPI values, thus indicating a potential increment in drought severity. Nikolaidis & Karatzas (2012) compiled a Special Water Resources Management Plan for Tavronitis basin, in which a preliminary drought management plan is included. Apart from the general directions presented in this plan, SPI was calculated based on precipitation data from Palaia Roumata meteorological station for the period 1960-2005. The results indicated 8 severely dry years and when expressed as drought frequency, 2 severely dry years per 10 years are caclulated. From the above, it can be concluded that prolonged droughts frequency is of major concern for KEDHP F.OR and therefore drought management actions have to be proposed.

9.2.3.2 Drought management

Except from prolonged droughts (more than a year) for which operation drought management actions has to be implemented, one more specific threshold can be specified for KEDHP F.OR in order to trigger the necessity for operation actions implementation. Taking into account that: 1) according to FAO (2016a) olive water needs between 600 and 800 mm in order to maintain high yields, 2) average annual rainfall for the northern part of KEDHP F.OR is about 600 mm, from which about 550 mm occur from October to March and c) winter rainfall is critical for olive production, it can be suggested that a drought period that can potentially affect olive orchards is triggered by decreased winter and early spring rainfall. Therefore, when the period October to March is dry, operational drought management actions should be applied. A similar approach can be considered for citrus, taking into account that citrus water needs are higher than olives.

A wide range of actions and practices have been proposed and some of them will be implemented in the ten pilot farms of KEDHP FOR. Since the majority of them are aiming to water saving, they can be used both as preventive and as operational actions in drought management. The aforementioned practices are grouped according to the way that water is saved and are described in more detail below:

Practices for reduction of water evaporation losses: Reducing water evaporation losses could significantly contribute to water saving since high air temperatures observed during summer period result in high evaporation potential. Practices that contribute to water evaporation losses reduction are:

1. Soil mulching: Weed mowing is proposed to be done during the high water demand period.
2. No weed control: Natural vegetation can remain on the farm during the wet season.
3. Shredding of pruned wood: Pruned wood of small diameter can be shredded on orchard surface.
4. No soil tillage: By applying this practice a minimum vegetation is kept on the farm.

Practices for reduction of water transpiration losses: Specific practices could be applied that aim to reduce water transpiration without affecting crop yield. Practices that contribute to water transpiration losses reduction are:

1. Winter pruning: Appropriate winter pruning can be applied in order to obtain the optimal balance between leaf area and yield.

2. Summer pruning: Appropriate summer pruning can be applied in order to reduce the transpiring leaves and radiation competition.

Practices for the improvement of soil water holding capacity: The increment of soil organic matter has been found to improve soil water holding capacity. Therefore, locally available organic matter can be applied in the farm during Autumn.

Practices for reduction of surface runoff losses: By reducing surface runoff more water will be available to infiltrate in the soil. Surface runoff can be reduced by introducing physical materials along the contour lines.

Practices for improving irrigation efficiency: Improving irrigation efficiency has been proved to contribute significantly to agricultural water saving. Several practices can be applied in order to improve irrigation efficiency:

1. Calculation of evapotranspiration losses: Crop water requirements estimation based on meteorological conditions and soil type provides the ability to apply the appropriate volumes of irrigation water and therefore to avoid excess water application in the farm.
2. Deficit irrigation: It has been proved that deficit irrigation can result in high water saving without significant impact in crop yield.
3. Avoidance of irrigation during very high temperature and high wind speed.
4. Appropriate modification from micro-sprinkle to drip irrigation applied directly on the soil surface.
5. In cases of high irrigation water salinity consider water blending for different sources in order to achieve electric conductivity values appropriate for the irrigated crop. This is especially important for citrus cultivations that are sensitive to this factor.

All the above described practices can be applied either as preventive or as operational measures. The difference is that for normal periods the application of such measures may be suggested as optional, while under drought periods their application may be considered as obligatory.

Other measures that can potentially contribute to risk management are the following:

1. Identification and minimization of water losses: Water saving potential of this practice is very high. The application of water losses identification, estimation and minimization methodology proposed in Chapter 2 can aid KEDHP F.OR both in normal and drought periods to save water.
2. Adaptation of irrigation strategy: According to FAO (2016a) for olives: *With winter rain of about 500 mm, irrigation is applied during and after stone hardening. Under conditions of little winter rain, irrigation is applied during bud differentiation (early spring), prior to flowering (early summer) and during yield formation and particularly during stone hardening. Irrigation is also applied at (a) two to three weeks before flowering; (b) when the fruit reaches one third its full size; and (c) when the fruit reaches almost full size.* For citrus, FAO (2016b) indicates that fruit shedding and growth rate reduction can occur when water deficit is observed during December or June. Moreover and especially for irrigation from groundwater, the increment in irrigation application frequency with simultaneous decrement in water volume per application may contribute to reduction of pressure in the abstracted aquifers.
3. Construction of water collection infrastructures: As described in Flood Management section, water collection infrastructures can contribute not only to mitigate flood impacts but also as water saving infrastructures that will provide water during drought periods. The F.OR has to stay in contact with the local

authorities and mainly with the local Technical Services Division and Directorate of Water, Decentralized Administration of Crete in order to perform a feasibility study for the construction of water collection infrastructures and identify potential funding tools, such as the National Strategic Reference Framework (NSRF). With regard to Tavronitis basin, Kourgialas et al. (2015) applied a hydrologic model and indicated several possible locations of the construction of small hydraulic structures (dam or/and reservoir).

4. Alternative water sources: In case of prolonged drought periods, alternative water sources may be used. Such sources could be recycled or reusable water.

Since the regional drought management plan of Crete has not been developed yet, KEDHP F.OR has to communicate its interest to the Regional Water Directorate of the, Decentralized Administration of Crete seeking information about future actions and reports related to droughts. Finally, increasing farmers awareness during drought period and training on the above mentioned practices can significantly contribute to water saving. Therefore, informational and training campaigns have to be organized by the KEDHP F.OR during drought periods.

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PART B – GOVERNANCE ACTIONS FOR MIRABELLO F.OR

1. CURRENT STATUS

The current status of Mirabello F.OR governance strategy was investigated 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 F.OR in relation to water governance directions indicated by the 4th principle of EWS was identified as low. More specifically:

- Mirabello F.OR 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 F.OR 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.
- 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 while there are no actions documented and implemented related to the management of incidents. Therefore, the current degree of transparency on water management for Mirabello F.OR is considered as low.
- Mirabello F.OR are currently implementing some Best Management Practices (BMPs), mainly within the context of the already established Environmental Management Systems. Since the implementation performance is not evaluated implementation of Good Agricultural Practices, the current potential of Mirabello F.OR 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.

Considering the above, a specific set of actions are presented below aiming to improve water governance in KEDHP FOR.

2. ENSURING COMPLIANCE WITH ALL LEGAL REQUIREMENTS LINKED TO WATER USE

The following actions are proposed in order to ensure compliance with all legal requirements linked to water use:

1. **Identify a person or department** who ensures compliance with legal requirements linked to water. In the context of this action, an assignment has been developed (Form MER-1) which has to be signed by the F.ORs management.
2. **Establish a procedure** for following up legal matters on water. This procedure (MER-PL) aims to ensure that legal and other e.g. contractual, requirements are not overlooked, and that their implementation is controlled, monitored and

reported to the Management. It is provided in Annex II and it is accompanied by Form MER-L.

3. 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. Taking into account the above the following actions are proposed:

1. **Quantify the aforementioned relations**: The appropriate documentation and forms were created for recording by the farmers (Form 4.3, for primary data, Annex II) and for processing them by the Water Steward (Form 4.3a). They contain information both on water and energy use per parcel, in relation to the various activities in the parcel. Such activities are pruning, mechanical cultivation, mechanical weed control and harvesting. The corresponding results are to be used for improving the energy efficiency. Form 4.3 provides also the means to calculate water consumption per unit of product which has to be calculated according to indicator 4.4.4.

MERAMBELLO		FORM MER-4.3 ACIVITY DIARY PER PARCEL												v1 13.11.2016
Parcel (Code)	Date	Pruning (Yes/No)	Mechanical Cultivation (Yes/No)	Mechanical weed control (Yes/No)	Harvesting (Yes/No)	Wages payed for activity (€/parcel)	Farmer's time spent on activity (Hr/parcel)	Energy used for activity (Lit oil)	Energy used for activity (Lit petrol/parcel)	Energy cost / activity (€/parcel)	Other costs / activity (€)	Yield (Kg/Parcel)	Estimated yield losses (%)	Notes
Farmer					**Signature**					Completed for year yyyy dd/mm/yyyy				

MERAMBELLO	FORM MER-4.3a CUMULATIVE ACTIVITY SPENDING														v1 13.11.2016	
	Irrigation		Irrigation (energy)		Pruning (energy)		Fertilization			Cultivation(energy)		Plant Protection			Harvest (energy)	
Parcel (Code)	M3/Ha	m3/Kg	kWh or Lt/m3	kWh or Lt/kg	Lit/Kg	Lit/m3 water	Lit/Kg	Lit/m3 water	Kg N-P-K/m3 water	Lit/Kg	Lit/m3 water	Lit/Kg	Lit/m3 water	Kg a.i.s/m3 water	Lit/Kg	Lit/m3 water
Water Steward							**Signature**					Completed for year yyyy dd/mm/yyyy				

The following instructions can be given to the farmers in order to fill in Form 4.3:

- Parcel code: Write down the code of the parcel
- Date: Date that the activity took place (not the date of filling the form)
- Pruning: Write YES if the activity against the given date was irrigation, and NO if it was not.
- Do the same for the next three columns. If you did more than one activity in one day, use two sequential lines with the same date.
- Write down in the eighth column the labour cost in € paid for the activity on that date.
- Write down the time in hours, spent by the farmer on the same activity, the energy consumption in liters of oil (diesel) and in liters of petrol, then

the cost in € of the fuel that was used and any other costs (just the €, not the items).

- Last, write down the yield in Kg that was obtained from this parcel (presumably, this is going to be written down when you will have written YES in the seventh column) and your estimation of the % of yield lost for any reason.
- Note 1: You should try to fill the same form every day (until it is full, so you start a new one). No matter if the parcels will be mingled. The water steward will separate them, later.
- Note 2: Do not forget to write down -in raw form- the correct amounts per whole parcel. Never proceed to calculations in order to express the input e.g. per hectare.

The reason for asking each farmer to fill this 'diary' is that it will allow the Water Steward to have a measure of the efficiency of the used inputs, by collecting all the inputs for each parcel and compiling Form MER-4.3a and then compare the efficiency between parcels.

2. **Improve water management in relation to energy and other resources:** The results of Form MER-4.3a can indicate improvement potential in water management in relation to energy and other resources. Therefore the Water Steward can analyze the corresponding data, identify parcels of low efficiency and propose improvement actions. Moreover, the pool of GAPs planned to be implemented in the pilot farms, which are described in detail in Deliverable C3.1, are also contributing to the improvement of water management in relation to energy and other resources.

4. RAISING EFFICIENCY OF WATER CONSUMPTION

In accordance to EWS standard, three specific actions have to be considered in order for Mirabello F.OR to raise its efficiency of water consumption. The first action is related to the identification of water losses and their destination. Water losses are defined as the applied water that does not return to its source. For example, when irrigation water source is an aquifer and an amount of the applied water turns into surface runoff then this amount of water is considered as lost. If the amount of water lost through surface runoff was draining into the aquifer, it would not be considered as lost.

Potential destinations of water losses are: a) the atmosphere, when water is lost though evaporation, b) the adjacent surface water body, when water is lost through surface runoff and c) the underlying aquifer, when water is lost through drainage.

Water losses in agriculture cover a significant portion of water used. Sometimes water losses may be higher than 50% of irrigation water abstractions. Therefore, there is always a significant potential for water saving by identifying and reducing water losses. Irrigation process can be divided into three components:

a) the **distribution-conveyance component**, which corresponds to the distribution and transportation of irrigation water from the source to the field,

b) the **on-farm application component**, which corresponds to the application of irrigation water in the field with an irrigation system-method.

c) the **storage component**, which corresponds to the special constructions (such as dams), in which irrigation water is collected prior to the distribution in the farms.

Water distribution systems in agriculture are categorized into surface and piping systems. With regard to surface systems, water losses are mainly attributed to

evaporation from water surface and water percolation along the system. Some indicative average conveyance efficiencies are 70% and 85% for well maintained-operated earthen channels and lined canals, respectively, while the corresponding efficiency for piping systems is 95%. Please keep in mind that accidental leakages may also be occurred in distribution systems because of system failures (such as broken pipes), resulting in water losses through surface runoff, drainage or evaporation.

With regard to the on-farm application of irrigation water, the water losses potential is significantly different depending on the irrigation system applied (surface irrigation, sprinkler irrigation, drip irrigation). For surface irrigation, such as furrow irrigation, evaporation, surface runoff and drainage are the three major water loss mechanisms. In terms of sprinkler irrigation, except from evaporation, wind drift and spray losses are also considered. Indicative field application efficiencies of irrigation are 60%, 75% and 90% for surface, sprinkler and drip irrigation, respectively. Except from the above, on-farm conveyance losses have to be considered because of accidents or not well-maintained irrigation systems resulting in water losses through surface runoff, drainage or evaporation. Moreover, the application of irrigation water above the crop requirements may result in significant water losses, mainly through evaporation, surface runoff and drainage.

Like an open water body, the irrigation water storage constructions are exposed to the evaporation process. Depending on the climate conditions, water losses from the storage construction through evaporation may be significant.

All the above, as well as the estimation procedure of water losses during the irrigation process are summarized in Form 4.4. It has to be mentioned that the appropriate considerations have to be made, depending on the irrigation water source and water loss destination. Therefore, total water loss has to be properly adjusted. Moreover, accidental water loss have to be considered when such incidents are happening and are significantly affecting water losses.

MERAMBELLO	**FORM MER 4.4 – WATER LOSSES ESTIMATION**					
Distribution – conveyance water losses (%)						
Type of water distribution system	Evaporation [1]		Deep percolation [2]			Total water distribution losses [3]=[1]+[2]
Open canals						
Piping system	-					
On-farm water application losses (%)						
Type of irrigation system	Water Distribution System [4]	Surface runoff [5]	Deep Percolation [6]	Soil & Canopy evaporation [7]	Wind drift [8]	Total on-farm water application losses [9]=[4]+…+[8]
Furrow					-	
Sprinkler						
Drip		-		-	-	
Water storage losses (%)						
Type of storage system	Evaporation [10]		Deep Percolation [11]			Total water storage losses [12]=[11]+[12]
Reservoir or dam						
TOTAL IRRIGATION WATER LOSSES (%) 13=[3]+[9]+[12]						

The second action is the planning, implementation and monitoring of measures that will enhance water efficiency. A set of measures are presented in the corresponding farm specific action plans which aim to improve water efficiency. The monitoring schedule as well as the measurement equipment are also presented. Such measures include:

- Calculation of evapotranspiration losses: This measure can lead to a more accurate calculation of crop water needs and therefore to avoid irrigation water excess and the corresponding water losses.

- Plan for farm irrigation network improvement: Repairs of the farm irrigation network are included. Moreover, a set of water-meters and volumetric valves will be introduced in selected orchard, in order to provide farmers with the tools to precisely control the amount of irrigation water that is applied to the orchard.
- Deficit irrigation: This measure includes application of regulated deficit irrigation may reduce water use by 20-30% in olive trees and 10-15% in citrus, with no negative effects on yield quality and quantity.

By comparing data recorded in Form MER-4.3 year after year and according to the measures and practices applied, the Water Steward of the organization has to fill-in the results in the following table MER-4.3b and compare the increasing water efficiency potential of the applied practices. It has to be mentioned that the compared periods have to be of the same extent.

MERAMBELLO	**FORM MER 4.3b-MONITORING WATER EFFICIENCY**				**v1 13.11.2016**		
Parcel code	Initial water consumption period	Initial water consumption (m3/Ha)	Measures taken	Current water consumption period	Current consumption (m3/Ha)	Water savings (m3/Ha)	Inherent Temporal variability1
Water Steward			**Signature**		Completed for year yyyy dd/mm/yyyy		

The final action includes the calculation of total water consumption per unit of product (fruits in this case), which can be conducted by the data collected in Form KED 4.3 by dividing consumed water to the crop yield. It has to be mentioned that the term "consumed water" is defined as the water abstracted from a specific water sources.

5. 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. This person will be responsible to inform the management of F.OR for any updates of the River Basin's Water Resources Management Plan, and make it available in FOR's premises. Assignment of the person above is facilitated by the Form MER-1.2 (Annex II) for assignment of roles and responsibilities.

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. According to the management system of each F.OR, internal communication can be accomplished by e.g. circulation of internal memos, by introducing a thematic issue in the agenda of formal personnel meetings, by using social media, etc. The activities selected should be recorded, e.g. in a quarterly report on WMAS. Verification of the efficacy of the measures

selected can be part of the internal audit of the F.OR's management system e.g. by interviewing a sample of the F.OR's personnel and a sample of farmers.

According to EWS Standard, a report with information on operational water management has to be available to customers, to the local community and the authorities (both, for water and for agriculture). This report shall include basic information on water management (for example water abstractions and their distribution on to the several crops) and other information such as actions and achievements linked to sustainable water management, definition of water-related risks and preventive measures implemented. Since Mirabello F.OR is not performing the operational water management, such a report is not mandatory. However, as the issue is quite novel for the Greek agriculture each F.OR will consider the usefulness it could have for its image in the area and proceed to design such a report, even as an alert to the innovation EWS brings and to stress the focal position of the F.OR as a local 'ambassador' of EWS. The contents may be selected among:

- Informal, awareness-raising about the consequences of forthcoming regulation.
- A brief presentation of findings, evaluation of practices tested, objectives update etc.
- Problems, especially the ones that may systematically affect other farmers in the basin.
- News on the expansion of implementation of EWS,
- Major events related to the implementation of the EWS in addition to the events related to the AgroClimaWater project.
- Brief reports on international appraisal of climate change news related to water issues.
- News on technology and science on irrigation water management e.g. under conditions of drought.

Depending on the availability of information and of human resources, the report could be either annual or every six months.

Cooperation between the three F.ORs could prove fruitful, especially capitalizing on the cross country element.

As a third action, promotional campaigns have to be organized and implemented on topics related to water. For agriculture, such campaigns may be related to irrigation (scheduling, methods, deficit irrigation, irrigation system maintenance) and GAPs that promote the sustainable water management from both the quantitative and qualitative point of view. The campaigns may be aligned with the milestones of the AgroClimaWater project, or with local agricultural nature festivities in each area, fairs and other major events related to agriculture. This action may well be combined with the edition of the report mentioned above, at least as much as the topics of reference are concerned.

The F.OR has also to be prepared in order to efficiently manage accidents, emergency situation and disasters. Therefore two action plans dealing with floods and droughts were compiled in which the corresponding risk, as well as management and mitigation actions are proposed. These action plans are found in the last chapter of this part of the deliverable. With regard to other incidents that could significantly affect the agricultural activity in Mirabello FOR, such as fire, it is proposed for the F.OR to stay in contact with the Independent Civil Protection Office and Fire Station of Chania Municipality and ask to be informed in case of emergency situations. With regard to irrigation system breakdown, Mirabello F.OR have no direct intervention right. Therefore, when system breakdown is occurred, the Water Steward should contact the water supplier and ask for a plan on when the system is going to recover.

6. ENSURING CONTINUOUS IMPROVEMENT

Currently, there are no GAPs applied under an organized scheme in Mirabello FOR. Therefore, a pool of GAPs has to be established, which will be implemented depending on the specific needs of each farm. The performance of those GAPs has to be evaluated. The pool of GAPs that contributes to the continuous improvement is established from the GAPs proposed to be implemented in the ten pilot farms. The GAPs are summarized in Table 1, while their implementation, monitoring and evaluation processes are presented in detail in Deliverable C3.1. 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.

Table 4: Good agricultural practices (GAPs) proposed to be implemented in the pilot farms

Aim	Practice	Description
Reduction of water evaporation losses	Soil Mulching	Weed mowing during the high water demand season
	No weed control	Natural vegetation will remain on farm during rainy season
	Shredding of pruned wood	Pruned wood of small diameter will be shredded on orchard surface
	No soil tillage	Avoid bare soil to reduce evaporation losses
Reduction of transpiration water losses	Winter pruning	Appropriate winter pruning will be applied to obtain the optimal balance between leaf area and yield
	Summer pruning	Will be applied to reduce the transpiring leaves and reduce radiation competition
Reduction of surface runoff	Increase organic matter	Application of locally available organic matter (improving the soil water holding capacity)
	Fertigation	Apply fertilizers through irrigation
Maximizing the efficiency of irrigation	Calculation of evapotranspiration losses	Weekly bulletins (will be available on IOTSP) on crop irrigation water requirements (meteorological conditions, soil type, crop)
	Plan for farm irrigation network improvement	Repairs of the farm irrigation network. A set of water-meters and volumetric valves will 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

	Deficit irrigation	Application of regulated deficit irrigation may reduce water use by 20-30% in olive trees and 10-15% in citrus, with no negative effects on yield quality and quantity
	Rationalization of fertilizers and agrochemicals	A more environmental friendly agricultural practices policy

7. ENSURING TRANSPARENCY ON ECONOMIC ASPECTS OF WATER MANAGEMENT

Two actions are proposed in order for Mirabello F.OR 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. These investments may include capital investments, granting, loans etc. Special attention should be paid in order to identify the relation between investments made for sustainable water management and the total investments made for water management. Moreover, money saving potential could be identified from the water saving investments implemented.

Concerning the second action, an environmental cost analysis has to be performed. The cost included in the above analysis may include all environmental management costs such as:

1. Personnel employed for education and training.
2. External services for environmental management.
3. External certification of environmental management systems.
4. Personnel for general environmental management activities.
5. Research and development.
6. Investments in water saving programs and measures.
7. Other environmental management costs.
8. Environmental charges as percentage of water tariff.

8. WATER MANAGEMENT STRATEGY

An operational water management strategy has to be in place in which the following have to be addressed:

1. Include stakeholder concerns.
2. Incorporate all 4 EWS principles. It is important to make a clear link between the strategy and the 4 principles of EWS, and if possible with the indicator(s) addressed.
3. Identify and assess risks related to water use.
4. Incorporate preventive measures to mitigate impacts of water use and discharge.
5. Establish a monitoring scheme (frequency and method and report and follow-up on outcomes of monitoring).
6. Develop a water efficiency strategy.
7. Person or department in charge of implementation and monitoring of the strategy. An special assignment is presented in Form KED 1.3 (Annex II) Moreover, a responsible person or department that will cope with the legal

matters of water and a responsible person or department for the River Basin's Committee has to be defined as mentioned earlier.

8. Give effort to insure the continuous improvement in water management.

9. FLOODS AND DROUGHTS ACTION PLAN

9.1 Floods Action Plan

9.1.1 Introduction

A large number of flood definitions exists. According to WMO & UNESCO (2012) floods can be defined as "rises, usually brief, in the water level of a stream or a water body to a peak from which the water level recedes at a slower rate". There are three types of floods which can potentially affect the agricultural sector: river floods, flash floods and coastal floods. River floods occur when river water system capacity is exceeded and therefore river water is not able to be channeled through the river course. Flash floods are developed from localized, intense rainfalls and can occur anywhere in the basin, while coastal floods constitutes the result of increased sea level rise caused by storm surges driven by tropical storms or strong windstorms. According to Morris et al. (2010), flood development consists of three major components: the sources, the pathway and the receptor. Flood sources are the extreme rainfall events and/or the sudden snow-cover melt, while pathway is considered as the land and the hydrological system which transfer the water to the receptor. Finally, flood receptor is where flooding occurs. Agricultural land can serve either as pathway or receptor.

Since the agricultural sector is fully exposed to floods and their impacts, either as flood pathway or as flood receptor, the necessity for floods action plans development is high. Taking into account climate change projections, according to which floods frequency is expected to increase, the necessity for compilation of floods action plans becomes even higher.

Floods action plan constitutes a part of the F.ORs governance actions/strategy and more specifically contributes to EWS Standard indicator 4.5.5: Management of incidents:

1) Procedures are established, implemented and monitored to respond to accidents, security incidents, emergency situations, disasters and the like. 2) The impacts of such an occurrence to the environment, employees, the regional population and communities of the affected region are described or estimated. A specific methodology was established for the development of flood action plans by the three F.ORs participating in AgroClimaWater partnership. This methodology is implemented individually for each one of them and therefore one action plan per F.OR was compiled.

9.1.2 Flood action plan development methodology

The methodological framework followed in order to establish the flood action plan is presented in Fig. 1; Two are the main steps that each F.OR has to follow in order to compile it: a) identify the areas characterised by high flood risk and b) compile a flood management strategy by identifying actions, measures and practices that will lead to reduction of agricultural activity contribution to surface runoff and mitigation of the corresponding floods' impact.

Floods risk assessment can be based on reports, data and information developed within the context of Directive 2007/60/EC. More specifically, every EU Member State has to

be conform to Directive 2007/60/EC on the assessment and management of flood risks. Conformation to this Directive includes:

4. Preliminary flood risk assessment.
5. Development of flood hazard and flood risk maps.
6. Development and configuration of flood risk management plans for the areas that are potentially at any flood risk.

The milestones established towards the implementation of Directive 2007/60/EC are presented in
Table 2. Concerning the current implementation status of Greece, flood hazard and flood risk maps have been developed for most of Water Districts, while the compilation of flood risk management plans has been finalized only for Water District GR012 (Thrace-NE Greece).

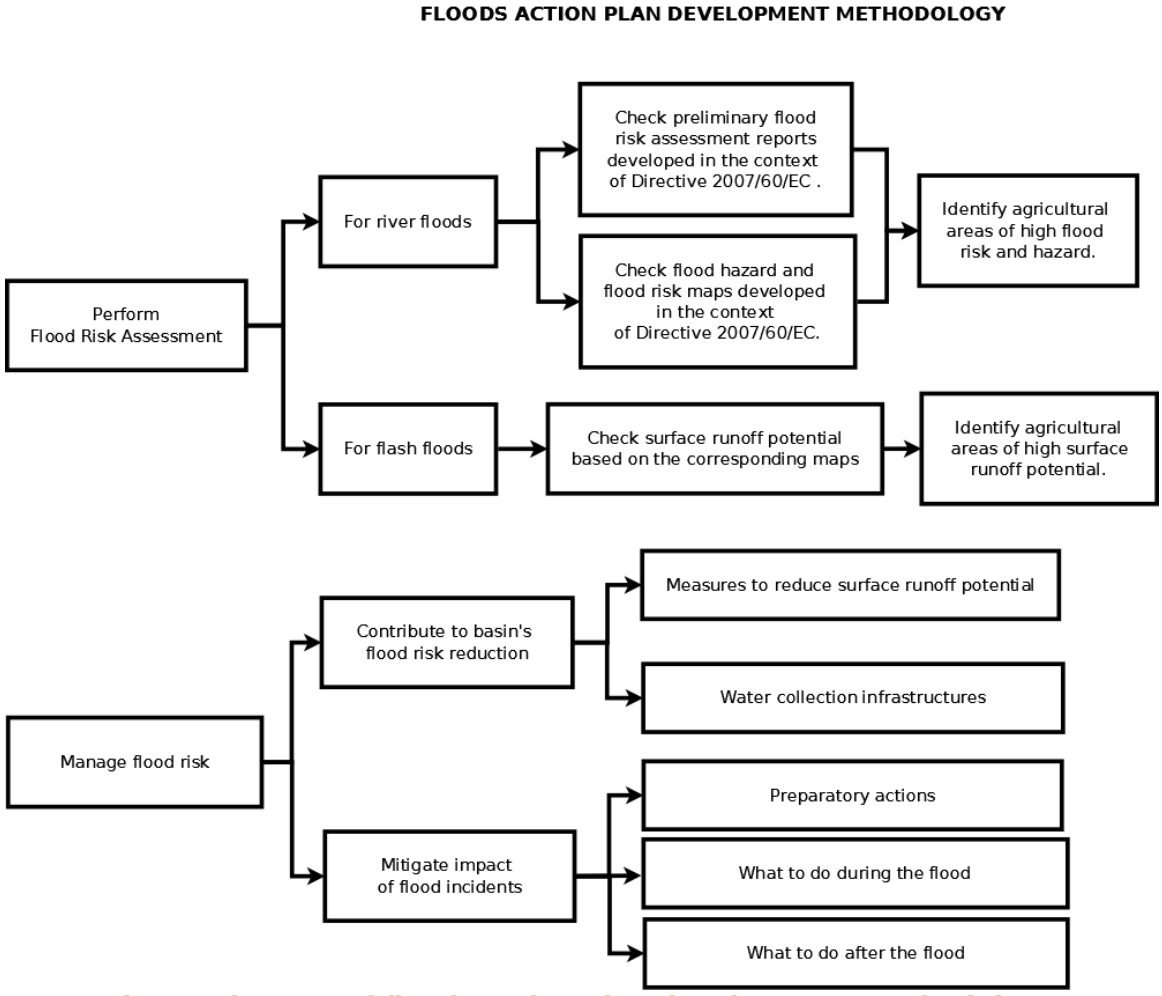

Fig. 6: Diagram of floods action plan development methodology

The results of preliminary flood risk assessment for Greece are provided in the following URL: http://www.ypeka.gr/Default.aspx?tabid=252. The user can find the corresponding report and maps as well as, GIS data (shapefiles and "kmz" files) for zones of potentially high flood risk, historic floods and significant historic floods. From preliminary flood risk assessment, the user can identify whether there are zones included in his area of interest which have been designated as being at high flood risk. The flood risk and hazard maps accompanied by the corresponding maps can be accessed through the following URL: http://floods.ypeka.gr/. For each of the zones of

potentially high flood risk the following information can be gathered by the corresponding maps:

1. Spatial distribution of maximum flood depth with return periods of 50, 100 and 1000 years.
2. Spatial distribution of maximum flood velocity with return periods of 50, 100 and 1000 years.
3. Spatial distribution of flooded areas with return periods of 50, 100 and 1000 years.
4. Spatial distribution of flood impact assessment with return periods of 50, 100 and 1000 years.
5. Spatial distribution of soil erosion vulnerability.

Table 5: Milestones towards the implementation of Directive 2007/60/EC (source: http://ec.europa.eu/environment/water/flood_risk/implem.htm)

Issue	Deadline	Reference
Entry into force	26.11.2007	OJ L 288, 6.11.2007 Art 18
Transposition	26.11.2009	Art 17
Reporting format Preliminary Flood Risk Assessment	22.12.2009	Art 11
Administrative arrangements to be in place and to be notified to the Commission	26.5.2010	Art 3
Cut-off date transitional measure (availability of existing tools)	22.12.2010	Art 13
Preliminary flood risk assessment	22.12.2011	Art 4 & 5
Public participation process starts (publication of mechanism and timetable for consultation)	22.12.2012	Art 9.3 & 10
Flood hazard and risk maps	22.12.2013	Art 6
Flood risk management plans	22.12.2015	Art 7
2nd Preliminary Flood Risk Assessment, specific requirement on climate change	22.12.2018	Art 14.1 & 4
Commission's first implementation report due.		
2nd Flood hazard and risk maps	22.12.2019	Art 14.2
End of 1st flood risk management cycle	22.12.2021	Art 14.3 & 4
2nd Flood Risk Management Plans, specific requirement on climate change.		
3rd Water Framework Directive River Basin Management Plans.		

It has to be mentioned that soil erosion potential has been investigated in the context of Action C2. Based on the above information, every participating F.OR can identify the river flood zones and investigate the potential flood hazard and flood risk for this zones. With regard to flash floods, in which agricultural land can be considered to serve as flood pathway, the surface runoff potential maps developed according to the methodology presented in the corresponding deliverable of Action C2 can be used in order to identify the surface runoff potential of each farm participating in every F.OR and therefore the risk for flash floods to occur.

Concerning flood risk management, actions, mechanisms and practices have to be identified in order to:

- Reduce the contribution of farms that indicate high surface runoff potential. These actions, measures and practices are also contributing to the mitigation of flash floods impacts both in the farm and the basin scale. They can be divided into two major categories including: a) measures that are applied on farm and aim to reduce surface runoff potential and therefore flash flood risk and b) infrastructures in which surface runoff can be collected and therefore flash floods impact can be mitigated, while these infrastructures may also contribute to mitigate river floods.
- Mitigate the impacts of river floods before their occurrence (i.e act in a preventive maner), during them and after them. The actions, mechanisms and practices identified in the basin's flood risk management plan (in case that it is existing)m which are related to F.OR activities, have to be incorporated into the current flood risk management plan.

9.1.2.1 Flood risk assessment

With regard to Havgas-Milatos basin in which farms of Mirabello F.OR are located, there were no high flood risk zones identified in preliminary flood risk assessment for Greece. Therefore, river flood risk for Havgas-Milatos basin can be considered as low.

With regard to flash flood risk assessment, the results of surface runoff potential as estimated in the context of Action C2 are used, which are presented in Table 3. The average runoff potential for all agricultural area classes was found to be high (values >1.8 and <2.4). The average runoff potential of olive groves, which constitute the dominant land cover for Mirabello basin (36.52% of the total basin area), was 1.92 and it is considered as high, while the corresponding range of variation was 0.84 (Low) – 2.66 (Very High), thus indicating a significant degree of runoff potential variation for olive groves in Mirabello basin. Higher average runoff potential was calculated for land principally occupied by agriculture, with significant areas of natural vegetation (2.28) and lower average runoff potential was calculated for complex cultivation patterns (1.82). Considering the above, it can be concluded that overall the agriculture activity developed in Havgas-Milatos basin can present moderate to high contribution to the development of flash floods, which is mainly attributed both on significant rainfalls met in the southern part of the basin and to the steep slopes.

Table 6: Surface runoff potential statistics for the agricultural lands of Havgas-Milatos basin

Land Cover Code	Land Cover Description	Area		Minimum		Maximum		Average	
		(km²)	(%)	Score	Class	Score	Class	Score	Class
223	Olive groves	10.99	36.52	0.84	Low	2.66	Very High	1.92	High
242	Complex cultivation patterns	1.74	5.79	0.92	Low	2.41	Very High	1.82	High
243	Land principally occupied by agriculture, with significant areas of natural vegetation	1.38	4.57	1.31	Moderate	2.51	Very High	2.28	High

With regard to coastal floods risk and according to Hellenic Special Secretariat for Water (2016), sea level rise estimations are not expected to significantly affect human activities and pose risk for life and therefore coastal floods scenarios were not developed.

The actions presented below aim to contribute to surface runoff potential reduction and therefore to directly reduce the contribution of agricultural activity in flash floods, since river flood potential for Havgas-Milatos basin was assessed as negligible. A wide range of practices are met in the literature which aim to contribute to surface runoff reduction from crop covered land. The actions practices and measures presented below are chosen from the pool of practices that are to be implemented in the context of the project as well as other actions applicable to the specific case of Havgas-Milatos basin.

The practices implemented within the context of the project that directly or indirectly contributes to surface runoff potential reduction are the following:

- No weed control: According to this practice, natural vegetation is remaining during the wet season. Therefore, soil is covered during the rainy season resulting in surface runoff potential decrease. This practices is similar to the establishment of cove crops.
- No soil tillage: Despite the fact that this practice was incorporated with a view to reduce evaporation losses, according to Aina (1993) other benefits such as storm runoff reduction and improved infiltration capacity can be considered by the application of this practice.
- Physical reduction of surface runoff: Surface runoff can be reduced by introducing physical materials along the contour lines.

Other practices and measures that are well known to be effective in reducing surface runoff potential from the farms are the following:

- Conservation buffers: This practice includes the maintenance of small areas or strips in permanent vegetation. There are several versions of this practice applied such as riparian buffers, filter strips and grassed waterways.
- Avoidance of vehicle movements and wheel ruts on wet soil.
- Avoid as much as possible to use heavy machinery within the farm. Heavy machines are contributing to soil compaction, which reduces water infiltration capacity and thus surface runoff potential is increasing.

Water collection infrastructures can contribute not only to mitigate flood impacts but also as water saving infrastructures that will provide water during the water demanding periods. The F.OR has to stay in contact with the local authorities and mainly with the local Technical Services Division and Directorate of Water, Decentralized Administration of Crete in order to perform a feasibility study for the construction of water collection infrastructures and identify potential funding mechanisms such as National Strategic Reference Framework (NSRF).

9.1.2.2 Other measures

Since flash floods can occur anywhere and anytime, some other measures are proposed in order to mitigate the impacts of flash floods during and after their occurrence. In case that a severe flash flood is occurred in the area, the following actions are proposed to be implemented:

- Get informed about the flood status. Information can be retrieved by the local media.
- Stay in touch with the Independent Civil Protection Office and Fire Station of Chania Municipality

Also, the following directions are proposed to be given to the farmers:

- Avoid being on the farm during the flood. Find a safe place to stay.

The set of actions that could be followed after the flood can be divided into those that can be implemented by the F.OR and those that can be applied by the farmers. Concerning the F.OR actions, the following are proposed:

- Get informed about the impacts of the flood and follow the directions of Independent Civil Protection Office and Fire Station of Chania Municipality. Also communicate with the Department of Rural Economy and Veterinary of Chania Prefecture.
- Communicate the information to the farmers.

Concerning the actions that can be applied by the farmers, the following are proposed:

- Be careful when trying to approach your farm in order to avoid injury.
- Stay in touch with the F.OR in order to guide you for the next steps.

One of the most significant impacts of flash floods in a farm is soil erosion. Therefore, when soils erosion gaps are observed in a farm, try to correct them with appropriate tillage. In case that this is not feasible, try to fill the erosion gaps with material from other sites.

9.2 Droughts Action Plan

9.2.1 Introduction

Drought constitute one of the more severe hazards with adverse economic, social and environmental impacts. According to the European Commission, (http://ec.europa.eu/environment/water/quantity/about.htm) *Droughts can be considered as a temporary decrease of the average water availability due to e.g. rainfall deficiency*. The usual types of droughts are presented in Fig. 5. A meteorological drought occurs when the actual rainfall in an area is significantly less than the long-term average rainfall observed in this area. Agricultural droughts happen when the available water is not sufficient to cover crop water needs during the crop cultivation period. Agricultural droughts are linked to either meteorological or hydrological droughts, since specific characteristics of meteorological or hydrological droughts are linked to impacts in agriculture. Hydrological droughts occur when there is evident low water availability in steams, reservoirs and aquifers and usually, they constitute the result of prolonged periods of meteorological droughts. In contrast to meteorological droughts, the duration and recovery of which are usually short, both the development and the recovery of hydrological droughts are usually lasting much longer.

Since agriculture is directly exposed to climate variability, the impacts of droughts in agriculture are also direct. Therefore, agriculture constitutes one of the most drought vulnerable productive sectors and subsequently the necessity for proper response in order to alleviate impacts is very high. Water scarcity and droughts constitutes one of the major water-related concerns of European Commission which was recognized in the Communication "Addressing the challenge of water scarcity and droughts" at 2007 [COM(2007)414]. The necessity for drought management has been also recognized in Directive 2000/60/EC, according to which, when and where needed, a specific "drought management (sub) plan" should be included in the WFD RBMP (art. 13.5).

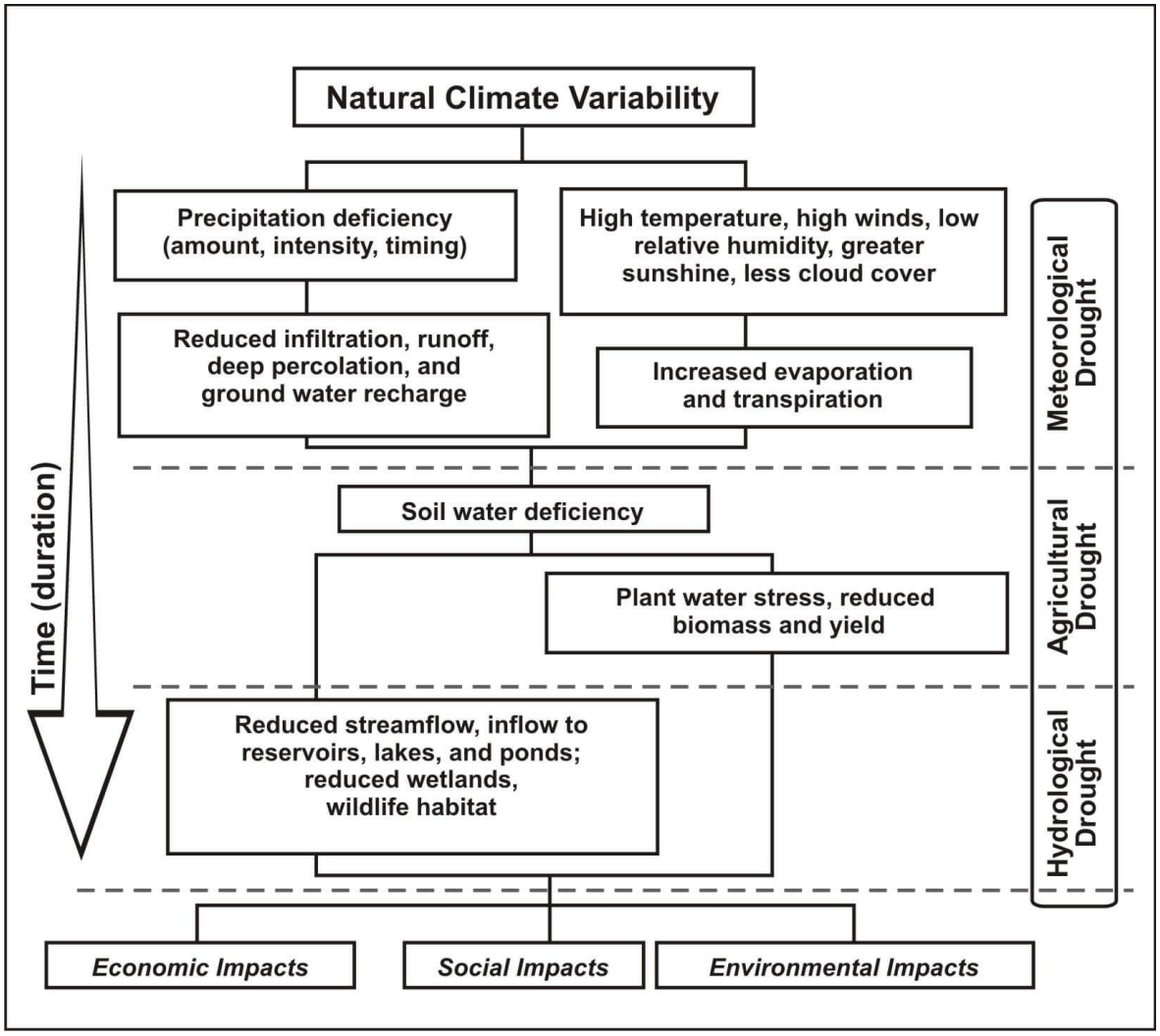

Fig. 7: Types of drought (Source: National Drought Mitigation Center, University of Nebraska-Lincoln, U.S.A., http://drought.unl.edu/DroughtBasics/TypesofDrought.aspx)

9.2.2 Drought action plan development methodology

Drought management constitutes a very complex processes, since a wide variety of sectors (e.g. agriculture, industry, tourism, environment, socioeconomical aspects) are interacting in a complicated way. Therefore drought management plans are commonly compiled at national and regional level for which a management procedure can be established in a common basis. Subsequently, compiling a drought action plan only for a specific sector (agriculture) and for a very specific area (area of farmers organization) constitutes a very tricky and demanding task.

Considering the above, the compilation of F.OR specific drought action plans have to be strongly connected to the regional drought management plans that in turn have to be compiled for drought vulnerable areas, in accordance to Directive 2000/60/EC (art. 13.5). In regional drought management plans, each F.OR can identify specific drought management directions, identify its role as a water user in the basin, as well as the interactions with the other water users and sectors.

The drought action plan development methodology described below 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 FOR. Drought risk assessment section aims to identify, analyze and evaluate drought risk. Based on drought risk assessment results, specific actions are proposed, according to which the F.OR is getting prepared to deal with droughts.

9.2.2.1 Drought risk assessment

According to the Guidelines for preparation of the Drought Management Plans in the context of the EU Water Framework Directive (Global Water Partnership Central and Eastern Europe 2015), drought risk assessment may include the flowing processes:

- risk identification – finding, recognizing, and describing risks
- risk analysis – determining the level of risk (i.e. the quantitative estimation of the probability of occurrence and severity of potential drought impacts)
- risk evaluation – evaluating the significance of the drought risk

Since the development of drought risk assessment including the aforementioned information requires specialized knowledge and expertise, it is proposed to retrieve this information from the drought management plan in case that such a plan exists for the specific Water District or the basin. Alternatively, other related scientific information resources may be gathered either from the local authorities or web sources. Moreover, internal information on drought occurrence and impact could be retrieved in case that such information is available within the FOR. Since drought constitutes a major hazard for agriculture, there is strong possibility for the F.OR to have recorded severe drought incidents, as well as their impacts on crop production.

9.2.2.2 Drought management

Before establishing the risk management plan, the F.OR has to consider the degree of its influence in local water resources management status and identify its role as a water user in relation to the other users located in the basin. For example, the direct degree of influence in water resources management status of a F.OR that own a wide number of private groundwater wells could be considered as higher compared to a FOR, the agricultural water needs of which are supplied by other authorities, such as Land Reclamation Organizations in Greece. In the first case, F.OR will be directly connected to the public authority that coordinates drought management in the basin, while for the latter case, F.OR will probably get specific drought management directions from water supplier.

According to the EU Guidelines for preparation of the Drought Management Plans in the context of the EU Water Framework Directive (Global Water Partnership Central and Eastern Europe 2015), the following categories could be used in order to classify the actions that could be applied in the case of F.ORs:

- Preventive actions: These actions aim to increase drought resistance and mitigate potential drought risk and impacts on the economy, society, and they are implemented under normal periods.
- Operational actions: This kind of actions are designed to be implemented during a drought period.

The core of drought management actions that can be potentially implemented by a F.OR is water saving. Therefore a number of specific actions and practices must be proposed and implemented, when necessary, in order to enhance drought mitigation potential of F.ORs. Most water saving actions and practices could be either applied as preventive or operation actions, since the majority of them can contribute to drought resistance

increase during normal periods and to drought impacts mitigation during drought periods. Nevertheless, a specific threshold based on rainfall distribution and crop type can be specified in order to trigger the necessity for operation actions implementation.

9.2.3 Drought action plan of Mirabello FOR

9.2.3.1 Drought risk assessment

According to the Water Resources Management Plan of Crete Water District (Hellenic Special Secretariat for Water, 2015) a drought management plan has not been developed yet. More specifically, 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). Therefore, the necessity for the development of a regional drought management plan has been recognized in the Water Resources Management Plan.

Given the absence of a regional drought management plan, information about drought risk assessment were retrieved from alternative sources. An important notice about drought risk in Crete Water District comes from the Water Resources Management Plan, according to which, the lack of rainfall during summer, combined to high air temperature and evapotranspiration are resulting in a drought conditions, usually lasting from June to September. Subsequently, the above mentioned 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 of Mirabello FOR, 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 FOR, since water resources availability is decreasing. As the agricultural activity of the Mirabello F.OR is focused on trees, providing trees with sufficient amounts of water throughout the year is essential to achieve sufficient production. According to FAO (2016a), water deficit during winter can cause reduced twig growth and defoliation in olive trees leading to a large percentage of imperfect flowers during spring, while flowering is also retarded.

Koutroulis et al. (2011) investigated the spatiotemporal characteristics of meteorological droughts in Crete based on the calculation of Standardized Precipitation Index (SPI) and its normalized version (SN-SPI) for the period 1973-2004. The results indicate that the part of Crete island that suffer most from drought events are the southern and the eastern. Havgas-Milatos basin is located in the eastern part. These results agree with those of Tsakiris & Vangelis (2004) according to which drought frequency is higher in the eastern part of Crete island. Koutroulis et al. (2011) identified the period 1987-1994 as a prolonged drought period for the island of Crete according to SPI and SN-SPI data for the period 1973-2004, while Tsakiris et al. (2007) presented the period 1989-1990 as the driest for the time span 1962-1992.

9.2.3.2 Drought management

Except from prolonged droughts (more than a year) for which operation drought management actions has to be implemented, one more specific threshold can be specified for Mirabello F.OR in order to trigger the necessity for operation actions implementation. Taking into account that: 1) according to FAO (2016a) olive water needs between 600 and 800 mm in order to maintain high yields, 2) average annual rainfall for the northern part of Mirabello F.OR is about 600 mm, from which about 550 mm occur from October to March and c) winter rainfall is critical for olive production, it

can be suggested that a drought period that can potentially affect olive orchards is triggered by decreased winter and early spring rainfall. Therefore, when the period October to March is dry, operational drought management actions should be applied. A similar approach can be considered for citrus, taking into account that citrus water needs are higher than olives.

A wide range of actions and practices have been proposed and some of them will be implemented in the ten pilot farms of Mirabello FOR. Since the majority of them are aiming to water saving, they can be used both as preventive and as operational actions in drought management. The aforementioned practices are grouped according to the way that water is saved and are described in more detail below:

Practices for reduction of water evaporation losses: Reducing water evaporation losses could significantly contribute to water saving since high air temperatures observed during summer period result in high evaporation potential. Practices that contribute to water evaporation losses reduction are:

1. Soil mulching: Weed mowing is proposed to be done during the high water demand period.
2. No weed control: Natural vegetation can remain on the farm during the wet season.
3. Shredding of pruned wood: Pruned wood of small diameter can be shredded on orchard surface.
4. No soil tillage: By applying this practice a minimum vegetation is kept on the farm.

Practices for reduction of water transpiration losses: Specific practices could be applied that aim to reduce water transpiration without affecting crop yield. Practices that contribute to water transpiration losses reduction are:

1. Winter pruning: Appropriate winter pruning can be applied in order to obtain the optimal balance between leaf area and yield.
2. Summer pruning: Appropriate summer pruning can be applied in order to reduce the transpiring leaves and radiation competition.

Practices for the improvement of soil water holding capacity: The increment of soil organic matter has been found to improve soil water holding capacity. Therefore, locally available organic matter can be applied in the farm during Autumn.

Practices for reduction of surface runoff losses: By reducing surface runoff more water will be available to infiltrate in the soil. Surface runoff can be reduced by introducing physical materials along the contour lines.

Practices for improving irrigation efficiency: Improving irrigation efficiency has been proved to contribute significantly to agricultural water saving. Several practices can be applied in order to improve irrigation efficiency:

1. Calculation of evapotranspiration losses: Crop water requirements estimation based on meteorological conditions and soil type provides the ability to apply the appropriate volumes of irrigation water and therefore to avoid excess water application in the farm.
2. Deficit irrigation: It has been proved that deficit irrigation can result in high water saving without significant impact in crop yield.
3. Avoidance of irrigation during very high temperature and high wind speed.
4. Appropriate modification from micro-sprinkle to drip irrigation applied directly on the soil surface.
5. In cases of high irrigation water salinity consider water blending for different sources in order to achieve electric conductivity values appropriate for the

irrigated crop. This is especially important for citrus cultivations that are sensitive to this factor.

All the above described practices can be applied either as preventive or as operational measures. The difference is that for normal periods the application of such measures may be suggested as optional, while under drought periods their application may be considered as obligatory.

Other measures that can potentially contribute to risk management are the following:

1. Identification and minimization of water losses: Water saving potential of this practice is very high. The application of water losses identification, estimation and minimization methodology proposed in Chapter 2 can aid Mirabello F.OR both in normal and drought periods to save water.
2. Adaptation of irrigation strategy: According to FAO (2016a) for olives: *With winter rain of about 500 mm, irrigation is applied during and after stone hardening. Under conditions of little winter rain, irrigation is applied during bud differentiation (early spring), prior to flowering (early summer) and during yield formation and particularly during stone hardening. Irrigation is also applied at (a) two to three weeks before flowering; (b) when the fruit reaches one third its full size; and (c) when the fruit reaches almost full size.* For citrus, FAO (2016b) indicates that fruit shedding and growth rate reduction can occur when water deficit is observed during December or June. Moreover and especially for irrigation from groundwater, the increment in irrigation application frequency with simultaneous decrement in water volume per application may contribute to reduction of pressure in the abstracted aquifers.
3. Construction of water collection infrastructures: As described in Flood Management section, water collection infrastructures can contribute not only to mitigate flood impacts but also as water saving infrastructures that will provide water during drought periods. The F.OR has to stay in contact with the local authorities and mainly with the local Technical Services Division and Directorate of Water, Decentralized Administration of Crete in order to perform a feasibility study for the construction of water collection infrastructures and identify potential funding tools, such as the National Strategic Reference Framework (NSRF). With regard to Tavronitis basin, Kourgialas et al. (2015) applied a hydrologic model and indicated several possible locations of the construction of small hydraulic structures (dam or/and reservoir).
4. Alternative water sources: In case of prolonged drought periods, alternative water sources may be used. Such sources could be recycled or reusable water.

Since the regional drought management plan of Crete has not been developed yet, Mirabello F.OR has to communicate its interest to the Regional Water Directorate of the, Decentralized Administration of Crete seeking information about future actions and reports related to droughts. Finally, increasing farmers awareness during drought period and training on the above mentioned practices can significantly contribute to water saving. Therefore, informational and training campaigns have to be organized by the Mirabello F.OR during drought periods.

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PART C – GOVERNANCE ACTIONS FOR AFI F.OR

1. CURRENT STATUS

The current status of AFI F.OR governance strategy was investigated 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 F.OR in relation to water governance directions indicated by the 4th principle of EWS was identified as low. More specifically:

- AFI F.OR 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.
- There are no procedure and documentation established that link water management to the management of other resources.
- 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 while there are no actions documented and implemented related to the management of incidents. Therefore, the current degree of transparency on water management for AFI F.OR is considered as low.
- In the context of ensuring continuous improvement in water management, GAPs 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.

Considering the above, a specific set of actions are presented below aiming to improve water governance in KEDHP FOR.

2. ENSURING COMPLIANCE WITH ALL LEGAL REQUIREMENTS LINKED TO WATER USE

The following actions are proposed in order to ensure compliance with all legal requirements linked to water use:

1. **Identify a person or department** who ensures compliance with legal requirements linked to water. In the context of this action, an assignment has been developed (Form MET-1) which has to be signed by the FORs management.
2. **Establish a procedure** for following up legal matters on water. This procedure (MET-PL) aims to ensure that legal and other e.g. contractual, requirements are not overlooked, and that their implementation is controlled, monitored and reported to the Management. It is provided in Annex III and it is accompanied by Form MET-L.

3. 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. Taking into account the above the following actions are proposed:

1. **Quantify the aforementioned relations**: The appropriate documentation and forms were created for recording by the farmers (Form 4.3, for primary data, Annex III) and for processing them by the Water Steward (Form 4.3a). They contain information both on water and energy use per parcel, in relation to the various activities in the parcel. Such activities are pruning, mechanical cultivation, mechanical weed control and harvesting. The corresponding results are to be used for improving the energy efficiency. Form 4.3 provides also the means to calculate water consumption per unit of product which has to be calculated according to indicator 4.4.4.

METAPONTINO		FORM META-4.3 ACIVITY DIARY PER PARCEL												v1 13.11.2016
Parcel (Code)	Date	Pruning (Yes/No)	Mechanical Cultivation (Yes/No)	Mechanical weed control (Yes/No)	Harvesting (Yes/No)	Wages payed for activity (€/parcel)	Farmer's time spent on activity (Hr/parcel)	Energy used for activity (Lit oil)	Energy used for activity (Lit petrol/parcel)	Energy cost / activity (€/parcel)	Other costs / activity (€)	Yield (Kg/Parcel)	Estimated yield losses (%)	Notes
Farmer					**Signature**					Completed for year yyyy dd/mm/yyyy				

METAPONTINO	FORM META-4.3a CUMULATIVE ACTIVITY SPENDING															v1 13.11.2016
	Irrigation		Irrigation (energy)		Pruning (energy)		Fertilization			Cultivation(energy)		Plant Protection			Harvest (energy)	
Parcel (Code)	M3/Ha	m3/Kg	kWh or Lt/m3	kWh or Lt/kg	Lit/Kg	Lit/m3 water	Lit/Kg	Lit/m3 water	Kg N-P-K/m3 water	Lit/Kg	Lit/m3 water	Lit/Kg	Lit/m3 water	Kg a.i.s/m3 water	Lit/Kg	Lit/m3 water
Water Steward							**Signature**					Completed for year yyyy dd/mm/yyyy				

The following instructions can be given to the farmers in order to fill in Form 4.3:

- Parcel code: Write down the code of the parcel
- Date: Date that the activity took place (not the date of filling the form)
- Pruning: Write YES if the activity against the given date was irrigation, and NO if it was not.
- Do the same for the next three columns. If you did more than one activity in one day, use two sequential lines with the same date.
- Write down in the eighth column the labour cost in € paid for the activity on that date.
- Write down the time in hours, spent by the farmer on the same activity, the energy consumption in liters of oil (diesel) and in liters of petrol, then the cost in € of the fuel that was used and any other costs (just the €, not the items).
- Last, write down the yield in Kg that was obtained from this parcel (presumably, this is going to be written down when you will have written

YES in the seventh column) and your estimation of the % of yield lost for any reason.

- Note 1: You should try to fill the same form every day (until it is full, so you start a new one). No matter if the parcels will be mingled. The water steward will separate them, later.
- Note 2: Do not forget to write down -in raw form- the correct amounts per whole parcel. Never proceed to calculations in order to express the input e.g. per hectare.

The reason for asking each farmer to fill this 'diary' is that it will allow the Water Steward to have a measure of the efficiency of the used inputs, by collecting all the inputs for each parcel and compiling Form MET-4.3a and then compare the efficiency between parcels.

2. **Improve water management in relation to energy and other resources**: The results of Form MET-4.3a can indicate improvement potential in water management in relation to energy and other resources. Therefore the Water Steward can analyze the corresponding data, identify parcels of low efficiency and propose improvement actions. Moreover, the pool of GAPs planned to be implemented in the pilot farms, which are described in detail in Deliverable C3.1, are also contributing to the improvement of water management in relation to energy and other resources.

4. RAISING EFFICIENCY OF WATER CONSUMPTION

In accordance to EWS standard, three specific actions have to be considered in order for AFI F.OR to raise its efficiency of water consumption. The first action is related to the identification of water losses and their destination. Water losses are defined as the applied water that does not return to its source. For example, when irrigation water source is an aquifer and an amount of the applied water turns into surface runoff then this amount of water is considered as lost. If the amount of water lost through surface runoff was draining into the aquifer, it would not be considered as lost.

Potential destinations of water losses are: a) the atmosphere, when water is lost though evaporation, b) the adjacent surface water body, when water is lost through surface runoff and c) the underlying aquifer, when water is lost through drainage.

Water losses in agriculture cover a significant portion of water used. Sometimes water losses may be higher than 50% of irrigation water abstractions. Therefore, there is always a significant potential for water saving by identifying and reducing water losses. Irrigation process can be divided into three components:

a) the **distribution-conveyance component**, which corresponds to the distribution and transportation of irrigation water from the source to the field,

b) the **on-farm application component**, which corresponds to the application of irrigation water in the field with an irrigation system-method.

c) the **storage component**, which corresponds to the special constructions (such as dams), in which irrigation water is collected prior to the distribution in the farms.

Water distribution systems in agriculture are categorized into surface and piping systems. With regard to surface systems, water losses are mainly attributed to evaporation from water surface and water percolation along the system. Some indicative average conveyance efficiencies are 70% and 85% for well maintained-operated earthen channels and lined canals, respectively, while the corresponding efficiency for piping systems is 95%. Please keep in mind that accidental leakages may also be

occurred in distribution systems because of system failures (such as broken pipes), resulting in water losses through surface runoff, drainage or evaporation.
With regard to the on-farm application of irrigation water, the water losses potential is significantly different depending on the irrigation system applied (surface irrigation, sprinkler irrigation, drip irrigation). For surface irrigation, such as furrow irrigation, evaporation, surface runoff and drainage are the three major water loss mechanisms. In terms of sprinkler irrigation, except from evaporation, wind drift and spray losses are also considered. Indicative field application efficiencies of irrigation are 60%, 75% and 90% for surface, sprinkler and drip irrigation, respectively. Except from the above, on-farm conveyance losses have to be considered because of accidents or not well-maintained irrigation systems resulting in water losses through surface runoff, drainage or evaporation. Moreover, the application of irrigation water above the crop requirements may result in significant water losses, mainly through evaporation, surface runoff and drainage.
Like an open water body, the irrigation water storage constructions are exposed to the evaporation process. Depending on the climate conditions, water losses from the storage construction through evaporation may be significant.
All the above, as well as the estimation procedure of water losses during the irrigation process are summarized in Form 4.4. It has to be mentioned that the appropriate considerations have to be made, depending on the irrigation water source and water loss destination. Therefore, total water loss has to be properly adjusted. Moreover, accidental water loss have to be considered when such incidents are happening and are significantly affecting water losses.

METAPONTINO	**FORM MET 4.4 – WATER LOSSES ESTIMATION**					
Distribution – conveyance water losses (%)						
Type of water distribution system	Evaporation [1]		Deep percolation [2]			Total water distribution losses [3]=[1]+[2]
Open canals						
Piping system	-					
On-farm water application losses (%)						
Type of irrigation system	Water Distribution System [4]	Surface runoff [5]	Deep Percolation [6]	Soil & Canopy evaporation [7]	Wind drift [8]	Total on-farm water application losses [9]=[4]+…+[8]
Furrow					-	
Sprinkler						
Drip		-		-	-	
Water storage losses (%)						
Type of storage system	Evaporation [10]		Deep Percolation [11]			Total water storage losses [12]=[11]+[12]
Reservoir or dam						
TOTAL IRRIGATION WATER LOSSES (%) 13=[3]+[9]+[12]						

The second action is the planning, implementation and monitoring of measures that will enhance water efficiency. A set of measures are presented in the corresponding farm specific action plans which aim to improve water efficiency. The monitoring schedule as well as the measurement equipment are also presented. Such measures include:

- Calculation of evapotranspiration losses: This measure can lead to a more accurate calculation of crop water needs and therefore to avoid irrigation water excess and the corresponding water losses.
- Plan for farm irrigation network improvement: Repairs of the farm irrigation network are included. Moreover, a set of water-meters and volumetric valves will be introduced in selected orchards, in order to provide farmers with the tools to precisely control the amount of irrigation water that is applied to the orchard.

- Deficit irrigation: This measure includes application of regulated deficit irrigation. For instance they may reduce water use by 20-30% in olive trees and 10-15% in citrus, with no negative effects on yield quality and quantity.

By comparing data recorded in Form MET-4.3 year after year and according to the measures and practices applied, the Water Steward of the organization has to fill-in the results in the following table MET-4.3b and compare the increasing water efficiency potential of the applied practices. It has to be mentioned that the compared periods have to be of the same extent.

METAPONTINO		FORM META 4.3b-MONITORING WATER EFFICIENCY			v1 13.11.2016		
Parcel code	Initial water consumption period	Initial water consumption (m3/Ha)	Measures taken	Current water consumption period	Current consumption (m3/Ha)	Water savings (m3/Ha)	Inherent Temporal variability1
Water Steward			**Signature**		Completed for year yyyy dd/mm/yyyy		

The final action includes the calculation of total water consumption per unit of product (fruits in this case), which can be conducted by the data collected in Form MET 4.3 by dividing consumed water to the crop yield. It has to be mentioned that the term "consumed water" is defined as the water abstracted from a specific water sources.

5. 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 Authority. Thus, a person or -if possible- a department has to be defined which will represent and report on River Basin Authority activities and vice versa. This person will be responsible to inform the management of F.OR for any updates of the River Basin's Water Resources Management Plan, and make it available in FOR's premises. Assignment of the person above is facilitated by the Form MET-1.2 (Annex III) for assignment of roles and responsibilities.

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. According to the management system of each F.OR, internal communication can be accomplished by e.g. circulation of internal memos, by introducing a thematic issue in the agenda of formal personnel meetings, by using social media, etc. The activities selected should be recorded, e.g. in a quarterly report on WMAS. Verification of the efficacy of the measures selected can be part of the internal audit of the F.OR's management system e.g. by interviewing a sample of the F.OR's personnel and a sample of farmers.

According to EWS Standard, a report with information on operational water management has to be available to customers, to the local community and the authorities (both, for water and for agriculture). This report shall include basic

information on water management (for example water abstractions and their distribution on to the several crops) and other information such as actions and achievements linked to sustainable water management, definition of water-related risks and preventive measures implemented. Since AFI F.OR is not performing the operational water management, such a report is not mandatory. However, as the issue is quite novel for the Italian agriculture each F.OR will consider the usefulness it could have for its image in the area and proceed to design such a report, even as an alert to the innovation EWS brings and to stress the focal position of the F.OR as a local 'ambassador' of EWS. The contents may be selected among:

- Informal, awareness-raising about the consequences of forthcoming regulation.
- A brief presentation of findings, evaluation of practices tested, objectives update etc.
- Problems, especially the ones that may systematically affect other farmers in the basin.
- News on the expansion of implementation of EWS,
- Major events related to the implementation of the EWS in addition to the events related to the AgroClimaWater project.
- Brief reports on international appraisal of climate change news related to water issues.
- News on technology and science on irrigation water management e.g. under conditions of drought.

Depending on the availability of information and of human resources, the report could be either annual or every six months.

Cooperation between the three F.ORs could prove fruitful, especially capitalizing on the cross country element.

As a third action, promotional campaigns have to be organized and implemented on topics related to water. For agriculture, such campaigns may be related to irrigation (scheduling, methods, deficit irrigation, irrigation system maintenance) and GAPs that promote the sustainable water management from both the quantitative and qualitative point of view. The campaigns may be aligned with the milestones of the AgroClimaWater project, or with local agricultural nature festivities in each area, fairs and other major events related to agriculture. This action may well be combined with the edition of the report mentioned above, at least as much as the topics of reference are concerned.

The F.OR has also to be prepared in order to efficiently manage accidents, emergency situation and disasters. Therefore two action plans dealing with floods and droughts were compiled in which the corresponding risk, as well as management and mitigation actions are proposed. These action plans are found in the last chapter of this part of the deliverable. With regard to other incidents that could significantly affect the agricultural activity in AFI FOR, such as fire, it is proposed for the F.OR to stay in contact with the National Civil Protection department of Basilicata Region and Fire Corps of Basilicata Region and ask to be informed in case of emergency situations. With regard to irrigation system breakdown, AFI F.OR have no direct intervention right. Therefore, when system breakdown is occurred, the Water Steward should contact the water supplier and ask for a plan on when the system is going to recover.

6. ENSURING CONTINUOUS IMPROVEMENT

In the Agri basin (Metapontino area) some GAPs related to the reduction of water consumption are already applied before the LIFE AgroClimaWater implementation. In particular, in most cases pruning and shredding of pruning are applied for all crops, while regulated deficit irrigation (RDI) is applied for apricot and peach and cover crops

are used only in olive groves. In most farms a rationalization of fertilizers and agrochemicals is already performed, by using a register of products application. Nevertheless, their implementation scheme is not organized. Therefore, a pool of GAPs has to be established, which will be implemented depending on the specific needs of each farm. The performance of those GAPs has to be evaluated. The pool of GAPs that contributes to the continuous improvement is established from the GAPs proposed to be implemented in the ten pilot farms in which GAPs the already applied GAPs have been included.

In particular, the GAPs are aimed at:

1. the rationalization of irrigation
2. the minimization of groundwater use
3. the optimization of rainwater use
4. the minimization of water discharges and run-offs
5. the augmentation of water retention in the soil – avoid deep percolation
6. the minimization of evaporation from the soil and the transpiration by plants
7. the optimal use of the applied substances (fertilizers, insecticides, pesticides)

Practices for increasing soil organic matter are expected to contribute in improving the soil water holding capacity and in reducing deep percolation water and nutrient losses especially in orchards with coarse textured soils, reducing the rapid vertical movement of water along the soil profile.

Appropriate pruning of the orchard trees permits to achieve a balance between yield and the transpiring surface of the trees (leaves). The green pruning can lead to up to 30% reduction of transpiration water losses.

Direct evaporation of water from soil surface will be avoided by the introduction of an appropriate mulching technique, by weed mowing and/or shredding of pruned wood. These practices lead to 50% to 60% reduction of water evaporation losses and allow for cost savings with respect to soil tillage practices.

In irrigated orchards, where there is the option of fertigation, fertilizers will be applied through this method in order to minimize nitrate losses to ground water. The fertigation is expected to lead to 10 and 30% savings in water and nutrients compared to the quantities conventionally applied.

Maintenance of natural orchard vegetation during the rainy season, introduction of winter cover crops and no soil cultivation in sloppy areas will be the key practices applied for reducing water runoffs and nutrient losses in an orchard. Introduction of barriers perpendicular to the slope may reduce nutrient and soil losses and the potential for surface water pollution.

A schedule for the irrigation system will be introduced. Application of regulated deficit irrigation (RDI) will be applied for some crops, reducing water use by 20-30% with no negative effects on yield quality and quantity.

Weekly bulletins on crop irrigation water requirements will be issued for informing the responsible agriculturalists and/or the participating farmers on the actual crop water requirements during the growing season, based on calculation of ETc (crop evapotranspiration).

In addition to the ones that will be established by the LIFE ACW project for the Agri basin, the innovative measures presented below, consist in a DSS (Decision Support System) management system for precision farming technology. It is able to monitor the irrigation and field fertilization according to the crop and soil need on a day-by-day base, considering also the weather forecast, through wireless sensors and specific algorithms for data gathering and an easy-to-use web-based software. This system will enable the

farmer to monitor the use water and fertilizer, reducing the waste and the environmental impact.

The use of a decision support system (DSS) in agriculture will permits:

- ✓ To increase the productivity and resource efficiency, including water use efficiency, of agriculture;
- ✓ To reduce the leaching of nutrients and other chemical inputs from cultivated lands into terrestrial and aquatic environments;
- ✓ To enhance the adaptive capacity of production systems to cope with rapidly changing environmental/climatic conditions and increasingly scarce natural resources.

7. ENSURING TRANSPARENCY ON ECONOMIC ASPECTS OF WATER MANAGEMENT

Two actions are proposed in order for AFI F.OR 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. These investments may include capital investments, granting, loans etc. Special attention should be paid in order to identify the relation between investments made for sustainable water management and the total investments made for water management. Moreover, money saving potential could be identified from the water saving investments implemented.

Concerning the second action, an environmental cost analysis has to be performed. The cost included in the above analysis may include all environmental management costs such as:

1. Personnel employed for education and training.
2. External services for environmental management.
3. External certification of environmental management systems.
4. Personnel for general environmental management activities.
5. Research and development.
6. Investments in water saving programs and measures.
7. Other environmental management costs.
8. Environmental charges as percentage of water tariff.

8. WATER MANAGEMENT STRATEGY

An operational water management strategy has to be in place in which the following have to be addressed:

1. Include stakeholder concerns.
2. Incorporate all 4 EWS principles. It is important to make a clear link between the strategy and the 4 principles of EWS, and if possible with the indicator(s) addressed.
3. Identify and assess risks related to water use.
4. Incorporate preventive measures to mitigate impacts of water use and discharge.
5. Establish a monitoring scheme (frequency and method and report and follow-up on outcomes of monitoring).
6. Develop a water efficiency strategy.

7. Person or department in charge of implementation and monitoring of the strategy. A special assignment is presented in Form MET 1.3 (Annex III) Moreover, a responsible person or department that will cope with the legal matters of water and a responsible person or department for the River Basin's Authority has to be defined as mentioned earlier.
8. Give effort to insure the continuous improvement in water management.

9. FLOODS AND DROUGHTS ACTION PLAN

9.1 Floods Action Plan

9.1.1 Introduction

A large number of flood definitions exists. According to WMO & UNESCO (2012) floods can be defined as "rises, usually brief, in the water level of a stream or a water body to a peak from which the water level recedes at a slower rate". There are three types of floods which can potentially affect the agricultural sector: river floods, flash floods and coastal floods. River floods occur when river water system capacity is exceeded and therefore river water is not able to be channeled through the river course. Flash floods are developed from localized, intense rainfalls and can occur anywhere in the basin, while coastal floods constitutes the result of increased sea level rise caused by storm surges driven by tropical storms or strong windstorms. According to Morris et al. (2010), flood development consists of three major components: the sources, the pathway and the receptor. Flood sources are the extreme rainfall events and/or the sudden snow-cover melt, while pathway is considered as the land and the hydrological system which transfer the water to the receptor. Finally, flood receptor is where flooding occurs. Agricultural land can serve either as pathway or receptor.

Since the agricultural sector is fully exposed to floods and their impacts, either as flood pathway or as flood receptor, the necessity for floods action plans development is high. Taking into account climate change projections, according to which floods frequency is expected to increase, the necessity for compilation of floods action plans becomes even higher.

Floods action plan constitutes a part of the FORs governance actions/strategy and more specifically contributes to EWS Standard indicator 4.5.5: Management of incidents:

1) Procedures are established, implemented and monitored to respond to accidents, security incidents, emergency situations, disasters and the like. 2) The impacts of such an occurrence to the environment, employees, the regional population and communities of the affected region are described or estimated. A specific methodology was established for the development of flood action plans by the three FORs participating in AgroClimaWater partnership. This methodology is implemented individually for each one of them and therefore one action plan per F.OR was compiled.

9.1.2 Flood action plan development methodology

The methodological framework followed in order to establish the flood action plan is presented in Fig. 8; Two are the main steps that each F.OR has to follow in order to compile it: a) identify the areas characterized by high flood risk and b) compile a flood management strategy by identifying actions, measures and practices that will lead to

reduction of agricultural activity contribution to surface runoff and mitigation of the corresponding floods' impact.

Floods risk assessment can be based on reports, data and information developed within the context of Directive 2007/60/EC. More specifically, every EU Member State has to be conform to Directive 2007/60/EC on the assessment and management of flood risks. Conformation to this Directive includes:

7. Preliminary flood risk assessment.
8. Development of flood hazard and flood risk maps.
9. Development and configuration of flood risk management plans for the areas that are potentially at any flood risk.

The milestones established towards the implementation of Directive 2007/60/EC are presented in Table 7. With regards to the current implementation status of Directive 2007/60/EC in Italy, not only flood risk and flood hazard maps have been developed but also the compilation of flood risk management plans has been finalized.

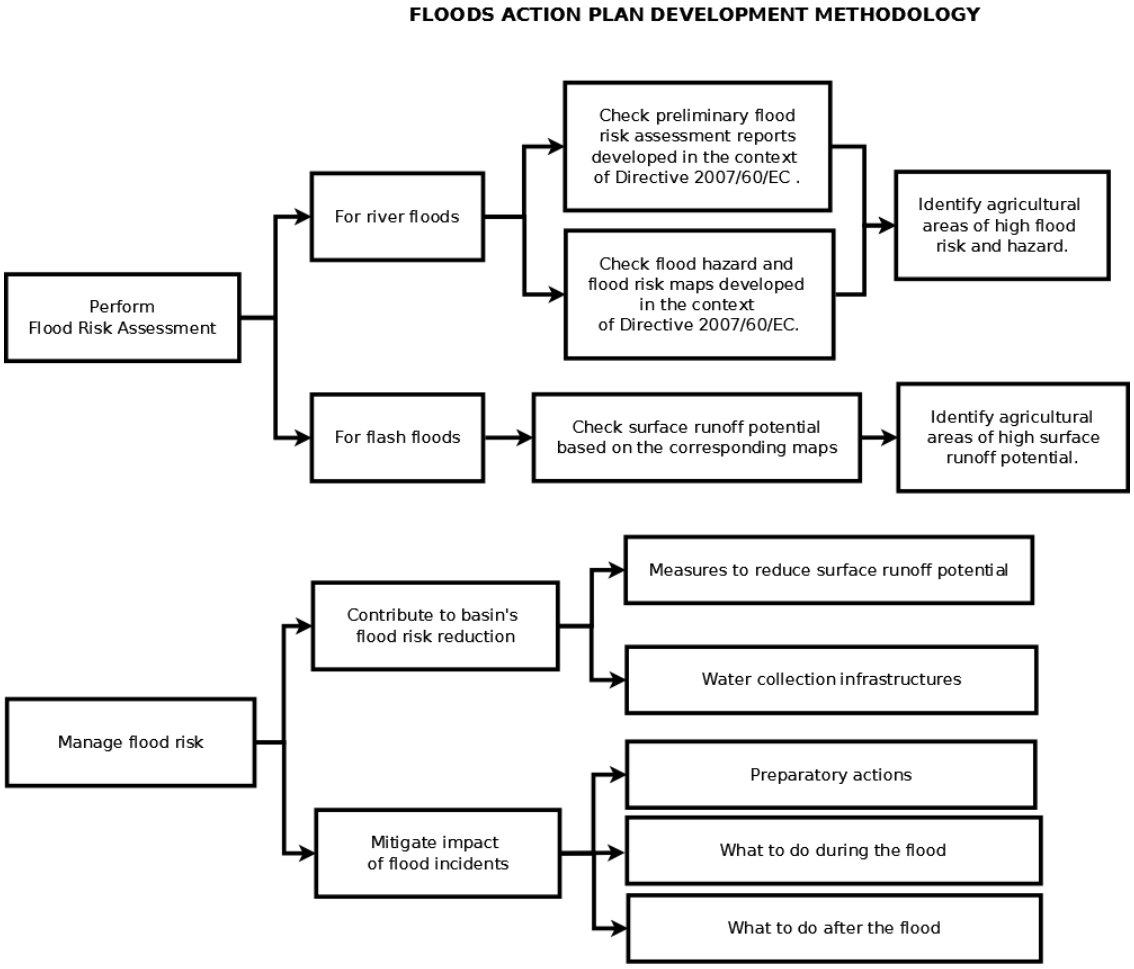

Fig. 8. Diagram of floods action plan development methodology.

Table 7: Milestones towards the implementation of Directive 2007/60/EC (source: http://ec.europa.eu/environment/water/flood_risk/implem.htm)

Issue	Deadline	Reference
Entry into force	26.11.2007	OJ L 288, 6.11.2007 Art 18
Transposition	26.11.2009	Art 17

Reporting format Preliminary Flood Risk Assessment	22.12.2009	Art 11
Administrative arrangements to be in place and to be notified to the Commission	26.5.2010	Art 3
Cut-off date transitional measure (availability of existing tools)	22.12.2010	Art 13
Preliminary flood risk assessment	22.12.2011	Art 4 & 5
Public participation process starts (publication of mechanism and timetable for consultation)	22.12.2012	Art 9.3 & 10
Flood hazard and risk maps	22.12.2013	Art 6
Flood risk management plans	22.12.2015	Art 7
2nd Preliminary Flood Risk Assessment, specific requirement on climate change	22.12.2018	Art 14.1 & 4
Commission's first implementation report due.		
2nd Flood hazard and risk maps	22.12.2019	Art 14.2
End of 1st flood risk management cycle	22.12.2021	Art 14.3 & 4
2nd Flood Risk Management Plans, specific requirement on climate change.		
3rd Water Framework Directive River Basin Management Plans.		

According to the floods directive scoreboard (http://ec.europa.eu/environment/water/flood_risk/implem.htm) Italy reported for all Units of Management with significant flood risk presenting flood hazard and flood risk maps (Art. 6, deadline reporting 22.3.2014).

The Water directive was implemented with the D.Lgs. 152/2006. The National River Basin Authorities in earlier 2009 were responsible for coordinating and carrying out plans. The water management plans of eight districts were approved in February 2010. The district plans are built according to catchments and subunits and the information is coordinated with the hazard and risk maps of the flood and landslide management plans (in Italian piano di assetto idrogeologico, PAI). The flood directive was implemented with the D.Lgs. 49/2010, in February (Brugioni M., 2010). In agreement with the floods directive, the decree 49/2010 mandated preliminary flood risk assessment (PFRA), assessing potential risks based on readily available information such as instrumental records and long-term assessment. On the basis of PFRA, river basin authorities have to identify areas prone to potentially significant flood risks, and to develop flood risk management plans coordinated at the river-basin-district level (Mysiak J. et al., 2013). The hazard maps therefore cover the geographical areas which have been flooded, which could be flooded with an indication of the probability, taking into account the existing flood defence structures. These areas shall be shown according to the three following scenarios presented in Table 8.

Table 8: Hazard level sheet (source: "aggiornamento PAI – Fasce Fluviali E Mappe della Pericolosità e Mappe del Rischio Idraulico" - Hydrographic district of the Southern Apennines 2014)

Floodplain	Event scenarios D.L.gs 49/2010	Hazard level
T = 30 years Area with high frequency flood very high hydraulic hazard	20≤ T ≤50 years Frequently occurring flood events (high probability of happening)	P3
T = 200 years Area with moderate frequency of flooding high hydraulic hazard	100 ≤ T ≤200 years Less frequently occurring flood events (medium probability of happening)	P2
T = 500 years Area with low frequency flood moderate hydraulic hazard	200 < T ≤500 years Rare extreme flood events (low probability of happening)	P1

The risk maps are provided, according to the following four risk classifications:

Table 9: Risk classification sheet (source: "aggiornamento PAI – Fasce Fluviali E Mappe della Pericolosità e Mappe del Rischio Idraulico" - Hydrographic district of the Southern Apennines 2014)

R4 very high risk areas/items	Envisaged losses of human lives and severe lesions to persons; severe damages to buildings, infrastructures and the environment and socioeconomic activities destruction.
R3 high risk areas/items	Envisaged problems to human safety; damages to buildings and infrastructures compromising their use and provoking hold-up of socio-economic activities and severe damages to the environment
R2 medium risk areas/items	Probability of minor damages to buildings infrastructures and environment, not compromising human safety, use and economic activities
R1 moderate risk area/items	Social, economic and environmental damages are low

Moreover, the damage maps are provided, according to the following four damage classes:

Table 10: Damage classes sheet (source: "aggiornamento PAI – Fasce Fluviali E Mappe della Pericolosità e Mappe del Rischio Idraulico" - Hydrographic district of the Southern Apennines 2014)

Class of exposed element		MACRO CATEGORIES with assumption of vulnerability = 1	Class of damage
E4 very high exposure value	1	Urbanized areas	D4 very high damage
	2	Strategic structures	
	3	Strategic infrastructure of network transport	
	4	Environmental heritage, landscape, historical, cultural, archaeological, protected areas of high interest	
	5	Areas affected by economic, industrial and technological plants, potentially dangerous	
E3 high exposure value	1	Transport infrastructure and main networks	D3 high damage
	2	Mining areas, landfills, treatment plants, incinerators, cemeteries	
E2 medium exposure value	1	Secondary transport infrastructure	D2 medium damage
	2	Specialized agricultural areas	
	3	Green spaces, urban parks, outdoor sports equipment	
E1 low exposure value	1	Unspecialized agricultural areas	D1 low damage
	2	Unprotected natural areas	

The Legislative Decree no. 49/2010, art. 6 - paragraph 4 introduced a specific part on coastal areas for establishing flood hazard maps. According to the European and National legislation, the Interregional River Basin Authority of Basilicata, has made the

assessment of hazard and flood risk areas of the main rivers that cross the area on the Metaponto Coastal Plain (Bradano, Basento, Cavone, Agri and Sinni rivers).
For the definition of the hazard scenarios due to coastal storms, along the Ionian coastal area, has been take into account:

- The areas directly affected by coastal storms that are crossed by the wave run-up, for which the potential hazard scenarios were evaluated. In particular very high hydraulic hazard was attributed to the potentially floodable areas for storms with Tr of 10 years, high hydraulic hazard was attributed to those floodable areas for storms with return periods of 30 years, while moderate hazard was attributed to the floodable areas for storms through time return of 500 years (Table 11);
- Potentially floodable areas during storms with return period of 500 years in which further studies are needed for defining the extension of flooding mechanism. These areas were classified as ASVm areas ("aree assoggettate a verifica mareggiate" - areas subject to coastal storm to be verified)

Table 11: Ionian coast - dynamic simulation: hazard scenarios (source: "Piano di Gestione del Rischio di Alluvioni" - Hydrographic district of the Southern Apennines, 2016)

Potential flooding areas from storm surges	Hazard level
T = 10 years Area with high frequency flood	P3 Very high hydraulic hazard
T = 30 years Area with moderate frequency of flooding	P2 High hydraulic hazard
T = 500 years Area with low frequency flood	P1 Moderate hydraulic hazard
ASVm - "aree soggette a verifica" - area to be verified	

The relevant subjects

Directive 2007/60/EC was transposed into Italian by Legislative Decree 49/2010, taking into account the relevant national legislation, particularly the Legislative Decree 152/2006 (Italian transposition of Directive 2000/60/EC) and the Prime Minister's Decree 29 September 1998. The Ministry of the Environment and Land Protection – Directorate for Soil Protection plans, finances and controls the actions aimed at the hydrogeological risk reduction. According to Legislative Decree 152/2006 and with the provision of activities already carried out about hydrogeological plans, the responsibility for the implementation of the preliminary assessments, hazard and risk maps and the preparation of management plans was entrusted to the authorities of district Basin (art. 3). The regions, in coordination with each other and with the Department of Civil Protection, are responsible for preparing the part of the management plans for the relevant river basin district on the national and regional warning system for the hydraulic risk for the purposes of civil protection (art.3).

Information and Public Participation

Communication and public participation in the procedure for drawing up flood risk management plans have a strategic role in sharing and legitimacy of the plans (in accordance with Directive). Therefore, the Legislative Decree 49/2010 implements and emphasizes this role by providing (art. 10) that, the authorities of district Basin and the

regions pertaining to the river basin, in coordination with each other and with the National Department of Civil Protection, can make available to the public the preliminary flood risk assessment, hazard maps and flood risk, and the plans of flood risk management. The same authorities shall encourage the active participation in the review and updating of the management plans of all relevant interested parties.
The Ministry of Environment and Protection of Land and Sea inform the European Commission of the decisions reached concerning the transitional measures (article 11, paragraphs 1,2 and 3) and make available to the public and the European Community the relevant information regarding the preliminary assessment, the risk and hazard maps and the flood risk management plans on the national Geoportal (http://www.pcn.minambiente.it/GN/). The national Geoportal was national point of access to geographical and environmental information for the INSPIRE Directive (2007/2/EC transposed by Legislative Decree 32/2010).

Measures of the Flood Risk Management Plan ("PGRA")

The management measures for flood risk, both at river district scale and at Unit of Management scale (Interregional River Basin Authority of Basilicata), have been identified in relation to the management objectives defined in accordance with the Technical Report -2013-071 "Guidance for reporting under the Floods Directive (2007/60/EC)" 29 (Table 10.3-2) and "Note sulla compilazione del Database Access conforme agli Schema per il reporting della Dir.2007/60/CE art. 7: Piani di gestione del Rischio di Alluvioni"(October 2014). The management measures for flood risk were prepared by ISPRA (Table 12).
As regards the implementation phases of the measures, the measures of the Flood Risk Management Plan ("PGRA") have been placed according to one divided in a first programming cycle (2016-2021) and in a second cycle (2022-2027). The expected time schedule at District scale (Table 13) foresee from the first cycle, the activation/implementation of prevention measures (M2), Preparation (M4) and some protection measures (M3) already accrued under the different aspects of their concrete realization.
The European Commission fixed at 26/05/2010 the deadline for notification by the Member States, the Competent Authorities responsible for the Directive requirements.
As the implementation phase was not carry out respecting the deadline, Italy taken advantage of the possibility (Art. 3.2) to assign the river basins to different unity of management than river basin districts identified under Directive 2000/60.
Therefore the Ministry sent, within the timeframe requested, the communication containing the indication of both the 51 Unit of Managment (UoM) and the relevant competent authority (Competent Authorities - CA).

Table 12: General Measures of the Flood Risk Management Plan ("PGRA") (source: "Piano di Gestione del Rischio di Alluvioni" - Hydrographic district of the Southern Apennines, 2016)

Types of Measures for Risk Management Floods (ISPRA, modified ottobre2014)		
ASPECTS OF RISK MANAGEMENT	**CODE TYPE MEASURE**	**TYPE OF MEASURE**
M2 Prevention measures	**M21**	Constraint
	M22	Removal and Relocation
	M23	Reduction
	M24	Other types of preventive measures for the inhabitants and the economic activities and the environmental and cultural heritage
M3 Protection Measures	**M31**	Management of Floods in Natural Systems / Management of the Outflows and the Basin
	M32	Adjustment of Outflows
	M33	Interventions in Riverbed, in floodplain and Coast
	M34	Surface Water Management
	M35	Other types of measures to increase protection from floods including programs or maintenance policies related to infrastructure works for flood protection
M4 Preparation Measures	**M41**	Flood Forecasting and Alerting
	M42	Emergency planning and response during the event
	M43	Preparation and Public Awareness
	M44	Other types of measures to increase protection from floods including programs or maintenance policies related to infrastructure works for flood protection
M5 Recovery and Review Measures (Recovery of pre-event conditions)	**M51**	Restoring Pre-Event Conditions, both Private and Public
	M52	Environmental restoration
	M53	Other types

Table 13: Time schedule (source: "Piano di Gestione del Rischio di Alluvioni" - Hydrographic district of the Southern Apennines, 2016)

MEASURES			**TIME STEPS OF EXECUTION, IMPLEMENTATION AND COMPLETION OF THE FlOOD RISK MANAGMENT PLAN ("PGRA")**												
			STEP 1: CYCLE 2016-2021						**STEP 2: CYCLE 2022-2027**						**STEP 3: CYCLE**
MEASURES CODE			**STEP 1 A (I° Period)**			**STEP 1.1 B (II° Period)**			**STEP 1 A (I° Period)**			**STEP 2.1 B (II° Period)**			**2028 and further**
M2	**M3**	**M4**	**2016**	**2017**	**2018**										
						2019	**2020**	**2021**							
									2022	**2023**	**2024**				
												2025	**2026**	**2027**	
															2028 and further

The results flood risk assessment for Italy are provided in the following URL: http://www.pcn.minambiente.it/GN/direttiva-alluvioni,http://www.ildistrettoidrograficodellappenninomeridionale.it/dam_002.htm The user can find the corresponding report (http://www.pcn.minambiente.it/GN/direttiva-alluvioni?showall=&start=2, http://www.ildistrettoidrograficodellappenninomeridionale.it/dam_075.htm) and maps/cartography (http://www.pcn.minambiente.it/viewer/, http://www.ildistrettoidrograficodellappenninomeridionale.it/dam_113.htm) as well as, WMS data (shapefiles and "kmz" files) for zones of potentially high flood risk, historic

floods and significant historic floods. From preliminary flood risk assessment, the user can identify whether there are zones included in his area of interest which have been designated as of high risk flood risk.
The user can find other information on the Competent Authorities' website that for Basilicata region is the Interregional River Basin Authority of Basilicata (www.autoritadibacino.basilicata.it). Furthermore GIS data (shapefiles) for zones of potentially flood hazard, and risk and damage maps (pdf only) can be download by the following link: http://www.adb.basilicata.it/adb/pStralcio/download.asp.
It has to be mentioned that soil erosion potential has been investigated in the context of Action C2. Based on the above information, every participating F.OR can identify the river flood zones and investigate the potential flood hazard and flood risk for this zones.
With regard to flash floods, in which agricultural land can be considered to serve as flood pathway, the surface runoff potential maps developed according to the methodology presented in the corresponding deliverable of Action C2 can be used in order to identify the surface runoff potential of each farm participating in every F.OR and therefore the risk for flash floods to occur.
Concerning flood risk management, actions, mechanisms and practices have to be identified in order to:

- Reduce the contribution of farms that are indicated as high surface runoff potential. These actions, measures and practices are also contributing to the mitigation of flash floods impacts both in the farm and the basin scale. They can be divided into two major categories including: a) measures that are applied on farm and aim to reduce surface runoff potential and therefore flash flood risk and b) infrastructures in which surface runoff can be collected and therefore flash floods impact can be mitigated, while these infrastructures may also contribute to mitigate river floods.
- Mitigate the impacts of river floods before their occurrence (i.e act in a preventive manner), during them and after them. The actions, mechanisms and practices identified in the basin's flood risk management plan (in case that it is existing) which are related to F.OR activities, have to be incorporated into the current flood risk management plan.

9.1.3 Flood risk assessment

The Agri sub-basin is part of the UoM ITR171 – Agri Basento Cavone that include the hydrografic basins of the Basento, Cavone and Agri river in the middle of the Basilicata Region (Fig. 10).

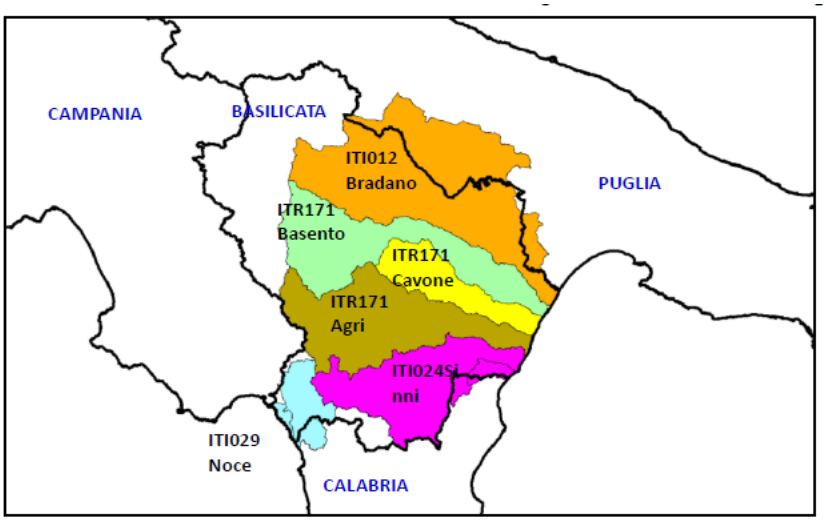

Fig. 9: UoMs within Basilicata Region (source: Hydrographic district of the Southern Apennines - Interregional River Basin Authority of Basilicata)

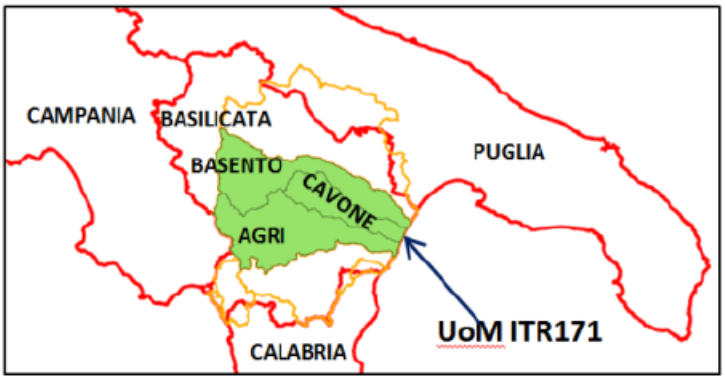

Fig. 10: UoM ITR171 – Agri Basento Cavone (source: Hydrographic district of the Southern Apennines - Interregional River Basin Authority of Basilicata)

Analyzing the data related to hazard and risk maps of the flood risk management plan different zones were identified which are presented in the following Figures:

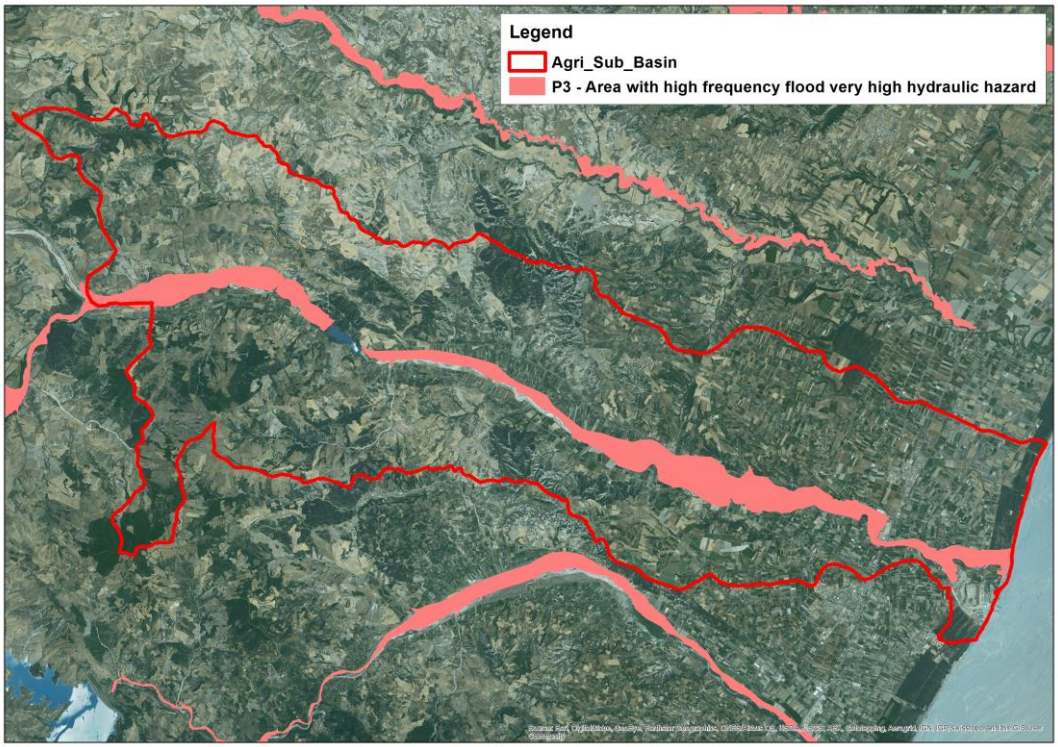

Fig. 11: P3 hazard area within the Agri sub basin (source: Hydrographic district of the Southern Apennines - Interregional River Basin Authority of Basilicata)

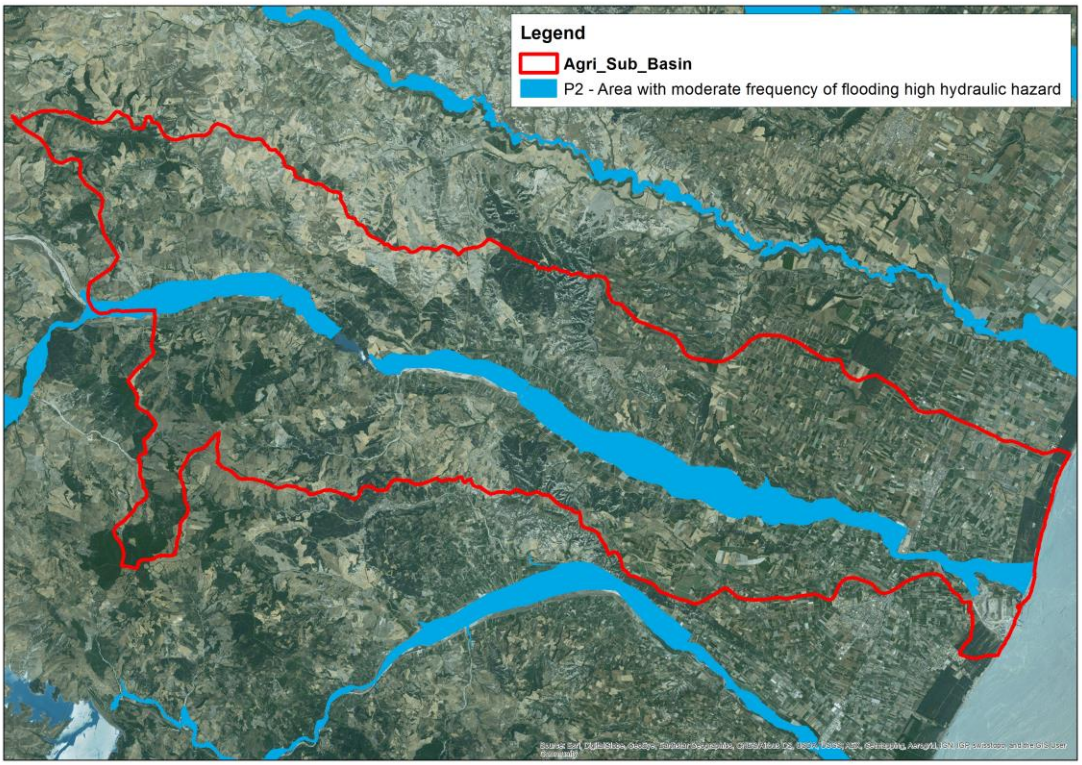

Fig. 12: P2 hazard area within the Agri sub basin (source: Hydrographic district of the Southern Apennines - Interregional River Basin Authority of Basilicata)

With regard to Agri river basin and concerning hazard maps, a very high hydraulic hazard area (P3) was identified which is presented in Fig. 11. This zone is located along the Agri river course.

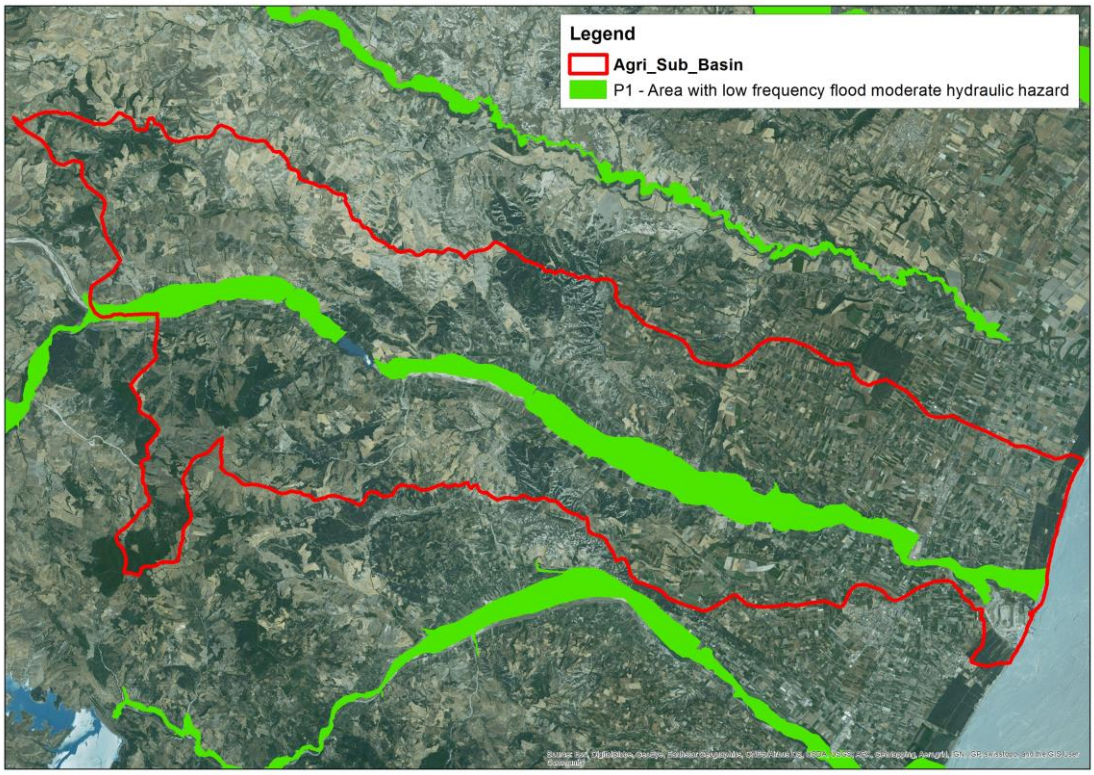

Fig. 13: P1 hazard area within the Agri sub basin (source: Hydrographic district of the Southern Apennines - Interregional River Basin Authority of Basilicata)

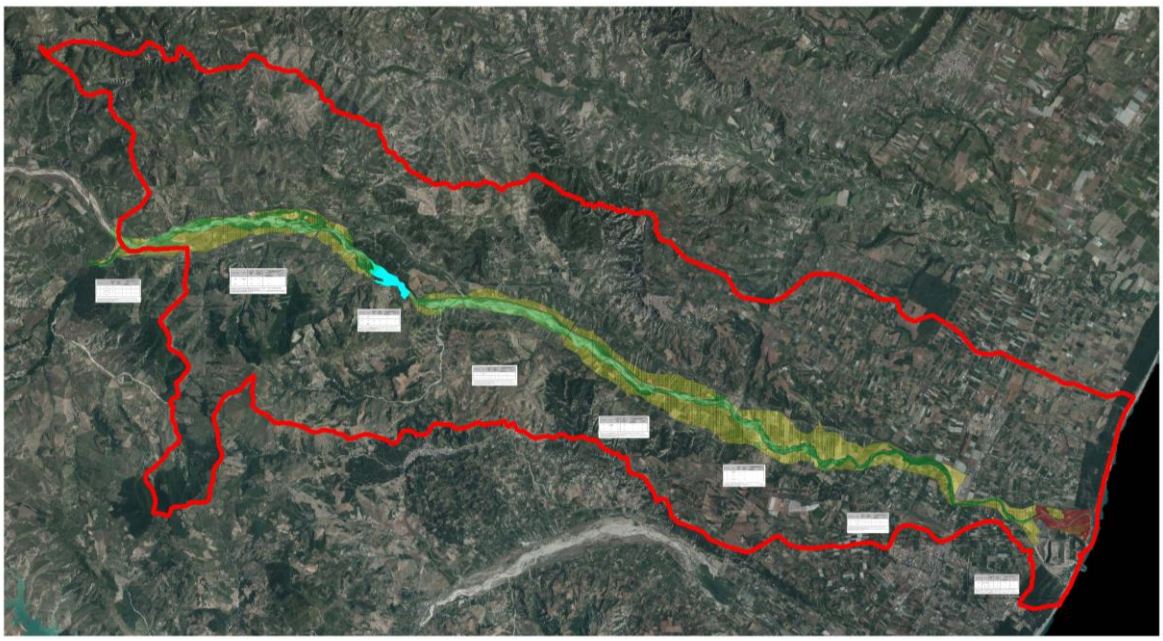

Fig. 14: Agri sub basin risk map (source: Hydrographic district of the Southern Apennines - Interregional River Basin Authority of Basilicata)

As far as the risk map concerned a very high risk area (R4) was identified which is presented in Fig. 14. This zone is located 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 very high damage (D4) as shown in Fig. 15.

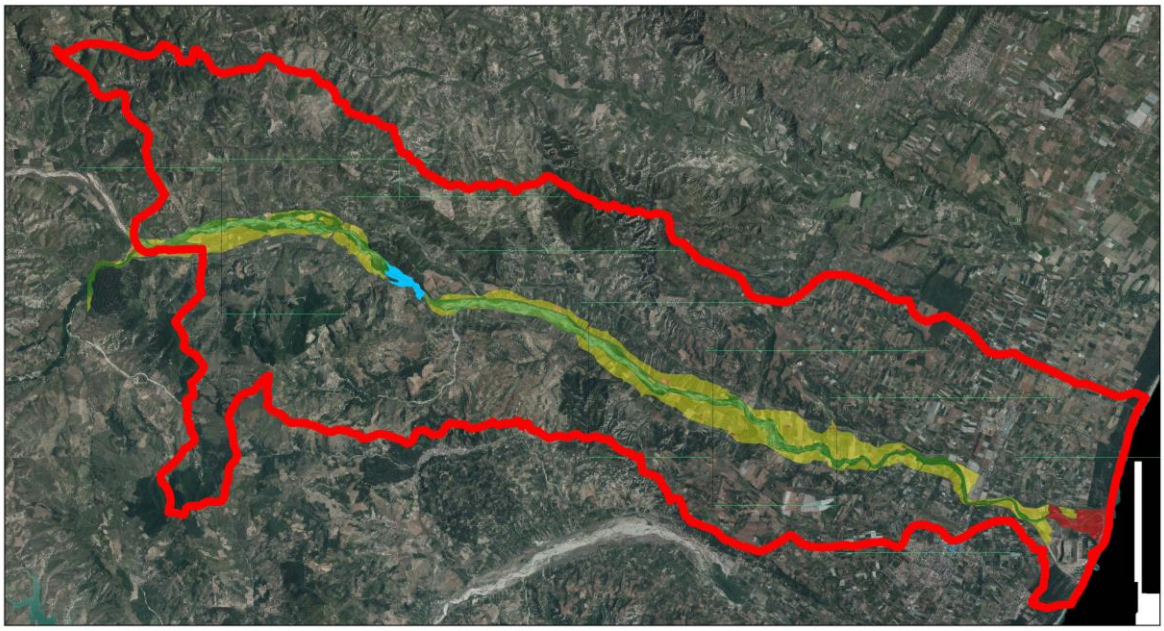

Fig. 15: Agri sub basin damage map (source: Hydrographic district of the Southern Apennines - Interregional river basin authority of Basilicata)

According to the Article. 6, paragraph 5, letter 'a' of Legislative Decree no. 49/2010 the the indicative number of inhabitants potentially affected by the floods must be identified for hydraulic risk areas identified and perimetrate in the related maps. The number of inhabitants potentially exposed to the risk of floods within the Agri sub basin are showed in the Table 14.

Table 14: Number of Inhabitants potentially exposed within the Agri sub basin

Municipality	Number of Inhabitants potentially exposed
Montalbano Ionico	25
Policoro	35
Scanzano	26
Stigliano	6
Tursi	39

The hydraulic simulations conducted on the final stretch of the River Agri showed that for all three events of overflow, downstream of the railway line Taranto - Reggio

Calabria, the flooding is confined within the river and the road embankments ("Mappe della Pericolosità e Mappe del Rischio Idraulico", Interregional River Basin authority of Basilicata).

Analyzing hazard maps, potential risk of coastal storm (Fig. 9-11) and the indices/erosion maps (presented within the Management Plan of the Flood Risk, Hydrographic district of the Southern Apennines - Interregional river basin authority of Basilicata 2016) it is evident that coastal dynamics related to the storms and the erosion are threatening the Ionian coast. Critical areas are close to the mouth of the river Agri (UoM ITR171) where erosion and coastal retreat have caused damage to agriculture and coastal dune.

Fig. 16: Coastal storm hazard map within the Agri sub basin (source: Hydrographic district of the Southern Apennines - Interregional river basin authority of Basilicata)

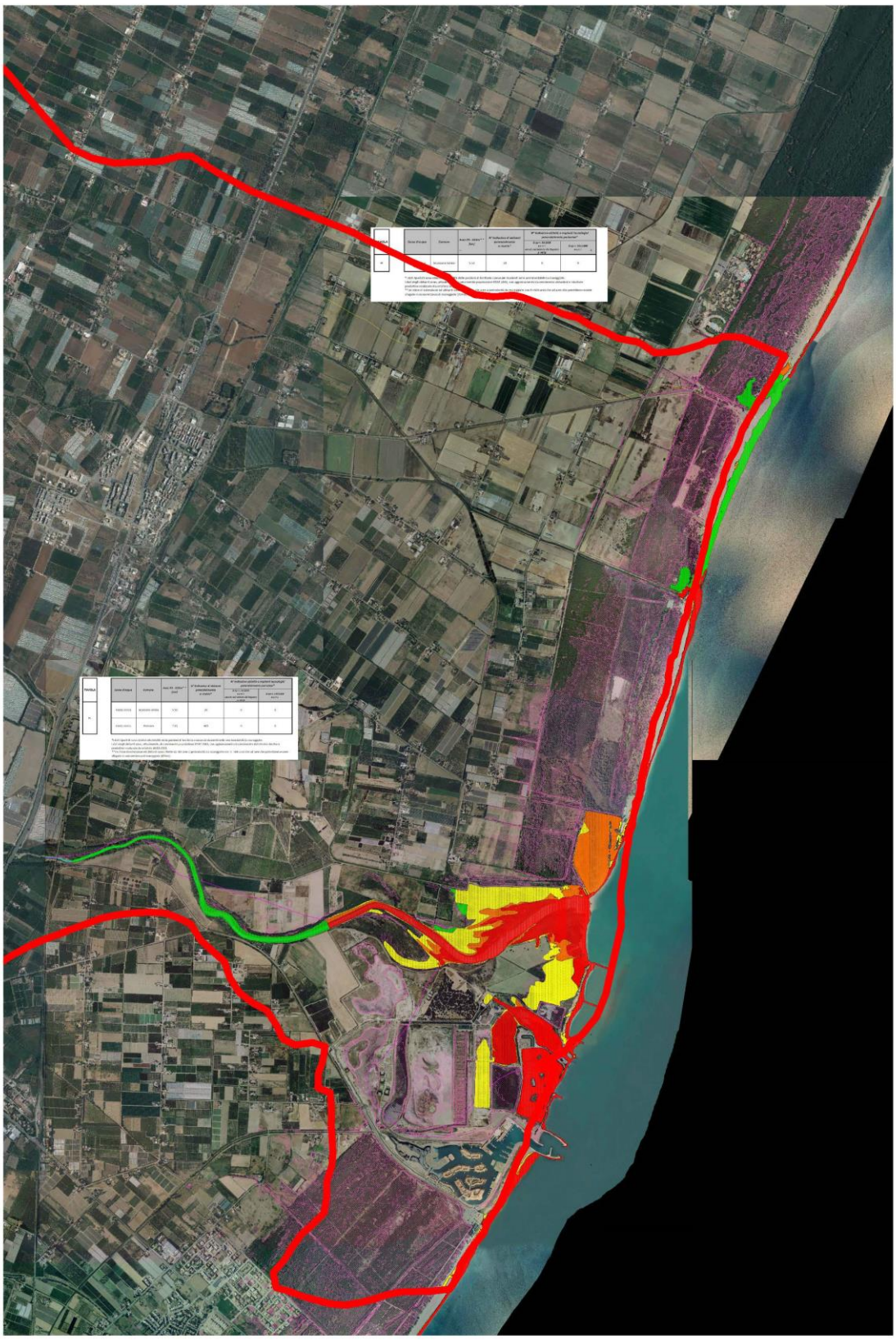

Fig. 17: Coastal storm risk map within the Agri sub basin (source: Hydrographic district of the Southern Apennines - Interregional river basin authority of Basilicata)

Fig. 18: Coastal storm damage map within the Agri sub basin (source: Hydrographic district of the Southern Apennines - Interregional river basin authority of Basilicata)

With regard to flash flood risk assessment, the results of surface runoff potential as estimated in the context of Action C2 are used, which are presented in Table 3. The average runoff potential for all agricultural areas categories was classified as moderate. The lowest average runoff potential was calculated for fruit trees and berry plantations (1.24-Moderate), while the highest runoff potential was calculated for land principally occupied by agriculture, with significant areas of natural vegetation (1.72-Very high). Especially for non-irrigated arable land, which constitute the dominant land cover for Metapontino basin (36.58%), the average runoff potential was 1.66 and it is considered as moderate, while the corresponding range of variation was 0.65 (Low) – 2.26 (High).

Table 15: Surface runoff potential statistics for the agricultural lands of AFI basin

Land Cover Code	Land Cover Description	Area		Minimum		Maximum		Average	
		(km²)	(%)	Score	Class	Score	Class	Score	Class
211	Non/irrigated arable land	151.22	36.58	0.65	Low	2.26	High	1.66	Moderate
221	Vineyards	0.26	0.06	0.98	Low	1.79	Moderate	1.39	Moderate
222	Fruit trees and berry plantations	38.15	9.23	0.71	Low	2.09	High	1.24	Moderate
223	Olive groves	7.34	1.78	0.81	Low	2.21	High	1.59	Moderate
241	Annual crops associated with permanent crops	39.35	9.52	0.74	Low	2.19	High	1.40	Moderate
242	Complex cultivation patterns	28.79	6.97	0.82	Low	2.13	High	1.28	Moderate
243	Land principally occupied by agriculture, with significant areas of natural vegetation	29.65	7.17	0.73	Low	2.23	High	1.72	Moderate

9.1.4 Floods risk management

9.1.4.1 Reducing farms contribution to floods

The actions presented below aim to contribute to surface runoff potential reduction and therefore to directly reduce the contribution of agricultural activity in flash floods. Nevertheless, the direct reduction of flash floods may reduce (depending on the incident) the contribution of agricultural activity in river floods. A wide range of practices are met in the literature which aim to contribute to surface runoff reduction from crop covered land. The actions, practices and measures presented below are chosen from the pool of practices that are to be implemented in the context of the project as well as other actions applicable to the specific case of Agri sub basin.

The practices implemented within the context of the project that directly or indirectly contributes to surface runoff potential reduction are the following:

- No weed control: According to this practice, natural vegetation is remaining during the wet season. Therefore, soil is covered during the rainy season resulting in surface runoff potential decrease. This practices is similar to the establishment of cove crops.
- No soil tillage: Despite the fact that this practice was incorporated with a view to reduce evaporation losses, according to Aina (1993) other benefits such as storm

runoff reduction and improved infiltration capacity can be considered by the application of this practice.

- Physical reduction of suface runoff: Surface runoff can be reduced by introducing physical materials along the contour lines.

Other practices and measures that are well known to be effective in reducing surface runoff potential from the farms are the following:

- Conservation buffers: This practice includes the maintenance of small areas or strips in permanent vegetation. There are several versions of this practice applied such as riparian buffers, filter strips and grassed waterways.
- Avoidance of vehicle movements and wheel ruts on wet soil.
- Avoid as much as possible to use heavy machinery within the farm. Heavy machines are contributing to soil compaction, which reduces water infiltration capacity and thus surface runoff potential is increasing.

Water collection infrastructures can contribute not only to mitigate flood impacts but also as water saving infrastructures that will provide water during the water demanding periods.

For the Italian case, the AFI F.OR has to stay in contact with the local authorities and mainly with the Interregional River Basin Authority of Basilicata and the Reclamation Consortium of Bradano e Metaponto ("Consorzio di Bonifica di Bradano e Metaponto") as well as other relevant institutional subjects in order to develop plans of actions for the maintenance and the correct management of the existing hydraulic infrastructures such as pipes, drainage channels and improving the local alerting system in case of flooding.

Moreover It could be identified potential European and National funding mechanisms for reaching the objectives.

The communication could be also focused on:

- the definition of management strategies in flood risk areas useful: to reduce damages produced by anthropic activities and natural phenomena; to safeguard and/or to preserve natural hydraulic dynamics of water surface bodies;
- the identification of structural and non structural actions/works reducing and preventing flooding hazard and risk.

9.1.4.2 Actions before the flood

A set of actions can be performed in order to ensure sufficient preparation for the flood. These action includes:

- Ask the National Civil Protection department of Basilicata Region (http://www.protezionecivilebasilicata.it/protcivbas/home.jsp) or the Basilicata agro-meteorological service (Servizio Agrometeorologico Lucano (SAL), http://www.ssabasilicata.it/CANALI_TEMATICI/Agrometeorologia/) and other relevant institutional subjects about how you will be informed when a flood event is expected to be occurred.
- Inform the farmers about the expected flood incident.

The following directions have to be given to the farmers:

- Avoid applying fertilizers and plant protection products prior to the flood, since the possibility for water bodies pollution from runoff or leaching is high.
- In case that electricity supply is available in your farm make sure that it is turned off and secured.

- In case that a groundwater pumping well or borehole exists in or near the farm, it has to be sealed properly in order to avoid runoff water entering through the annulus.
- A list of the existing on-farm machinery and equipment has to be drawn.
- Make sure that potentially hazardous substances, such as fertilizers, plant protection products and fuels are not exposed in the farm. These should be securely stored in appropriate infrastructure at the field or removed to such a place off the farm.
- Update the list of available F.OR member farmers' machinery that can be set at the disposal of the authorities to serve during the flood and/or alleviate its impacts. This list that is originally drawn and maintained by the F.OR administration, is notified to the Independent Civil Protection Office.
- Secure or remove heavy/hazardous equipment and machinery from the farm.

9.1.4.3 Actions during the flood

A set of actions can be performed in order to ensure sufficient preparation for the flood. These action includes:

- Get informed about the flood status. Information can be retrieved by the local media.
- Stay in touch with the National Civil Protection department of Basilicata Region, the Fire Corps of Basilicata Region (http://www.vigilfuoco.it/sitiVVF/basilicata/) and other relevant institutional subjects. Report the availability of farmers-members machinery to help in case that is needed.

The following directions are proposed to be given to the farmers:

- Avoid being on the farm or any other exposed location during the flood. Find a safe place to stay and do move without any specific scope. Do not use flooded bridges or river/creek passages.

9.1.4.4 Actions after the flood

The set of actions that could be followed after the flood can be divided into those that can be implemented by the F.OR and those that can be applied by the farmers. Concerning the F.OR actions, the following are proposed:

- Get informed about the impacts of the flood and follow the directions of the National Civil Protection department of Basilicata Region. Also communicate with the Interregional River Basin Authority of Basilicata since it is the Unit of Management body identified for the Flood Risk Management Plan ("PGRA").
- Communicate the information to the farmers.
- Ask farmers if fertilizers of plant protection products have been applied in the farm before the flood and communicate this information to Interregional River Basin Authority of Basilicata.

Concerning the actions that can be applied by the farmers, the following are proposed:

- Be careful when trying to approach your farm in order to avoid injury.
- Compare the list of your equipment compiled before flood in order to identify damages or losses.
- Check the overall status of your farm before and after the flood.
- Stay in touch with the F.OR in order to guide you for the next steps.
- In case that fertilizers of plant protection products have been applied in the farm before the flood, communicate this information to the FOR.

- Report loss of any agrochemical, piece of equipment or machinery and any changes to the soil cover at your farm.

The most significant impacts of floods in a farm are deposition of sediment of productive land, agricultural soil erosion and soil nutrient losses. In order to mitigate the above mentioned impacts the following practices could be applied by the farmers:

- Try to incorporate the sediment excess into the field by tillage. In case that this is not feasible the sediment has to be removed from the farm and disposed off in a designated site. By no means should this sediment be disposed off next to the course of a creek, torrent or river.
- Try to rehabilitate soil erosion with appropriate tillage. In case that this is not feasible, try to fill the erosion gaps with material from other sites. Take all precautions to use appropriate soil for this purpose (adjacent site, consult an agronomist, etc).
- Check the nutrient concentrations of the soil in the farm and properly adjust. Cover crops application has been found to significantly contribute to soil recovery after flooding.

9.2 Droughts Action Plan

9.2.1 Introduction

Drought constitute one of the more severe hazards with adverse economic, social and environmental impacts. According to the European Commission, (http://ec.europa.eu/environment/water/quantity/about.htm) *Droughts can be considered as a temporary decrease of the average water availability due to e.g. rainfall deficiency*. The usual types of droughts are presented in Fig. 5. A meteorological drought occurs when the actual rainfall in an area is significantly less than the long-term average rainfall observed in this area. Agricultural droughts happen when the available water is not sufficient to cover crop water needs during the crop cultivation period. Agricultural droughts are linked to either meteorological or hydrological droughts, since specific characteristics of meteorological or hydrological droughts are linked to impacts in agriculture. Hydrological droughts occur when there is evident low water availability in steams, reservoirs and aquifers and usually, they constitute the result of prolonged periods of meteorological droughts. In contrast to meteorological droughts, the duration and recovery of which are usually short, both the development and the recovery of hydrological droughts are usually lasting much longer.

Since agriculture is directly exposed to climate variability, the impacts of droughts in agriculture are also direct. Therefore, agriculture constitutes one of the most drought vulnerable productive sectors and subsequently the necessity for proper response in order to alleviate impacts is very high. Water scarcity and droughts constitutes one of the major water-related concerns of European Commission which was recognized in the Communication "Addressing the challenge of water scarcity and droughts" at 2007 [COM(2007)414]. The necessity for drought management has been also recognized in Directive 2000/60/EC, according to which, when and where needed, a specific "drought management (sub)plan" should be included in the WFD RBMP (art. 13.5).

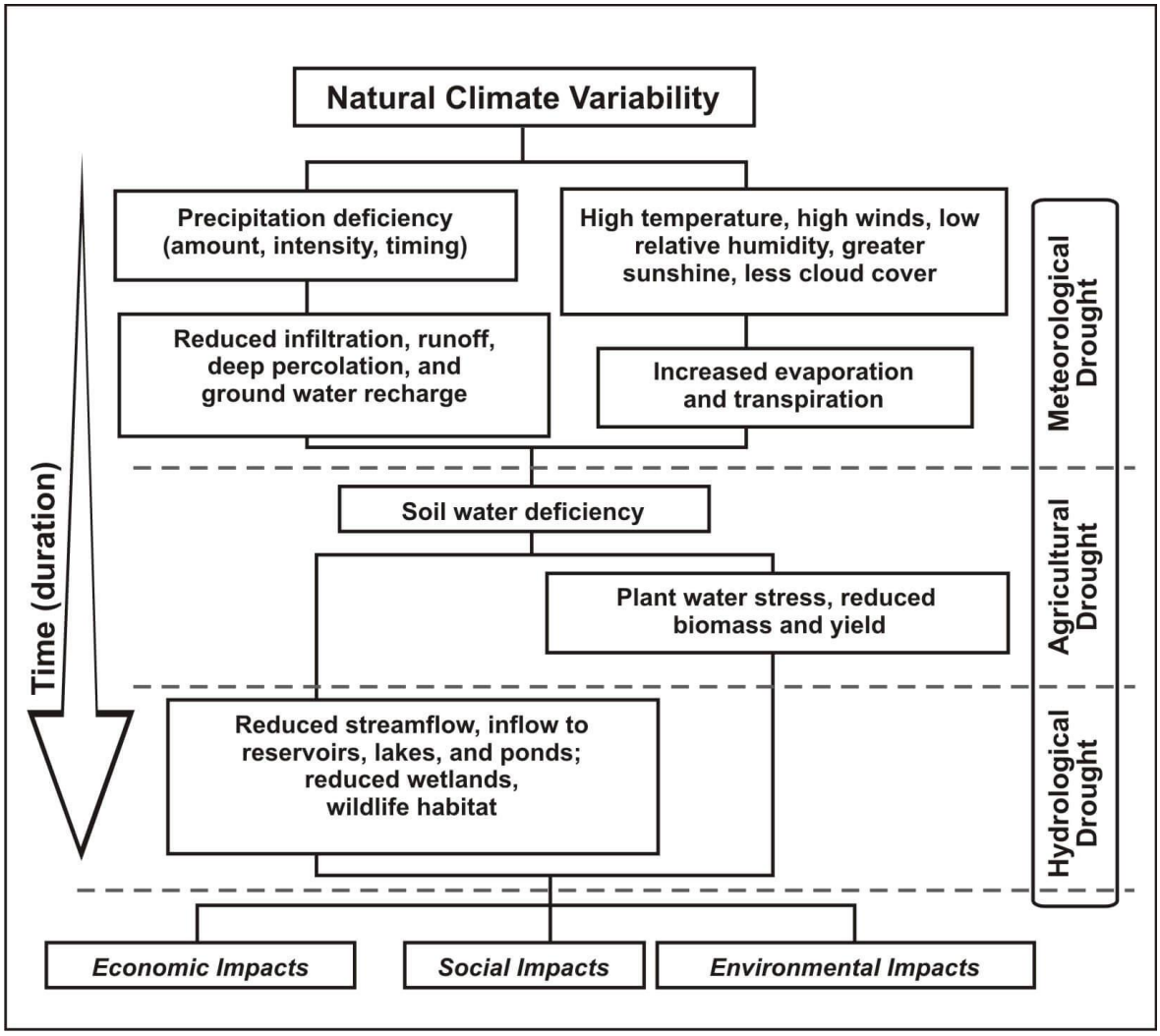

Fig. 19. Types of drought (Source: National Drought Mitigation Center, University of Nebraska-Lincoln, U.S.A., http://drought.unl.edu/DroughtBasics/TypesofDrought.aspx).

9.2.2 Drought action plan development methodology

Drought management constitutes a very complex processes, since a wide variety of sectors (e.g. agriculture, industry, tourism, environment, socioeconomical aspects) are interacting in a complicated way. Therefore drought management plans are commonly compiled at national and regional level for which a management procedure can be established in a common basis. Subsequently, compiling a drought action plan only for a specific sector (agriculture) and for a very specific area (area of farmers organization) constitutes a very tricky and demanding task.

Considering the above, the compilation of F.OR specific drought action plans have to be strongly connected to the regional drought management plans that in turn have to be compiled for drought vulnerable areas, in accordance to Directive 2000/60/EC (art. 13.5). In regional drought management plans, each F.OR can identify specific drought management directions, identify its role as a water user in the basin, as well as the interactions with the other water users and sectors.

The drought action plan development methodology described below 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 FOR. Drought risk assessment section aims to identify, analyze and evaluate drought risk. Based on drought risk assessment results, specific actions are proposed, according to which the F.OR is getting prepared to deal with droughts.

9.2.2.1 Drought risk assessment

According to the Guidelines for preparation of the Drought Management Plans in the context of the EU Water Framework Directive (Global Water Partnership Central and Eastern Europe 2015), drought risk assessment may include the flowing processes:

- risk identification – finding, recognizing, and describing risks
- risk analysis – determining the level of risk (i.e. the quantitative estimation of the probability of occurrence and severity of potential drought impacts)
- risk evaluation – evaluating the significance of the drought risk

Since the development of drought risk assessment including the aforementioned information requires specialized knowledge and expertise, it is proposed to retrieve this information from the drought management plan in case that such a plan exists for the specific Water District or the basin. Alternatively, other related scientific information resources may be gathered either from the local authorities or web sources. Moreover, internal information on drought occurrence and impact could be retrieved in case that such information is available within the FOR. Since drought constitutes a major hazard for agriculture, there is strong possibility for the F.OR to have recorded severe drought incidents, as well as their impacts on crop production.

9.2.2.2 Drought management

Before establishing the risk management plan, the F.OR has to consider the degree of its influence in local water resources management status and identify its role as a water user in relation to the other users located in the basin. For example, the direct degree of influence in water resources management status of a F.OR that own a wide number of private groundwater wells could be considered as higher compared to a FOR, the agricultural water needs of which are supplied by other authorities, such as Land Reclamation Organizations in Italy ("Consorzio di Bonifica di Bradano e Metaponto). In the first case, F.OR will be directly connected to the public authority that coordinates drought management in the basin, while for the latter case, F.OR will probably get specific drought management directions from water supplier.

According to the EU Guidelines for preparation of the Drought Management Plans in the context of the EU Water Framework Directive (Global Water Partnership Central and Eastern Europe 2015), the following categories could be used in order to classify the actions that could be applied in the case of FORs:

- Preventive actions: These actions aim to increase drought resistance and mitigate potential drought risk and impacts on the economy, society, and they are implemented under normal periods.
- Operational actions: This kind of actions are designed to be implemented during a drought period.

The core of drought management actions that can be potentially implemented by a F.OR is water saving. Therefore a number of specific actions and practices must be proposed and implemented, when necessary, in order to enhance drought mitigation potential of FORs. Most water saving actions and practices could be either applied as preventive or operation actions, since the majority of them can contribute to drought resistance increase during normal periods and to drought impacts mitigation during drought

periods. Nevertheless, a specific threshold based on rainfall distribution and crop type can be specified in order to trigger the necessity for operation actions implementation.

9.2.3 Drought action plan of AFI FOR

9.2.3.1 Drought risk assessment

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. More specifically, in the WRMP 2010 version the 4th objective mentioned is the mitigation of the effects of floods and droughts combating land degradation; while in the WRMP 2015 -2021 updated version between the main foreseen measures the AG.43 measure stated: It should be organized, at the district scale, a monitoring task forces (chosen between the several competent institutions) to be activated in cases of extreme drought and water scarcity, also for the monitoring and mitigation processes. Moreover in the Flood Risk Managament Plan 2016 there is a paragraph related to climate change adaptation focused on the main consequences that climate change could cause about landslide and flood events and the related desertification processes.
Therefore, the necessity for the development of a regional drought management plan has been recognized in the Water Resources Management Plan.
Given the absence of a regional drought management plan, information about drought risk assessment were found from other sources. Basilicata Region as well as other Southern Italy's regions are affected by the desertification issue (S.A.R., 2004) 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. (CNSLD, 1999 ; Peace & Baldassarre, 2005; Ferrara et al, 2005; Piro et al., 2007).
The histogram of precipitation (elaboration by Servizio Agrometeorologico Lucano) highlights the positive and negative deviations from the average over the last 50 years. The broken line shows the rainfall and the trend line shows that there has been a slow but steady decrease of the precipitation levels (Fig. 20).
The Fig. 21 shows a comparison of average temperatures in which it is highlighted that the values measured in 2007 are always higher than the average of the 1959-2006 period (source: Amati C. Relazione Geologica e Geomorfologica dei luoghi - Bosco Pantano di Policoro e Foce Sinni).
According to Interregional River Basin Authority of Basilicata, Basilicata region, though rich in water resources, is an area interested also by 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 occurred increasingly often. This situation has recently determined a difficult situation in water primary availability, also creating many problems to the main economical activities in the area (agriculture, tourism, tertiary sector and, in a lesser way, industrial activities). The meteorological events occurred in the past few years, such that rainfall has been scarce especially during the winter and autumnal periods, has been constraining the efficient filling of water reservoirs, thus limiting water availability in those regions depending in an almost exclusive way on the resource accumulated in Basilicata artificial lakes. The severe drought occurred in Apulia and Basilicata regions during the summer of 2000 and 2001 is quite highlighting in this respect, such that it induced the Italian Prime Minister to declare the emergency situation with regards to the water availability in both

regions, for the 2001-2004 period (Interregional River Basin Authority of Basilicata: Basilicata system for water resources planning and management: experiences and tools for water crisis and flooding risk prevention).

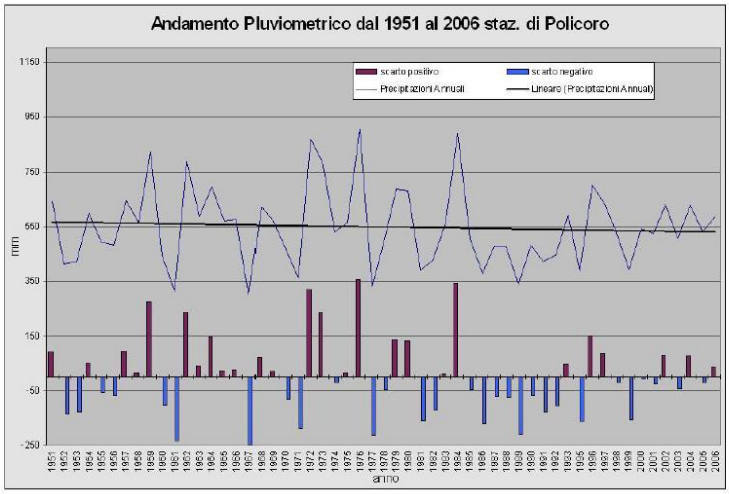

Fig. 20: The histogram of precipitation in Agri Sub basin – Policoro weather station - elaboration by Servizio Agrometeorologico Lucano (source: Amati C. Relazione Geologica e Geomorfologica dei luoghi - Bosco Pantano di Policoro e Foce Sinni).

Fig. 21: Comparison of average temperatures the 1959-2006 period with the year 2007 - elaboration by Servizio Agrometeorologico Lucano (source: Amati C. Relazione Geologica e Geomorfologica dei luoghi - Bosco Pantano di Policoro e Foce Sinni).

Since the agricultural activity of the AFI F.OR is focused on trees, providing trees with sufficient amounts of water throughout the year is essential to achieve sufficient production. For example according to FAO (2016a), water deficit during winter can cause reduced twig growth and defoliation in olive trees leading to a large percentage of imperfect flowers during spring, while flowering is also retarded.

Therefore, summer droughts can be considered of high risk for the agricultural production of AFI FOR, since in the past there have already been emergency situation of severe drought and prolonged droughts is the major risk for agricultural production in AFI FOR, since water resources availability is decreasing.

From the above, it can be concluded that prolonged droughts frequency is of major concern for AFI F.OR and therefore drought management actions have to be proposed.

9.2.3.2 Drought management

Except from prolonged droughts (more than a year) for which operation drought management actions has to be implemented, one more specific threshold can be specified for AFI F.OR in order to trigger the necessity for operation actions implementation. Taking into account that:

1) According to The production regulation "Disciplinare di produzione integrata" of Basilicata Region (Regione Basilicata, 2015):

- Olive needs a mean volume of irrigation water ranging from 1000-2500 m3/ha per year;
- Citrus needs a mean volume of irrigation water ranging from 3000-5000 m3/ha m3/ha per year;
- A typical peach water requirements is 3500-4500 m3/ha per year;
- A typical apricot water requirements is 3000-3500 m3/ha per year.

2) Average annual rainfall for Agri Sub Basin is about 630 mm, poorly distributed rainfall, concentrated and sometimes torrential noticeable summer dryness. The presence of the rains in autumn - winter and the drought in spring-summer affects both agriculture and the production techniques. This emphasizes the need of a functional irrigation system (Quinto G. R. et al. 2010).

Drought effects on fruit trees will be more marked in Southern Italy regions, whose climates are characterized by elevated water deficit. It will be necessary, therefore, to use correctly water available for irrigation by localized irrigation systems primary in the species more sensitive to water deficit, having as aim the control of damages on the current production and on the preparation of plants for the following year. Soil and plant management, all the techniques that increase water use efficiency and mineral elements uptake must be used (summer pruning, anticipation of the winter pruning, fruit thinning, fertirrigation and leaf fertilization, grass cover elimination, etc.).

In order to maximize the efficiency of water resources, in addition to the choice of irrigation method, the type of training system plant, the management of soil and tree canopy, it is important to intervene in the management of the irrigation method. When water resources are not available in quantities necessary to meet the needs of our orchard throughout the irrigation season, it is necessary to establish accurately the volumes and the phases of the annual cycle. (Xiloyannis et al. 2002, "Proposte per contenere i danni da siccità alle piante da frutto").

A wide range of actions and practices have been proposed and some of them will be implemented in the ten pilot farms of AFI FOR. Since the majority of them are aiming to water saving, they can be used both as preventive and as operational actions in drought management. The aforementioned practices are grouped according to the way that water is saved and are described in more detail below:

<u>Practices for reduction of water evaporation losses</u>: Reducing water evaporation losses could significantly contribute to water saving since high air temperatures observed during summer period result in high evaporation potential. Practices that contribute to water evaporation losses reduction are:

5. Soil mulching: Weed mowing is proposed to be done during the high water demand.
6. No weed control: Natural vegetation can remain on the farm during the wet season.
7. Shredding of pruned wood: Pruned wood of small diameter can be shredded on orchard surface.

8. No soil tillage: By applying this practice a minimum vegetation is kept on the farm.

Practices for reduction of water transpiration losses: Specific practices could be applied that aim to reduce water transpiration without affecting crop yield. Practices that contribute to water transpiration losses reduction are:

3. Winter pruning: Appropriate winter pruning can be applied in order to obtain the optimal balance between leaf area and yield.
4. Summer pruning: Appropriate summer pruning can be applied in order to reduce the transpiring leaves and radiation competition.

Practices for the improvement of soil water holding capacity: The increment of soil organic matter has been found to improve soil water holding capacity. Therefore, locally available organic matter can be applied in the farm during autumn.

Practices for reduction of surface runoff losses: By reducing surface runoff more water will be available to infiltrate in the soil. Surface runoff traps, such as bio-rolls from pruning residues could be installed vertical to the slope of the farm, but in AFI area surface runoff traps are not usually used by farmer. Moreover the 10 pilot farms chosen don't have high slope. For the reduction of surface runoff loss will be used dense spontaneous weed soil cover.

Practices for improving irrigation efficiency: Improving irrigation efficiency has been proved to significantly contributing to agricultural water saving. Several practices can be applied in order to improve irrigation efficiency:

6. Calculation of evapotranspiration losses: Crop water requirements estimation based on meteorological conditions and soil type gives the ability to apply the appropriate volumes of irrigation water and therefore to avoid excess water application in the farm.
7. Deficit irrigation: It has been proved that deficit irrigation can result in high water saving without significant impact in crop yield.

All the above described practices can be applied either as preventive or as operational measures. The difference is that for normal periods the application of such measures may be suggested as optional, while under drought periods their application may be considered as obligatory.

Other measures that can potentially contribute to risk management are the following:

5. Identification and minimization of water losses: Water saving potential of this practice is very high. The application of water losses identification, estimation and minimization methodology proposed in Chapter 2 can aid AFI F.OR both in normal and drought period to save water.
6. Adaptation of irrigation strategy: Irrigation in arid regions requires special attention to optimize the management of all components of the orchard system in order to increase water use efficiency and reduce environmental impacts (e.g. soil salinization, degradation of ground and surface waters). The irrigation strategy will include:

   - The application of regulated deficit irrigation (RDI) with specific crop coefficients to calculate the plant water requirement. (Dichio B. et al. 2011);
   - Optimization measures of irrigation systems;
   - Introduction of control systems and automation for irrigation plants;
   - Application of optimized protocols for the management of irrigation (water balance) and plant nutrition (nutritional balance);
   - Application of sustainable management techniques for the orchards: soil management, canopy management, nutrition, interventions to increase

allocations of organic carbon of the soil and with the aim to reduce soil erosion and leaching;

- Acquisition of parameters for determining the effect of the innovative protocols;

7. Maintenance of water collection infrastructures: develop plans of actions for the maintenance and the correct management of the existing hydraulic infrastructures such as pipes, drainage channels.
8. Alternative water sources: In case of extended drought periods, alternative water sources may be used. Such sources could be recycled or reusable water.

Since the regional drought management plan of Basilicata Region has not been developed yet, AFI F.OR has to communicate its interest to Interregional River Basin Authority of Basilicata for information about actions and reports related to droughts. Finally, increasing farmers awareness during drought period and training on the above mentioned practices can significantly contribute to water saving. Therefore, informational and training campaigns have to be organized by the AFI F.OR during drought periods.

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ANNEX I

KEDHP	Form KED-1.1 Legal matters responsible	v1 - 13.11.2016
Author/Signature	Editor/Signature	

Assignment

Date:__/__/____

The present assignment refers to the project of our organization to comply with the requirements of the EWS standard, implementing our policy on water, issues decided on __/__/____ and the related strategy.

Mr/Mrs _____ from __/__/____ will be responsible for:

1. As RL (Responsible for Legal matters), to follow up, summarize in Form KED-L 4and brief management on legal matters relating to water management, according to the procedure KED-PL.

2. As RB (Responsible for River Basin's Committee) to:

   - Make formally known the commitment of the Organization for the implementation of the EWS project to the above Committee, and describe his role.
   - Maintain regular contacts with the local River Basin Committee, according to a schedule that he will document, in order to establish a two-way communication with regard the issues concerning the Organization and the EWS project. Also, to participate in meetings and training events, and to inform the Organization on activities or decisions that affect its water policy and strategy, and to report accordingly.

3. As Water Steward to ensure the implementation control and monitoring the results of the organization's Water Management Strategy, by taking all necessary measures, according to the EWS Standard, the Guideline document and the Quality Manual referring to the Water Strategy.

For the management — The employee

Name — Name

Signature — Signature

KEDHP	Form KED-PL Procedure for Legal Matters	v1 - 13.11.2016
Author/Signature	Editor/Signature	

Procedure for following up legal matters on water

Objective: To ensure that legal and other e.g. contractual, requirements are not overlooked, and that their implementation is controlled, monitored and reported to the Management.

Owner: The person assigned the role of Responsible for Legal matters (RL), or in absence of this role, the Water Steward (WS) for the organization.

Related documents: Form KED-1 (assignment of the role of water steward).

Description: The RL, or in his absence the WS:

1. Collects information on new legislation or other obligations of the Organization, e.g. contracts with reference to water, new standards to which it abides, etc. For this:
   - lists all possible sources of information for EU, national and local legislation that refers to water in the basin of interest to the Organization, by means of e.g. links to EUR-Lex, national (Ministry) and communication with local authorities. Also, local press and other mass media that may broadcast news on water in the area, should be included in the list.
   - For each source, the WS makes a plan to follow-up regularly, to identify newly appearing legislation relevant to the activity of the organization. Information- collection activity should be documented, even if not always productive, i.e. when there is no new legislation to report.
   - The results of information-collection are recorded on form KED-L summarizing the points of the new legislation that require action by the Organization. In such a case, the RL or the WS drafts a plan for the management of the Organization to comply with the new legislation (or other) requirement.
2. Monitors compliance to the existing water-related legislation and other obligations, asking for information by the control system of the Organization which he uses to produce a 'report on compliance' to the management.

Records: The following documents are kept in Organization's Records for 5 years:

- Communication and information-collection record, on a yearly basis (forms KED-L).
- Legislation, contracts, standards etc, as part of Organization's external documents.
- Reports of responsible person to the management, on legal compliance.

KEDHP	Form KED-L Procedure for Legal Matters	v1 - 13.11.2016
Author/Signature	Editor/Signature	

Record of legal and other requirements

Date	Legislation	Articles	Topics of i	Importance (1-3)	Organization's compliance	Action plan - Deadline
Water Steward			Signature		Date of last update:	

KEDHP	Form KED-1.2 Responsible for River Basin's Committee	v1 - 13.11.2016
Author/Signature	Editor/Signature	

Assignment

Date:__/__/____

The present assignment refers to the project of our organization to comply with the requirements of the EWS standard, implementing our policy on water, issues decided on __/__/____ and the related strategy.

Mr/Mrs _____ from __/__/____ will be responsible for:

As RB (Responsible for River Basin's Committee) to:

- Make formally known the commitment of the Organization for the implementation of the EWS project to the above Committee, and describe his role.
- Maintain regular contacts with the local River Basin Committee, according to a schedule that he will document, in order to establish a two-way communication with regard the issues concerning the Organization and the EWS project. Also, to participate in meetings and training events, and to inform the Organization on activities or decisions that affect its water policy and strategy, and to report accordingly.

For the management

Name

Signature

The employee

Name

Signature

KEDHP	Form KED-1.3 Responsible for Water Stewardship	v1 - 13.11.2016
Author/Signature	Editor/Signature	

Assignment

Date:__/__/____

The present assignment refers to the project of our organization to comply with the requirements of the EWS standard, implementing our policy on water, issues decided on __/__/____ and the related strategy.

Mr/Mrs _____ from __/__/____ will be responsible for:

As Water Steward to ensure the implementation control and monitoring the results of the organization's Water Management Strategy, by taking all necessary measures, according to the EWS Standard, the Guideline document and the Quality Manual referring to the Water Strategy.

For the management

Name

Signature

The employee

Name

Signature

ANNEX II

MIRABELLO	Form MER-1.1 Legal matters responsible	v1 - 13.11.2016
Author/Signature	Editor/Signature	

Assignment

Date:__/__/____

The present assignment refers to the project of our organization to comply with the requirements of the EWS standard, implementing our policy on water, issues decided on __/__/____ and the related strategy.

Mr/Mrs _____ from __/__/____ will be responsible for:

4. As RL (Responsible for Legal matters), to follow up, summarize in Form MER-L 4and brief management on legal matters relating to water management, according to the procedure MER-PL.

5. As RB (Responsible for River Basin's Committee) to:

   - Make formally known the commitment of the Organization for the implementation of the EWS project to the above Committee, and describe his role.
   - Maintain regular contacts with the local River Basin Committee, according to a schedule that he will document, in order to establish a two-way communication with regard the issues concerning the Organization and the EWS project. Also, to participate in meetings and training events, and to inform the Organization on activities or decisions that affect its water policy and strategy, and to report accordingly.

6. As Water Steward to ensure the implementation control and monitoring the results of the organization's Water Management Strategy, by taking all necessary measures, according to the EWS Standard, the Guideline document and the Quality Manual referring to the Water Strategy.

For the management — The employee

Name — Name

Signature — Signature

MIRABELLO	Form MER-PL Procedure for Legal Matters	v1 - 13.11.2016
Author/Signature	Editor/Signature	

Procedure for following up legal matters on water

Objective: To ensure that legal and other e.g. contractual, requirements are not overlooked, and that their implementation is controlled, monitored and reported to the Management.

Owner: The person assigned the role of Responsible for Legal matters (RL), or in absence of this role, the Water Steward (WS) for the organization.

Related documents: Form MER-1 (assignment of the role of water steward).

Description: The RL, or in his absence the WS:

3. Collects information on new legislation or other obligations of the Organization, e.g. contracts with reference to water, new standards to which it abides, etc. For this:
   - lists all possible sources of information for EU, national and local legislation that refers to water in the basin of interest to the Organization, by means of e.g. links to EUR-Lex, national (Ministry) and communication with local authorities. Also, local press and other mass media that may broadcast news on water in the area, should be included in the list.
   - For each source, the WS makes a plan to follow-up regularly, to identify newly appearing legislation relevant to the activity of the organization. Information- collection activity should be documented, even if not always productive, i.e. when there is no new legislation to report.
   - The results of information-collection are recorded on form MER-L summarizing the points of the new legislation that require action by the Organization. In such a case, the RL or the WS drafts a plan for the management of the Organization to comply with the new legislation (or other) requirement.
4. Monitors compliance to the existing water-related legislation and other obligations, asking for information by the control system of the Organization which he uses to produce a 'report on compliance' to the management.

Records: The following documents are kept in Organization's Records for 5 years:

- Communication and information-collection record, on a yearly basis (forms MER-L).
- Legislation, contracts, standards etc, as part of Organization's external documents.
- Reports of responsible person to the management, on legal compliance.

MIRABELLO	Form MER-L Procedure for Legal Matters	v1 - 13.11.2016
Author/Signature	Editor/Signature	

Record of legal and other requirements

Date	Legislation	Articles	Topics of i	Importance (1-3)	Organization's compliance	Action plan - Deadline
Water Steward			Signature		Date of last update:	

MIRABELLO	Form MER-1.2 Responsible for River Basin's Committee	v1 - 13.11.2016
Author/Signature	Editor/Signature	

Assignment

Date:__/__/____

The present assignment refers to the project of our organization to comply with the requirements of the EWS standard, implementing our policy on water, issues decided on __/__/____ and the related strategy.

Mr/Mrs _____ from __/__/____ will be responsible for:

As RB (Responsible for River Basin's Committee) to:

- Make formally known the commitment of the Organization for the implementation of the EWS project to the above Committee, and describe his role.
- Maintain regular contacts with the local River Basin Committee, according to a schedule that he will document, in order to establish a two-way communication with regard the issues concerning the Organization and the EWS project. Also, to participate in meetings and training events, and to inform the Organization on activities or decisions that affect its water policy and strategy, and to report accordingly.

For the management

Name

Signature

The employee

Name

Signature

MIRABELLO	Form MER-1.3 Responsible for Water Stewardship	v1 - 13.11.2016
Author/Signature	Editor/Signature	

Assignment

Date:__/__/____

The present assignment refers to the project of our organization to comply with the requirements of the EWS standard, implementing our policy on water, issues decided on __/__/____ and the related strategy.

Mr/Mrs _____ from __/__/____ will be responsible for:

As Water Steward to ensure the implementation control and monitoring the results of the organization's Water Management Strategy, by taking all necessary measures, according to the EWS Standard, the Guideline document and the Quality Manual referring to the Water Strategy.

For the management

Name

Signature

The employee

Name

Signature

ANNEX III

METAPONTINO	Form MET-1.1 Legal matters responsible	v1 - 13.11.2016
Author/Signature	Editor/Signature	

Assignment

Date:__/__/____

The present assignment refers to the project of our organization to comply with the requirements of the EWS standard, implementing our policy on water, issues decided on __/__/____ and the related strategy.

Mr/Mrs _____ from __/__/____ will be responsible for:

7. As RL (Responsible for Legal matters), to follow up, summarize in Form MET-L 4and brief management on legal matters relating to water management, according to the procedure MET-PL.

8. As RB (Responsible for River Basin's Committee) to:

   - Make formally known the commitment of the Organization for the implementation of the EWS project to the above Committee, and describe his role.
   - Maintain regular contacts with the local River Basin Committee, according to a schedule that he will document, in order to establish a two-way communication with regard the issues concerning the Organization and the EWS project. Also, to participate in meetings and training events, and to inform the Organization on activities or decisions that affect its water policy and strategy, and to report accordingly.

9. As Water Steward to ensure the implementation control and monitoring the results of the organization's Water Management Strategy, by taking all necessary measures, according to the EWS Standard, the Guideline document and the Quality Manual referring to the Water Strategy.

For the management — The employee

Name — Name

Signature — Signature

METAPONTINO	Form MET-PL Procedure for Legal Matters	v1 - 13.11.2016
Author/Signature	Editor/Signature	

Procedure for following up legal matters on water

Objective: To ensure that legal and other e.g. contractual, requirements are not overlooked, and that their implementation is controlled, monitored and reported to the Management.

Owner: The person assigned the role of Responsible for Legal matters (RL), or in absence of this role, the Water Steward (WS) for the organization.

Related documents: Form MET-1 (assignment of the role of water steward).

Description: The RL, or in his absence the WS:

5. Collects information on new legislation or other obligations of the Organization, e.g. contracts with reference to water, new standards to which it abides, etc. For this:
   - lists all possible sources of information for EU, national and local legislation that refers to water in the basin of interest to the Organization, by means of e.g. links to EUR-Lex, national (Ministry) and communication with local authorities. Also, local press and other mass media that may broadcast news on water in the area, should be included in the list.
   - For each source, the WS makes a plan to follow-up regularly, to identify newly appearing legislation relevant to the activity of the organization. Information- collection activity should be documented, even if not always productive, i.e. when there is no new legislation to report.
   - The results of information-collection are recorded on form MET-L summarizing the points of the new legislation that require action by the Organization. In such a case, the RL or the WS drafts a plan for the management of the Organization to comply with the new legislation (or other) requirement.
6. Monitors compliance to the existing water-related legislation and other obligations, asking for information by the control system of the Organization which he uses to produce a 'report on compliance' to the management.

Records: The following documents are kept in Organization's Records for 5 years:

- Communication and information-collection record, on a yearly basis (forms MET-L).
- Legislation, contracts, standards etc, as part of Organization's external documents.
- Reports of responsible person to the management, on legal compliance.

METAPONTINO	Form MET-L Procedure for Legal Matters	v1 - 13.11.2016
Author/Signature	Editor/Signature	

Record of legal and other requirements

Date	Legislation	Articles	Topics of i	Importance (1-3)	Organization's compliance	Action plan - Deadline
Water Steward			Signature		Date of last update:	

METAPONTINO	Form MET-1.2 Responsible for River Basin's Committee	v1 - 13.11.2016
Author/Signature	Editor/Signature	

Assignment

Date:__/__/____

The present assignment refers to the project of our organization to comply with the requirements of the EWS standard, implementing our policy on water, issues decided on __/__/____ and the related strategy.

Mr/Mrs _____ from __/__/____ will be responsible for:

As RB (Responsible for River Basin's Committee) to:

- Make formally known the commitment of the Organization for the implementation of the EWS project to the above Committee, and describe his role.
- Maintain regular contacts with the local River Basin Committee, according to a schedule that he will document, in order to establish a two-way communication with regard the issues concerning the Organization and the EWS project. Also, to participate in meetings and training events, and to inform the Organization on activities or decisions that affect its water policy and strategy, and to report accordingly.

For the management	The employee
Name	Name
Signature	Signature

METAPONTINO	Form MET-1.3 Responsible for Water Stewardship	v1 - 13.11.2016
Author/Signature	Editor/Signature	

Assignment

Date:__/__/____

The present assignment refers to the project of our organization to comply with the requirements of the EWS standard, implementing our policy on water, issues decided on __/__/____ and the related strategy.

Mr/Mrs _____ from __/__/____ will be responsible for:

As Water Steward to ensure the implementation control and monitoring the results of the organization's Water Management Strategy, by taking all necessary measures, according to the EWS Standard, the Guideline document and the Quality Manual referring to the Water Strategy.

For the management

Name

Signature

The employee

Name

Signature