Project title: Best Water Use
Project acronym: BestU

Deliverable D3.1.2: Guidelines Good Practice Manual
Work Package 3: Research on current situation

Contracting authority:

Εκπόνηση παραδοτέου:

March 2019

The Project is co-funded by the European Regional Development Fund (ERDF) and national funds of the countries partcipating in the Cooperation Programme INTERREG V-A "Greece-Bulgaria 2014-2020"

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1. Introduction

This Deliverable (D 3.1.2) was implemented in the frames of the project "Best Water Use" (Interreg V-A, Greece Bulgaria 2014-2020) and more specifically the Work Package 3 (WP3) concerning the development of the Guidelines for Good Practice for water conservation and main usage categories.

More specifically, the aim of the deliverable is to seek and demonstrate good management practices concerning the different uses of water in Greece and in other European countries and covering all categories of use so that they can be utilized in the context of other project actions, such as developing rational water management guidelines. In particular, best water saving practices for urban, irrigation, industrial, energy and tourism use are proposed.

1.1. Need for rational water management

Water management is a very important issue from various perspectives, such as the development of water systems for the future, the protection of available water bodies from pollution and overexploitation. A very important issue with regard to water is its availability, quality and management

In recent years, water bodies have received man-made point and non-point pressures, which lead to their physical, chemical and biological degradation, resulting in a reduction in their ability to provide services. The main pressures on ecosystems, which are summarized in five main categories, as adopted by the European Environment Agency (2015), including mainly climate change, resource over-exploitation and nutrient enrichment. Despite the efforts made in recent years, which focus on achieving the Sustainable Development Goals (SDGs) proposed by the United Nations, most man-made pressures has intensified. (Millennium Ecosystem Assessment, 2005).

Droughts, ie the temporary reduction of available water resources, are often referred to as natural disasters, as they can have a serious impact on the natural resources, socio-economic stability and the well-being of people. Water scarcity, ie when water demand exceeds exploitable water resources, can be a consequence of drought, which is a problem that endangers the health and safety of societies. The European Environment Agency (EEA) in its 2009 European Environment Agency confirms that though Southern European countries address the serious water scarcity problems, pressure on water resources is now occurring in some parts of the North. In addition, climate change is expected to increase the intensity and frequency of droughts in the future, further exacerbating the demand for water resources, especially in the summer months.

The availability of water of the right quality, at the right time and place in order to meet environmental, economic and human needs requires the active management of water resources.

1.2. Existing Legislation

Over the last 30 years, EU Member States have made significant progress in improving the quality of water bodies thanks to EU legislation, in particular the Water Framework Directive, the Urban Waste Directive and the Directive for the quality of drinking water. These key legislative texts support the EU's commitment to improving the water situation in Europe. The aim of EU policies is to significantly reduce

the negative impacts of pollution, excessive pumping and other pressures on water and ensure that there is sufficient good quality water both for human use and for the environment.

More specifically, the main objectives of the European water policy are:

- -to ensure that the water abstraction rates of water resources are sustainable in the long term and promote the sustainable use of water, based on the long-term protection of available water resources
    - to ensure a balance between pumping and recharge of groundwater in order to achieve good groundwater status

The Water Framework Directive obliges Member States to use pricing of water-related services as an effective tool for promoting water conservation. This would also make it possible to determine the environmental cost of water in the water prices. National, regional and local authorities should, inter alia, introduce measures to improve the efficiency of water use and encourage changes in practices that are necessary for the protection of water resources and its quality.

1.3. Uses of water and consumption rates (Greece and Europe)

The overall use of water resources can be considered viable in the long term in much of Europe. However, some areas may have problems related to water scarcity. This is particularly the case in parts of southern Europe where improvements in the efficiency of the use of agricultural waters (and other uses) are likely to be achieved in order to avoid the lack of seasonal waters. Areas associated with low rainfall, high population density or intensive agricultural or industrial activity may also address sustainability issues in the coming years, which could be aggravated by the impact of climate change on water availability and water management practices.

Europeans use billions of cubic meters of water each year not only as drinking water but also for use in agriculture, industry, heating and cooling, tourism and other service sectors. With thousands of freshwater lakes, rivers and underground water springs, Europe's water supply may seem unlimited. However, population growth, urbanization, pollution and the effects of climate change, such as ongoing droughts, have enormous water supplies in Europe and its quality.

The sector with the largest use of water varies from region to region. Overall, agriculture is the highest water user in Southern Europe, while cooling in energy production exerts the greatest pressure on water resources in Western and Eastern Europe. The manufacturing industry is the largest user in Northern Europe.

1.4. The Objectives of Good Practices

Recommended best practices will fall in the following categories:

- **Fundamenta**l: Best practices for saving water considered necessary for the implementation of all services of general interest
- **Informative**: Best practices that provide useful information on water saving to customers of public utilities aiming to promote conservation actions and behaviors

- **Supporting**: Best practices that provide technical information, data, and help with water performance to customers (closely related to best practice information)
- **Management**: Best Practices that provide improved usability management procedures and actions to promote water conservation
- **Understanding**: Best practices aimed at improving knowledge and awareness of the use and efficiency of water
- **Functional**: Best practices that seek to improve water retention in everyday use

2. Existing literature review and examples of water savings by category of usage

With the awareness of the existence of scarce resources, it is understandable that the key to sustainability lies in the good management of existing water supplies. According to the European Environment Committee, sustainability should strive to balance available water at any given point in time and space with the demand for water for various uses and the need for sufficient water to protect human health and the aquatic ecosystem. Available water must be of sufficient quality to satisfy the various users, including the protection of human life. The proposed measures / practices can be used to increase water availability and / or control and reduce water demand.

2.1. Water supply/Urban water use

Urban water supplies are households, industry and commercial areas as end users, but they are also used for urban services such as city washing, fire stations, maintenance of recreation areas (fountains, lakes, swimming pools and recreational parks). This deliverable will ensure best practices at the urban level and in particular at home (at building level).

In particular, as part of the WaterCoRe - Water scarcity and droughts project; coordinated actions in European regions (WaterCoRe project IVC), a Good Practice Guide was developed focusing on practical solutions related to water scarcity and drought in Europe in the context of the development of improved policies and water scarcity and drought management tools in many parts of Europe, which was the target of this project. In particular, it is initially proposed to use water-saving devices in the basins and in the showers. Then, as water losses in water distribution networks can reach very high rates, it is proposed to reduce leakage through network maintenance and renewal, which is one of the key elements of any effective water management policy. In addition, for the efficient planning and allocation of water resources it is necessary to have a clear picture of the quantities of water use. In this context, it is proposed to measure and monitor the consumption of water for all its uses, including urban consumption. Finally, it is proposed to use rainwater in various activities (eg gardening, parks, street cleaning, etc.).

In addition, Mrs Lytra B. in the framework of a postgraduate dissertation (Lytra B., 2013) proposes measures and technologies for water saving at residential level. More specifically, she suggests:

- ✓ **Use of technologies related to hydraulic equipment, direct water saving**: these technologies concern water-saving systems and appliances in the shower (eg high pressure showers, electric showers, etc.), water-saving fountains (e.g. use of nozzles) in water-saving toilets.
- ✓ **Use of technologies related to domestic electrical appliances, direct water saving:** these devices mainly concern dishwashers and washing machines.
- ✓ **The use of rainwater collection and treatment systems:** these systems concern both domestic water use and centralized rainwater management (segregation of rainwater from sewage systems).
- ✓ **Use of gray water recycling systems**: Gray water can be utilized for various uses depending on the degree of treatment except for drinking water.
- ✓ **Using Double Piping Systems**: Double piping systems are used for water supply if there are two different water qualities. In such cases, in addition to the supply of drinking water, there is also a lower quality non-potable water, which is fed for non-potable uses and therefore contributes to the saving of drinking water.

In the context of TRUST (FP7 / 2007-2013) (Makropoulos C. et al., 2012), some best practices of urban water use have been described in various countries around the world, including European ones. Measuring systems have been implemented in Sofia, which serve to determine the efficiency and the implementation of water saving measures as well as the pricing and mandatory distribution of water which can not be applied without the use of measurement devices. In Germany a centralized rainwater collection was implemented, which could be a viable option for densely populated urban areas and reduce drinking water consumption and wastewater production.

The Mesogeios SOS Network has published a Good Practice Guide for the sustainable management of urban water (Mitroopoulou M, 2013). Initially, it is proposed to enhance the citizens' water awareness, which can be achieved through an integrated information and awareness campaign and through participatory processes. It then describes the importance of managing non-reimbursable water in water supply networks, which implies control and reduction of losses resulting in increased urban water use efficiency. For this reason, it is proposed to draw up a plan for a targeted and time-honored pricing policy, including non-reimbursable water pricing, full water cost recovery, systematic network maintenance and early replacement of infrastructure and work to reduce actual losses. It includes:

- ✓ Detection of in-pipe acoustic leaks and non-acoustic methods (gas detection),
- ✓ Separation of the network in watertight sub-bands of input flow measurement
- ✓ Pressure control and management with telemetering leakage or breakage warning systems (requires knowledge and experience)
- ✓ Active leakage control, not visible and unreported
- ✓ Leakage repair (speed and quality of repairs)

In the context of managing non-contributing water, there are some examples where such measures have been implemented. In particular, effective water network control, constant night flow monitoring for leak detection, pressure regulation and control, reduction of leakage time and water and money savings, and replacement of water meters with corresponding automated reading systems were carried out in **Cyprus**. In **Romania** practices were implemented including pressure management, preventive loss management and improved speed and quality of repairs. On the **island of Kos**, the water supply network has been evaluated and monitored through a complete mapping and hydraulic simulation while in **Kozani** under the European WATERLOSS program, a hydraulic model was developed and used for pressure zones and DMAs, and 2 pilot control stations for pressure management (PRVs) were installed. Finally, new water consumption measurement technologies (smart meters) have been implemented in **Prague**.

The same guide proposes the use of non-conventional water resources. In particular, it is proposed to use rainwater harvested from rooftops and road surfaces in urban settings that can be used for minor uses. Some examples of the use of rainwater are **Germany** where the rainwater is recovered and used for domestic use (lavatories, laundries and gardens) and **Greece**, and more specifically the Cyclades. It is also proposed to use flood water, where large amounts of such water are produced in urban areas and the use of "gray" water, which, after appropriate and small scale treatment, can be reused for selected household uses (mainly in the toilet) for urban use (in construction) and for irrigation (gardens, parks), replacing the use of drinking, clean water, where its high quality is not necessary. In **Cyprus**, the CYPROBELL water recycling system has been systematically utilized. This system can be installed in one or more residences, blocks of flats, schools, stadiums, nursing homes, etc. Finally, it is proposed to manage wastewater and to use it mainly for irrigation of urban areas and recreation areas. Exploitation of processed waste for urban use was implemented in **Germany**.

According to Katerzidou (2018), the proposed urban water use practices are related to system monitoring and measurement: water meters, water pricing, leakage detection and repair, water supply maintenance, control equipment installation, high civil servicing, the separation of high quality water and re-use water, the creation of an institutional framework for water saving adoption, financial incentives and penalties and, finally, education and information. The efficiency of the above practices is high and in some cases very high, while only the practice of high service ranges from moderate to high.

In addition, the same study proposes water saving practices at home as well as in outdoor activities and leisure areas. In particular, the first category describes the following best practices:

Table 1. Best water saving practices at home level suggested by Katerzidou (2018).

Water use	Practices
Basin	• Reduced amount of water • Use parts to avoid leakage
Shower	• Reduced discharge • Reduce the duration of the shower

Water use	Practices
Washbasin	• Reduction of water pressure • Use valves with automatic closing • Washing dishes in a bowl (not in running water)
Washing machine	• Use only full load • Use of appliances with low water consumption
Dishwasher	• Use only when it is full • Use of appliances with low water consumption
Gardens and lawns	• Irrigation (saturation of 15cm soil) • Information on irrigation frequency
Washing of pavements and cars	• Avoid washing with hose • Use of re-used water in car wash services
Swimming pools	• Use of water purifiers • Exhaust control cover (if not in use)
Leakage control	• Applying good techniques • Placement of good quality materials • Locate damage and repair
Pressure control	• Use pressure regulators

Similarly, for the second category, the following practices are described (Katerzidou, 2018):

Table 2. Best water saving practices for outdoor spaces proposed by Katerzidou (2018)

Water use	Practices
Gardens and lawns	• Choice of plants resistant to water scarcity • Re-use of water • Installation of drip and microspray systems • Irrigation at night • Use of materials (leaves, fertilizer, bark) to reduce water evaporation • Check for weeds
Pools and lakes	• Use of water purifiers • In the case of fishing, use techniques similar to fish ponds
Golf courses	• Adoption of irrigation practices with easy management under water scarcity • Re-use of treated effluent for irrigation • Creating management irrigation strategies to tackle water scarcity
Parks and lakes	• Imposition of measures on water quality • Adoption of integrated water resource management

Water use	Practices
Sports facilities	• Irrigation with micro-spray systems • Exact irrigation
Public swimming pools	• Use of water and chemical cleaners • Implementing health prevention measures
Indoor facilities	• Water saving devices in toilets, showers, washbasins, • Leak detection and repair
General issues	• Publicizingand promotion of water saving measures • Advertise / update audiences • Education for children and young people

Table 3 summarizes the best practices proposed by literature used and projects that have been implemented.

Table 3. Best water saving / urban water saving practices according to existing literature

A/A	Good Practice	general	buildings	housing	Outdoor spaces
1	Education and awareness for behavioral change	√			
2	Pricing system / financial incentives and penalties	√			
3	Central rainwater collection	√			
4	Maintenance of water supply systems	√			
5	High quality customer service	√			
6	Separate distribution of high quality water and reused water	√			
7	Creating an institutional framework for adopting water saving	√			
8	System maintenance		√	√	
9	Replacement of high water consumption devices		√	√	
10	Use of measurement devices		√	√	√
11	Pressure management / control		√	√	
12	Water loss control systems / leakage detection and repair		√	√	√
13	Use of alternative water sources for uses beyond drinking water			√	√
14	Best practices irrigation			√	√

A/A	Good Practice	general	buildings	housing	Outdoor spaces
15	Use of water and chemical cleaners in public and private pools			√	√
16	Use only at full loads (dishwashers and clothes washing machines)			√	
17	Use of valves with automatic closure in washbasins		√	√	

2.2. Use of water for irrigation

Agriculture accounts for the highest use of water: about 40% of all water used per year in Europe. Despite improved efficiency in the sector since the 1990s, agriculture will continue to be the largest consumer in the years to come, and will burden water stress in Europe. This is due to the fact that more and more agricultural land must be irrigated, especially in the countries of southern Europe.

While only 9% of Europe's total arable land is irrigated, these areas account for around 40% of the total water use in Europe. In spring this percentage may exceed 60% to help crops grow after planting.

Therefore water management and saving in irrigation is vital. In this context, both the international and the Greek bibliography have proposed best practices for the use of water in the agricultural sector. The main objectives of irrigation demand management are (Katerzidou, 2018):

- ✓ reducing water demand,
- ✓ saving / conserving water,
- ✓ Higher yields per unit of water,
- ✓ Higher income of farmers.

In particular, from Katerzidou (2018), best water saving practices are proposed in both dry and irrigated agriculture. More specifically, it is proposed:

- **Selection of crops less affected by water scarcity.**
- **Crop management to address water scarcity**, such as crop selection taking into account seasonal rainfall, small cycle crops, supplementary irrigation at critical stages of crop growth, etc.
- **Land management to address water scarcity**, such as soil water retention techniques and runoff control, increasing soil infiltration rates, increasing water storage capacity in the soil, and so on.
- **Appropriate selection and use of irrigation systems**, both surface irrigation systems and irrigation systems with irrigation.
- **Adoption of planning strategies for irrigation systems** in order to optimize irrigation times and water volumes, with economic and environmental benefits.

Also, mainly for dry and semi-arid areas, it is proposed to use non-conventional water resources, in particular the use of desalinated water, rain water collection and the use of treated urban waste water.

Also, in the context of European projects, the effectiveness of implementing water saving practices in the agricultural sector has been examined. In particular, a new method of agricultural practice, called "low-input farming", was implemented in the project "AGROLESS - Common Guided Agricultural Practices for the Implementation of Spatial Diversified Reduced Input Agriculture" (European Territorial Cooperation Greece - Bulgaria 2007-2013). The implementation of 'low-input farming' is carried out through guided agricultural activities (fertilization, irrigation and plant protection) and leads to the reduction of the impact of agriculture on the environment and to maximizing the productivity and competitiveness of farms. According to the results of the application of these practices in pilot areas, a total of 60% irrigated water was saved.

As part of the WaterCoRe project (WaterCoRe project, 2010), water saving and irrigation practices are also proposed. More specifically, effective and sustainable irrigation is proposed through modernized irrigation systems and application of models for irrigation instructions. It is also suggested that the volume of water consumed for irrigation purposes is accurately measured and monitored. The re-use of treated wastewater for irrigation purposes is proposed by both WaterCoRe and the Mesogeios SOS Network (Mitroopoulou M, 2013). The re-use of waste water effluent is not a widespread practice at European Union level, but has been implemented in Italy, Spain and Portugal, as well as in Crete.

Finally, best water saving practices were proposed within the European WATERAGENDA projects (LIFE04 / ENV / GR / 000099) and WATERINCORE (1G-MED08-515). In particular, with regard to the first project and in the context of the more general proposals concerning the organization and improvement of methods and practices of agricultural activity, measures were proposed aimed at saving irrigation water use.

In particular, such measures include the implementation of the Code of Good Agricultural Practice, the replacement of irrigation systems with higher yield systems in irrigation water, rational irrigation of crops, the education of farmers on rational water use and crop restructuring in relation to with available water resources.

As part of the second project, good water practices in the proposed river basin include proposed water saving measures in the irrigation sector. In particular, it is proposed to audit and license drilling to prevent over-exploitation of water resources and illegal extraction, to implement a fair pricing policy, to upgrade grids and minimize losses, to restructure crops, to upgrade irrigation infrastructures to modernize farm water resources and to use of water, construction of irrigation networks in irrigated areas and implementation of irrigation regulations, installation of water meters in private drilling and re-use of treated waste for irrigation purposes.

The following table summarizes the best water saving practices proposed by literature (Table 4).

Table 4. Best practices for saving irrigation water according to the bibliography.

A/A	Good practices
1.	Crop restructuring

A/A	Good practices
2.	Crop management to tackle water scarcity
3.	Land management to address water scarcity
4.	Replacement and appropriate selection and use of irrigation systems
5.	Adoption of planning strategies for irrigation systems in order to optimize irrigation times and water volume (rational irrigation of crops)
6.	Use of unconventional water resources for anhydrous and semi-anhydrous areas
7.	Volumetric measurement of water use
8.	On-site irrigation control
9.	Implementation of precision farming
10.	Farmer education on rational use of water
11.	Verification and licensing of drilling
12.	Implementing a fair pricing policy
13.	Construction of irrigation networks in irrigated areas

2.3. Industrial use of water

Water is also used in factories, plants, for the production of petroleum products and by industries producing chemicals, food and products used for the purposes of manufacturing, processing, washing, thinning, cooling or transporting a product, as well as paper. The largest amounts of water are used to produce food, paper and chemicals.

In this context, Invest Northern Ireland ,the Northern Ireland Regional Economic Development Authority (Invest Northern Ireland, 2018),has developed a practical guide to achieving water efficiency in Northern Ireland, which includes the following practices:

- **Using water flow control devices**: As many types of industrial equipment require predetermined water flow rates to operate efficiently, it is recommended to use limited flow or process control devices that automatically shut down flow in specific situations.
- **Water reuse for rinsing and cleaning**: This practice involves water recirculation and pollutant filtration and water recovery for internal reuse.
- **Use of leakage detection equipment**: Due to the complex and inaccessible nature of a water distribution network, it is often difficult to detect the leakage without the help of leakage detection equipment. There are several technologies for recording data, monitoring systems and identifying inconsistencies that may indicate a leak in the water distribution network.
- **Use of water-saving surface cleaning equipment**: Such methods are cleaning / drying devices which operate by recovering dirty washing water from the floor surface, processing it and then

reusing it, and steam cleaners that use high temperature steam to sterilize an area can kill bacteria and fat without the need for chemicals.

- **Use of rainwater for various purposes**: These uses include applications such as cooling, washing, watering and cleaning / washing.
- **Recovery and reuse of "gray" water**: After appropriate treatment, this water can be used for different purposes other than drinking, such as toilet basins, outdoor irrigation or in laundries.
- **Employee training and awareness**: It is important for staff to be aware of the benefits of water efficiency and the importance of using and maintaining water saving technologies to make businesses effective as far as water consumption is concerned.

Water saving practices have been implemented in several businesses in Northern Ireland, which have yielded the corresponding benefits. More specifically, in an electrical generating company, they have re-used water to minimize drinking water consumption and optimize the application of cooling towers. Similarly, in a dairy industry they implemented a leakage detection and re-use of overflow water at the butter production unit.

In addition, best practices for the industrial sector are also proposed by Katerzidou (2018). These practices include more efficient recovery in temperature control, water recycling in the production process. In particular, the production process also proposes reduced water demand, adapting water quality to treatment requirements and replacing water use procedures with mechanical methods. In addition, washing is recommended to use cleaning machines, to avoid rubber washing and to reuse water. With regard to indoor water use, it is suggested to use water-repellent control devices and generally to use it carefully. In the case of external water use, water reuse, gardening with drought-resistant plants, low water consumption irrigation methods and the use of hood cleaning machines are proposed. Generally, water measurement, water quality monitoring, leakage detection and repair, and water testing are suggested to explore and apply efficient water use.

Finally, in the framework of the WaterCoRe project (2010), it is proposed to treat the industrial wastewater wastes and re-use them within the industrial site.

The following table summarizes the water saving practices proposed in the literature for the industrial sector.

Table 5. Best industrial water saving practices according to literature.

A/A	Best practices
1	Use of water-saving surface cleaning equipment
2	Recording of industrial water quantity
3	Employee awareness programs

A/A	Best practices
4	Control of water use in the industrial sector Water control to find and support efficient water use
5	Using water flow control devices
6	Reuse of overflow water
7	Optimization of cooling tower application
8	Alternative water sources and industrial water reuse
9	Waste treatment and re-use
10	Replacement of water use procedures by mechanical methods.
11	Using cleaning machines and avoiding hose use
12	Use water discharging control devices
13	Leak Detection and Repair

2.4. Use of water for Energy

Energy production also requires very high water consumption, which accounts for 28% of the total annual water consumption in Europe. The use of water in this sector is mainly related to cooling in nuclear power stations and based on fossil fuels also used in the production of hydropower. With regard to hydropower, water is not consumed but recycled and returned to water bodies. Conversely, cooling for energy is the largest consumer of water in the energy sector.

The Waste and Resources Action Program (WRAP) published a guidance leaflet on reducing water use in cooling towers and exhaust condensers (WRAP, 2010). These guidelines include the following water saving practices:

- ✓ Installation of meters for the effective monitoring of water consumption.
- ✓ Calculating the amount of water that is extracted (blow down water)
- ✓ Re-use of the blow-down water
- ✓ Regular checks for any leaks and losses and rehabilitation actions

According to the International Atomic Energy Agency (2012), the use and consumption of water in a nuclear power plant takes place in three key areas: water use for cooling systems, industrial and drinking water, and water for the dilution of waste. In this context, best practices are proposed for each water consumption stage.

Concerning the reduction of water consumption in cooling systems, the following are proposed:

- ✓ **Use of variable speed pumps for partial load or load after operation:** The demand for cooling water will be less during partial load operations and in shutdown operations where there is only a hot decomposition load
- ✓ **Speed conversions in cooling pumps for temperature changes in the water source**: For a constant thermal load, the cooling water demand on the heat exchangers in the process will be reduced.
- ✓ **Increasing concentration cycles in cooling towers using water treatment:** this process reduces water consumption, minimizes waste generation, reduces chemical treatment requirements, and reduces overall operating costs.
- ✓ **Recycling of water extracted for use as fill water:** water extracted from cooling systems results in water bodies. By applying appropriate technologies it can be reused at 85-90%.
- ✓ **Reducing water losses due to air velocity using impact separators:** The main purpose of such a system is to control unwanted water loss, reduce damage to mechanical components and reduce the nuisance caused to equipment in the environment by spraying.

Finally, in the Guide published by the MEDITERRANEAN SOS Network (Mitropoulos Ms., 2013) is proposing the use alternative water sources (mainly treated waste water) for use by cooling towers.

Overall, the best practices for water saving in the energy sector proposed in the existing literature are summarized in the table below.

Table 6. Best water saving practices for energy use according to the existing literature

A/A	Best practices
1	Calculating the amount of water that is extracted (blow down water)
2	Installing meters to effectively monitor water consumption
3	rain water reuse
4	Regular checks for any leaks and losses and remedial actions
5	Use of alternative water sources
6	Use variable speed pumps for partial load or load after operation
7	Speed conversions in cooling pumps for temperature changes in the water source
8	Increasing concentration cycles in cooling towers using water treatment
9	Reduce water loss due to air velocity using impact dividers

2.5. Use of water in tourism

Water consumption by tourism is relatively low compared to other sectors such as agriculture. In particular, water consumption associated with overnight stays in a hotel, which accounts for a large

share of tourist traffic. For example, it represents 4,5% of water demand in Malta and Cyprus and about 2% in major tourist destinations such as Greece and Tunisia (Eurostat European Commission, 2009). The largest consumers in the tourism sector are hotel facilities, restaurants and outdoor activities.

The International Organization for Sustainable Tourism "BIOSPHERE Tourism" proposes practices for water saving. In particular, it proposes the creation of a water saving management plan, which as a first step will measure water consumption to then set specific targets, develop targeted practices, reduce water consumption through the use of low-consumption systems in hotels, maintenance of systems to avoid leakage, staff training, and awareness raising and awareness raising.

In addition, the Joint Research Center (JRC) published a report on best environmental management practices in the tourism sector (Joint Research Center, 2013). Among other things, this report includes proposals for reducing water consumption in the field of accommodation, which is also the largest consumer of water in the tourism industry. In this context it proposes the following:

- **System maintenance: O**ptimizing system design to avoid excessive water pressure and heat loss, Regular inspection and maintenance of water components and leakage points, Monitoring of water consumption, including the measurement of significant areas using water and benchmarking
- **Installing water saving components in the hosting areas**: installation of sensors or timers for the control of valves and showers in public places, installation of low flow valves and equipment with pressure regulators.
- **Effective cleaning actions:** such as, for example, staff training in efficient cleaning techniques that minimize water and chemical consumption, control and reporting of water leakage.
- **Optimized small and large scale washing processes**: e.g. installation of retention tanks and modification of program for re-use of rinse water, optimized sorting and loading of laundry.
- **Optimized pool and spa space:** appropriate pool size, optimization of washing operations.
- **Reuse of rainwater and "gray water":** Rainwater collection and internal distribution system installation, installation of separate gray water collection and internal or external distribution system.
- **Water management in kitchens**: installation or retrofitting of low pressure high pressure spraying valves for prewash, application of efficient washing and cooking techniques.
- **Environmental management of green areas**: Installation and maintenance of efficient irrigation system, reuse of irrigation water.

Overall, the best practices proposed by the existing literature for saving water in the tourism sector are presented in Table 7.

Table 7. Best water saving practices for tourist use according to the existing literature

A/A	Best practices
1.	Creating a water saving management plan

A/A	Best practices
2.	Staff training and and awareness raising in customers
3.	Maintenance in order to avoid leackage
4.	Reducing water consumption through the use of low consumption systems
5.	Effective cleaning actions
6.	Optimized small and large scale washing process
7.	Optimized pool and spa space
8.	Reuse of rainfall water and "gray water"
9.	Water management in kitchens
10.	Environmental management of green spaces
11.	Monitoring of water consumption

3. Assessment of Practices- Methodology

3.1. Selection criteria for Practices

The best practices proposed in the literature will be evaluated against the criteria below to make their final classification. These criteria include:

- **Relevance**: the proposed practice solves a major problem at a local level.
- **Efficiency**: the results / benefits of the proposed practice to covers its cost, cost / benefit ratio.
- **Innovation:** A new, creative approach has been promoted and implemented, which has addressed the problem.
- **Impact / Effectiveness**: practical and clearly identifiable results have been recorded.
- **Replicabilty**: the proposed practice can be applied to other situations.
- **Strength**: Specific ways of activating the stakeholders in the operation of the structures.
- **Accessibility:** Degree of accessibility of users and stakeholders to products and services offered, accessibility / use of products and practices in relation to the capabilities of users.
- **Utilization**: the use of the practice / product for the benefit of various groups and users, the possibility of flexibility and exploitation of the product / practice as a tool for autonomous independent service.
- **Sustainability**: the proposed practice incorporates the possibility of a broad and long-term perspective benefit for the future of the local community and can become indispensable for local development.

3.2. Evaluation and Hierarchy of practices

As follows, for each water use category, each practice was rated based on the above criteria on a scale from 1 to 5, where 1 corresponds to minor satisfaction of the criterion and 5 to its excellent satisfaction. The tables below show the rating of each best practice for each water use. Grading of the minutes was based on the expert experience and knowledge of the Water Management Advisor who drafted these Guidelines.

Table 8. Evaluation of best water / urban water use practices

A/A	Best practices	Relevance	Efficiency	Innovation	Impact / Effectiveness	Replicability	Strength	Accessibility	Usefulness	Sustainability	Final Rating
1.	Education and awareness for behavioral change	3	4	2	3	4	5	3	4	4	**3,6**
2.	Pricing system / financial incentives and penalties	4	4	2	4	4	4	4	4	2	**3,6**
3.	Central rainwater collection	4	3	3	4	3	2	2	4	4	**3,2**
4.	Maintenance of water supply systems	3	3	2	3	3	2	2	4	3	**2,8**
5.	High quality services	2	3	1	2	3	3	3	3	2	**2,4**
6.	Separate distribution of high quality water and reused water	3	3	3	2	2	2	2	4	3	**2,7**
7.	Creation of an institutional /legislation framework for the adoption of water saving practices	3	4	2	2	4	4	2	4	4	**3,2**
8.	System maintenance	3	3	2	3	4	3	2	4	3	**3,0**
9.	Replacement of high water consumption devices	2	4	3	4	3	3	4	3	3	**3,2**
10.	Use of measurement devices	3	3	3	3	4	3	3	4	3	**3,2**
11.	Control and management of water pressure	2	3	3	3	4	2	3	3	3	**2,9**
12.	Water loss control systems / leakage detection and repair	4	4	3	3	4	2	2	4	3	**3,2**
13.	Use of alternative water sources for uses other than the potable water consumption	4	3	4	3	5	3	3	4	4	**3,7**
14.	Best practices in irrigation	3	3	3	4	4	3	4	4	3	**3,4**

A/A	Best practices	Relevance	Efficiency	Innovation	Impact / Effectiveness	Replicability	Strength	Accessibility	Usefulness	Sustainability	Final Rating
15.	Use of water and chemical cleaners in public and private pools	2	3	4	2	2	3	3	3	2	**2,7**
16.	Use only full loads (dishwashers and washing machines)	2	3	2	2	2	3	4	2	2	**2,4**
17.	Use of valves with automatic closure in washbasins	2	3	3	2	2	3	4	2	2	**2,6**

Table 9. Evaluation of best practices for irrigation water use

A/A	Best practices	Relevance	Efficiency	Innovation	Impact/Effectiveness	Replicability	Strength	Accessibility	Usefulness	Sustainability	Final Rating
1.	Crop restructuring	3	3	2	4	2	2	5	3	3	**3,0**
2.	Crop management to address water scarcity	4	3	3	3	2	3	4	4	4	**3,3**
3.	Land management to address water scarcity	4	4	2	3	2	3	4	4	4	**3,3**
4.	Replacement and appropriate selection and use of irrigation systems	5	2	3	3	3	2	5	3	3	**3,2**
5.	Adoption of strategic programming of irrigation systems for optimization of irrigation times and the volume of water (rational irrigation crops)	5	4	4	5	4	5	2	4	4	**4,1**
6.	Use of non-conventional water resources for arid and semi-arid areas	4	3	4	5	2	4	3	5	4	**3,8**
7.	Volumetric measurement of water use	5	3	3	2	4	3	3	5	3	**3,4**
10.	On-site irrigation control	5	3	2	2	4	3	3	2	3	**3,0**
11.	Implementation of precision farming	5	4	5	5	4	4	3	4	4	**4,2**
12.	Training of farmers in rational water use issues	3	4	2	3	4	5	3	4	4	**3,6**

A/A	Best practices	Relevance	Efficiency	Innovation	Impact/Effectiveness	Replicability	Strength	Accessibility	Usefulness	Sustainability	Final Rating
13.	Control and Licensing of drilling	4	3	3	2	2	3	3	3	3	**2,9**

Table 10. Evaluation of best industrial water use practices

A/A	Best practices	Relevance	Efficiency	Innovation	Impact/ Effectiveness	Replicability	Strength	Accessibility	Usefulness	Sustainability	Final Rating
1.	Use of surface cleaning equipment saving water	4	3	4	3	3	2	3	3	2	**3**
2.	Recording of industrial water quantity	2	3	2	3	3	3	2	3	3	**2,7**
3.	Employee awareness programs	3	3	2	3	4	4	3	4	3	**3,2**
4.	Control of water use in the industrial sector (rcontrol and support efficient water use)	2	3	3	3	4	3	3	3	3	**3**
5.	Use ofwater flow control devices	4	3	4	3	3	2	3	3	2	**3**
6.	Reuse of overflow water	3	4	3	4	3	3	3	4	3	**3,3**
7.	Optimization of cooling tower application	2	2	4	4	3	2	3	2	3	**2,8**
8.	Alternative water sources and reuse of industrial water	4	4	4	5	4	3	3	4	4	**3,9**
9.	Waste treatment and re-use	3	4	4	4	4	3	3	4	4	**3,7**
10.	Replacement of water use procedures by mechanical methods.	2	3	4	3	3	2	3	4	3	**3**
11.	Using cleaning machines and avoiding rubber washer	2	3	4	3	3	2	4	4	2	**3**
12.	Use water discharge control device	4	3	4	3	3	2	3	3	2	**3**
13.	Leak Detection and Repair	2	4	4	5	4	2	3	4	3	**3,4**

Table 11. Evaluation of best practices for energy use of water

A/A	Best Practices	Relevance	Efficiency	Innovation	Impact / Effectiveness	Replicability	Strenght	Accessability	Usefulness	Sustainability	Final rating
1.	Calculating the amount of water that is extracted (blow down water)	2	3	3	3	2	2	3	3	3	**2,7**
2.	Installing meters to effectively monitor water consumption	2	3	2	3	3	3	2	3	3	**2,7**
3.	Reuse of the water is extracted (blow down water)	3	4	3	4	3	3	3	4	3	**3,3**
4.	Regular checks for any leaks and losses and remedial actions	2	4	4	5	4	2	3	4	3	**3,4**
5.	Use of alternative water sources	4	4	4	4	4	3	3	4	4	**3,8**
6.	Using variable speed pumps for partial load or load after operation	2	3	4	3	2	2	3	2	2	**2,6**
7.	Converter speed usage in cooling pumps for temperature changes in the water source	2	3	4	3	2	2	3	2	2	**2,6**
8.	Increasing concentration cycles in cooling towers using water treatment	2	3	3	3	2	2	3	2	2	**2,4**
9.	Reduction in water loss due to wind velocity using impingement separators	2	2	4	3	2	2	3	2	2	**2,4**

Table 12. Evaluation of best practices in use of water in tourism

A/A	Best Practices	Relevance	Efficiency	Innovation	Impact / Effectiveness	Replicability	Strength	Accessibility	Usefulness	Sustainability	Final Rating
1.	Creating a management plan for water saving	4	4	2	3	4	3	3	4	4	**3.4**
2.	Staff training and increased customer awareness	3	4	2	3	4	4	4	4	4	**3.6**
3.	Maintenance of systems for preventing leaks	3	3	3	3	4	2	3	3	3	**3.0**

A/A	Best Practices	Relevance	Efficiency	Innovation	Impact / Effectiveness	Replicability	Strength	Accessibility	Usefulness	Sustainability	Final Rating
4.	Reducing water consumption through the use of low-power systems	3	3	4	3	4	3	3	3	3	**3.2**
5.	Effective cleaning operations	2	3	3	3	3	2	3	3	3	**2.8**
6.	Optimized small and large scale washing processes	2	3	3	3	2	2	3	2	2	**2.4**
7.	Optimized pool and spa space	2	2	3	3	2	2	3	2	2	**2.3**
8.	Reuse of rain water and "gray water"	3	4	4	3	4	2	3	4	4	**3.4**
9.	Water management in kitchens	2	2	3	3	3	2	3	3	3	**2.7**
10.	Environmental management of green spaces	2	3	3	4	4	2	3	4	4	**3.2**
11.	Monitoring water consumption	3	3	3	3	4	2	3	4	3	**3.1**

4. Selection and description of good practices according to water use

Following a thorough research in the literature on best practices for saving water for its main uses and taking into account good practices implemented within the European projects and the practices that meet most Selection criteria as mentioned in the previous paragraphs those receiving the highest score have been listed. The following present the final proposed deliverable under the BESTU project, best practices for the five main water uses.

A. WATER SUPPLY/URBAN USE	
BEST PRACTICE A1: Use of alternative water sources for uses other than potable water consumption	
DESCRIPTION	These sources include rain water collection, excess rainwater retention systems, recycling and reuse of "gray water" (domestic wastewater without the tap water from the toilets), etc. that can be used in watering gardens, municipal parks etc.
RESPONSIBLE FOR IMPLEMENTATION	Local authorities, residents

BEST PRACTICE A2: Training and awareness for behavioral changes	
DESCRIPTION	Education and awareness raising actions for citizens, students and entrepreneurs on water saving issues at home and at company level.
RESPONSIBLE FOR IMPLEMENTATION	Local authorities

BEST PRACTICE A3: Pricing system / financial incentives and penalties	
DESCRIPTION	The creation of a pricing system that includes revenue bonuses, cost-effectiveness, equal treatment of customers and relief measures for poorer customers.
RESPONSIBLE FOR IMPLEMENTATION	Water Services

BEST PRACTICE A4: Optimal irrigation practices for open spaces	
DESCRIPTION	These practices relate to both residential gardens and municipal green areas and include practices such as Water Resistant Plants, Water Reuse, Sludge and Microspray Systems, Irrigation at Night, Installation and Maintenance of New and Existing Rural Areas and Irrigation Systems,etc
RESPONSIBLE FOR IMPLEMENTATION	Local authorities, residents

BEST PRACTICE A5: Creating an institutional/legislation framework for adopting water saving	
DESCRIPTION	This framework will include rules and obligations for residential occupants regarding the use of water appliances and systems, type of appliances, general cleaning practices, etc.
RESPONSIBLE FOR IMPLEMENTATION	Local and Regional Authorities

BEST PRACTICE A6: Replacement of high water consumption devices	
DESCRIPTION	This practice concerns the replacement of water-borne devices (eg dishwashers and washing machines) with corresponding systems more efficient in saving water.

RESPONSIBLE FOR IMPLEMENTATION	Residents
BEST PRACTICE A7: Use of meters	
DESCRIPTION	Use of meters in households and at a wider level to determine the effectiveness and the implementation of water saving measures.
RESPONSIBLE FOR IMPLEMENTATION	Water supply services
BEST PRACTICE A8: Water loss control systems / leakage detection and repair	
DESCRIPTION	Implementation of leakage control systems for the water supply system and at domestic level (various water consumption devices) and immediate repair for as little water loss as possible.
RESPONSIBLE FOR IMPLEMENTATION	Water supply services and residents
BEST PRACTICE A9: Central rainwater harvesting system	
DESCRIPTION	Installation central unit rainwater collecting in the region and city, which is suitable particularly for dense urban areas and reduces the fresh water consumption and waste generation.
RESPONSIBLE FOR IMPLEMENTATION	Local authorities and water supply services
BEST PRACTICE A10: Maintenance of units	
DESCRIPTION	The maintenance of the systems will result in reducing leakage and thus water saving.
RESPONSIBLE FOR IMPLEMENTATION	Water supply services

B. IRRIGATIONAL USE

BEST PRACTICE B1: Implementation of reduced-input agriculture	
DESCRIPTION	The basic aim of low-input farming is to apply irrigation water, fertilizers and plant protection products only where and when needed to optimize crop productivity, product quality and food safety, strengthen the rural economy and reduce traceability harmful substances in the food, while reducing the undesirable effects on the environment and consequently the saving of irrigation water.
RESPONSIBLE FOR IMPLEMENTATION	Farmers

BEST PRACTICE B2: Adoption of planning strategies for irrigation systems in order to optimize irrigation times and water volume	
DESCRIPTION	Main purpose of this practice is to optimize the run time and water volume with parallel economic and environmental benefits.
RESPONSIBLE FOR IMPLEMENTATION	Local and Regional Authorities

BEST PRACTICE B3: Use of non-conventional water resources for arid and semi-arid areas	
DESCRIPTION	In arid and semi-arid regions it is suggested to use alternative water sources, such as t desalinated water, collected rainwater and treated wastewater
RESPONSIBLE FOR IMPLEMENTATION	Local authorities and farmers

BEST PRACTICE B4: Volumetric measurement of water use	
DESCRIPTION	Installation of irrigation water meters in drilling for the rational use of water by farmers, accurate pricing and determining the effectiveness of implementation of water saving measures.
RESPONSIBLE FOR IMPLEMENTATION	Local authorities, Water Services

BEST PRACTICE B5: Education of farmers in matters of rational use of water

DESCRIPTION	Implementing effective training programs in order to ensure the best and rational use of irrigation water, implementation the Code of Good Agricultural Practice (KOGP), integrated agriculture,etc.
RESPONSIBLE FOR IMPLEMENTATION	Local authorities

C. UNDUSTRIAL USE	
BEST PRACTICE C1: Alternative water sources and industrial water reuse	
DESCRIPTION	The practice involves recirculation of industrial water and after filtering the pollutants and recovering water its internal re-use. It also concerns the replacement of drinking water with alternative water supplies to improve water use efficiency.
RESPONSIBLE FOR IMPLEMENTATION	Industry
BEST PRACTICE C2: Waste treatment and re-use	
DESCRIPTION	This practice concerns the re-use of treated industrial waste in various operations taking place in industrial sites such as road spray-suppression and depends on the type of industry.
RESPONSIBLE FOR IMPLEMENTATION	Industry
BEST PRACTICE C3: Leak Detection and Repair	
DESCRIPTION	Detection and immediate leakage repair, resulting in a reduction in water consumption in the industrial sector.
RESPONSIBLE FOR IMPLEMENTATION	Industry
BEST PRACTICE C4: Reuse water overflow	

DESCRIPTION	This method has been applied to dairy industry in Northern Ireland and has resulted in the use of the overflow water in other activities within the industrial plant.
RESPONSIBLE FOR IMPLEMENTATION	Industry

BEST PRACTICE C5: Employee awareness programs	
DESCRIPTION	This practice involves the process of engaging both executives and workers in the water conservation efforts concerning the use industrial water in order to achieve the maximum benefit from water performance from this practice.
RESPONSIBLE FOR IMPLEMENTATION	Industry

D. ENERGY USE	
BEST PRACTICE D1: Use of alternative source of	
DESCRIPTION	These sources include rain water, condensation water from air-conditioning and refrigeration systems, recycled or reused water,etc
RESPONSIBLE FOR IMPLEMENTATION	Energy water user

BEST PRACTICE D2: Regular checks for any leaks and losses and restoration	
DESCRIPTION	Checks for leaks and losses and immediate restoration resulting in reduced water consumption and more efficient operation of systems.
RESPONSIBLE FOR IMPLEMENTATION	Energy water user

BEST PRACTICE D3: Reuse of the water extracted (blow down water)	
DESCRIPTION	The purpose of this practice is to reduce the consumption of potable water by utilizing the water extracted from the cooling system.

RESPONSIBLE FOR IMPLEMENTATION	Energy water user

BEST PRACTICE D4: Installation of meters and monitoring of measurement results	
DESCRIPTION	The inputs and outputs of the system must be known and quantified in order to evaluate system performance and efficiency of water-saving measures.
RESPONSIBLE FOR IMPLEMENTATION	Energy water user

BEST PRACTICE D5: Calculating the amount of water extracted (blow down water)	
DESCRIPTION	This calculation should be carried out periodically to ensure that the system continues to operate at the required level and therefore there is no over-use of water for its operation.
RESPONSIBLE FOR IMPLEMENTATION	Energy water user

E. USE IN TOURISM	
BEST PRACTICE E1: Εκπαίδευση του προσωπικού και ενημέρωση και αύξηση της ευαισθητοποίησης των πελατών	
DESCRIPTION	This practice involves actions such as, for example, provision of appropriate staff training and the use of alerts / water saving stickers in appropriate locations.
RESPONSIBLE FOR IMPLEMENTATION	Hotel business owners

BEST PRACTICE E2: Reuse of rain water and "gray water"	
DESCRIPTION	More specifically, the practice involves the installation of rainwater collection and internal distribution system, installation of separate collection of "gray water" and internal or external distribution system.

RESPONSIBLE FOR IMPLEMENTATION	Hotel business owners
BEST PRACTICE E3: Creating a management plan for water saving	
DESCRIPTION	In order to set and achieve realistic, relevant and measurable targets, thorough planning and follow-up will have to be done. The first step in creating a water saving management plan will be to measure water consumption and set specific targets.
RESPONSIBLE FOR IMPLEMENTATION	Hotel business owners
BEST PRACTICE E4 Reducing water consumption through the use of low-power systems	
DESCRIPTION	Such systems include for example installing sensors or timers for controlling the valves and showers in public spaces, installation of low flow valves and equipment with pressure regulators, low-power water systems (e.g., washing machines and dishwashers).
RESPONSIBLE FOR IMPLEMENTATION	Hotel business owners
BEST PRACTICE E5: Environmental management of green spaces	
DESCRIPTION	The management of outdoor spaces is mainly related to irrigation water use and more specifically, the adoption of efficient irrigation, regular control of irrigation equipment and immediate restoration of any leaks, installation and maintenance of efficient irrigation system, reuse of irrigation water etc.
RESPONSIBLE FOR IMPLEMENTATION	Hotel business owners
BEST PRACTICE E6: Installing sub-meters to record the consumption of water from high water consumption systems for water use analysis	
DESCRIPTION	The purpose of this practice is to assess the effectiveness of water saving measures and actions.
RESPONSIBLE FOR IMPLEMENTATION	Hotel business owners

5. Conclusions

Compared to many parts of the world, Europe has relatively abundant freshwater resources. However, these resources are not evenly distributed throughout the continent. In fact, according to estimates, about one third of the EU territory is exposed to water stress, where demand exceeds the available supply for a certain period of time. The main economic activities affecting water availability are agriculture, industry, energy production, tourism and, moreover, urban water use, which is one of the main sources of water consumption. Climate change is also expected to affect the availability of water in Europe, exerting additional pressure on southern regions already facing the water problem. Changes in water quantity or quality have a direct impact on both the local environment and the local population (European Environment Agency, 2018).

Therefore, the need for prevention and water-saving measures in all these areas is vital for the sustainability of resources. In this context, this deliverable has suggested best water saving practices for the main water uses, which could be the guidelines for local, regional or national programs aimed at the conservation and water savings actions in various sectors of water use, and is focusing on the main aspects and on issues related to the area under study.

A well-designed conservation and efficiency plan sets the stage for successful implementation of measures and practices to avoid water loss and to manage the demand for efficient water resource management. Developing such a plan and integrating it into infrastructure planning will help ensure that a service / business will optimize existing operations before considering developing additional resources for projected needs.

Also, utilities/general interest bodies should also recognize the relationship between water, sewage, storm water and energy when designing and assessing infrastructure needs and solutions, using close co-operation between all relevant services and organizations. The cost advantages of water conservation are even greater when considering the benefits of waste water costs.

inally, the EPA (Environmental Protection Agency) recommends that all stakeholders should participate in the development of efficient maintenance programs and that services / businesses should develop public approaches and education programs as part of water saving plans, programs and policies. The involvement of water user encourages the introduction of water saving measures and will increase efficiency measurement rates.

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