



SUWANU EUROPE

Deliverable 4.8

Practice Abstracts (First set of practice abstracts)

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Executive summary

Deliverable 4.8 of the SUWANU Europe is the result of the collection of water reuse initiatives and their summary in practice abstracts. These initiatives are focused the use of reclaimed water specifically intended for agricultural irrigation in Europe. The activities and results of the projects were compiled using the EIP-AGRI common format which facilitates knowledge flows on innovative and practice-oriented projects. A first set of 50 practice abstracts is presented in this report. Additional 50 practice abstracts will be presented in the further stage of the project. The outcome of this task can be consulted in an EIP-AGRI online database, accessible [here](#).

The practice abstracts are written in a concise and easily understandable way, which allows for the easy dissemination and access by practitioners, farmers, researchers and other actors, using the EIP-AGRI online database. The initiatives presented are from 9 different European countries, mostly Mediterranean, and among them there are three different Operational Groups.

1 Introduction

To enhance effective agricultural knowledge management and improve farming systems, it is important to take into consideration the dissemination of best practices, which includes developing effective knowledge infrastructure, involving different stakeholders and using appropriate information and communications technology tools in enhancing access to knowledge.

The objective of Deliverable 4.8 is to use the EIP AGRI channels to disseminate the project results, activities and related initiatives. In particular, we include here practice abstracts following EIP-AGRI common format for those initiatives identified by SUWANU Europe project and included in its project data base (available at <https://suwanu-europe.eu/database/>). Thus, we have produced a first set of 50 practice abstracts with success stories of previous and existing initiatives explained in an easy and accessible way, using the EIP-AGRI dissemination channel to achieve an effective knowledge transfer which can increase the adoption of agricultural innovations.

The purpose of this exercise is to widely disseminate water reuse success stories identified in SUWANU Europe. The EIP-AGRI brings together multiple innovation stakeholders at the EU level, such as farmers, advisers, researchers, businesses, NGOs and others. By using a common format in the form of “practice abstracts”, the EIP-AGRI facilitates knowledge on innovative, practice-oriented projects. Moreover, the use of the common format enables the farmers, researchers and advisers across the EU to contact and engage with each other. The aim of the practice abstracts is to disseminate outputs and results of the projects which are ready and relevant for practice, in a concise and easily understandable way to practitioners.

Within the Deliverable 4.8 the first set of 50 practice abstracts are presented. The rest of the practice abstracts are going to be presented following the end of the project.

The practice abstracts of the SUWANU Europe project, posted within the EIP-AGRI database, allow for an easier and effective way to promote the project activities. By using the EIP-AGRI database, the farmers, practitioners and researchers get direct access to different activities and projects which are written concisely and coherently.

2 Practice abstracts within the EIP-AGRI database

All of the the projects within the EIP-AGRI database can easily be found on the following link <https://ec.europa.eu/eip/agriculture/en/find-connect/projects>. By typing the keyword “SUWANU” in the “Fulltext search” box, visitors are guided to the SUWANU Europe project which allows visitors to explore and retrieve further information on the project information and the practice abstracts within the SUWANU Europe project, as it is shown in the Figure 1.

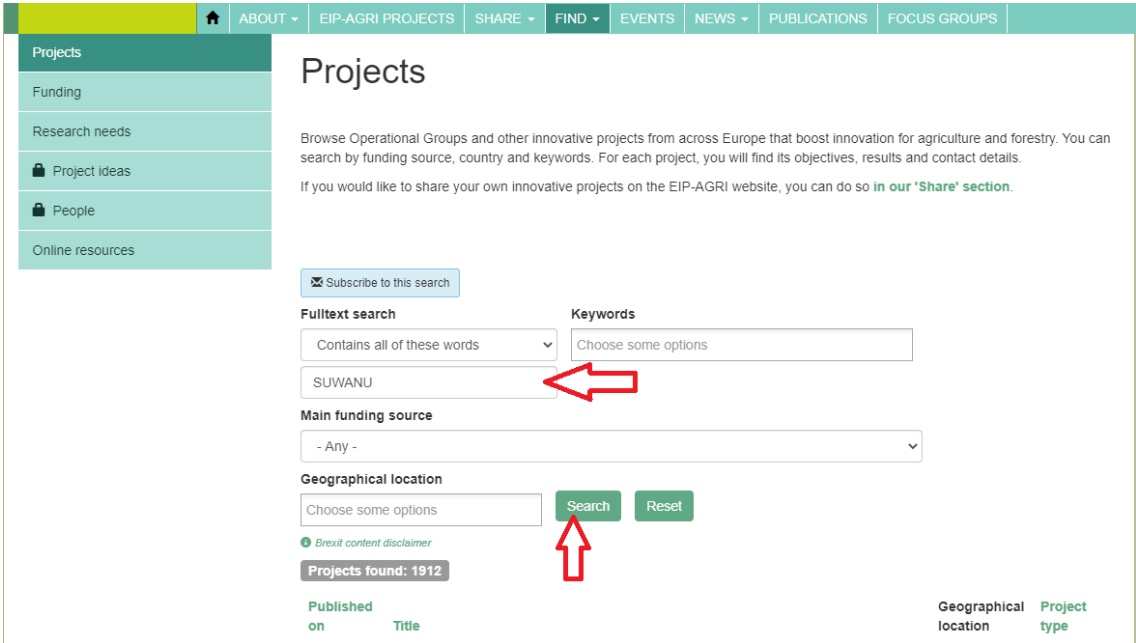


Figure 1 Searching the SuWaNu Europe’s project within the EIP-AGRI database

By the time of submission of the Deliverable 4.8., 1912 different projects have been posted within the EIP-AGRI database. The innovative projects which can be found within the database consist of Operational Groups and other innovative projects from across Europe that boost innovation for agriculture and forestry. Visitors can search the projects by funding source, country and keywords. For each project, its objectives, results and contact details are presented. Figure 2 presents the published SUWANU Europe project as shown on the EIP-AGRI website.



Figure 2 SuWaNu Europe’s project within the EIP-AGRI database

Figure 3 shows the details of the project once the SUWANU Europe project is selected by the website visitor. By clicking on the section called “Practice summary”, the section expands, and one can access the detailed information on all of the first 50 Practice abstracts published on the website.

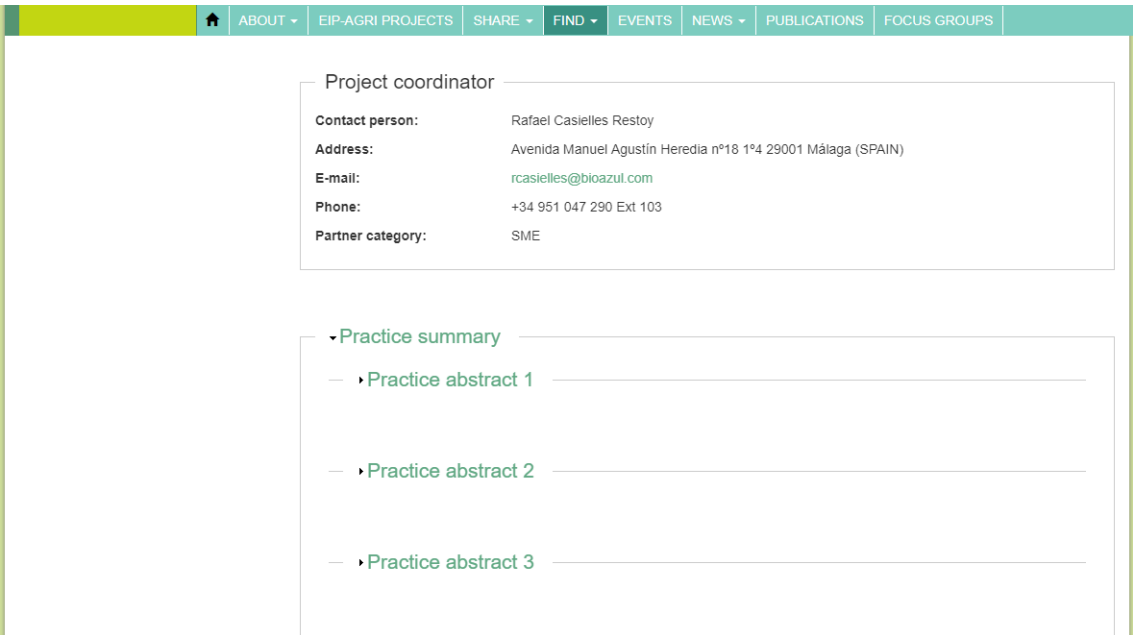


Figure 3 SuWaNu Europe’s detailed explanation

When clicking on each of the Practice abstracts numbered on the website, the practice abstract description will appear. When clicking the selected indicator, visitors will be guided towards the more detailed explanation in the expanded section, written in both English as well as the native language of the project (where applicable) which is shown in the Figure 4.

ABOUT

EIP-AGRI PROJECTS

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EVENTS

NEWS

PUBLICATIONS

FOCUS GROUPS

Practice abstract 19

Practice abstract 20

Short title (in English):

Combination of wastewater treatment technology with food production- ROOF WATER FARM

Short summary for practitioners (in English):

Roof Water-Farm combines wastewater treatment technology with food production. Hydroponics and aquaponics are used as building-integrable, water-based farming strategies.

Domestic wastewater of 250 inhabitants is separated into two different flows: blackwater and greywater. Blackwater is wastewater from toilets and greywater is wastewater from washing machines, sinks, dishwashers containing lesser contaminants. Additionally, the rainwater of 2,350 m2 roof area and 650 m2 sealed area is used.

Hydroponic modules use liquid fertilizer resulting from the black water treatment to produce plants. Aquaponics is composed of the terms aquaculture and hydroponics and refers to the combination of fish and plant production in an integrated system. Products such as carp species, salad, and strawberries showed good performance.

The Roof water farm project resulted in:

- Demonstration of cultivation technologies of water-based plant and fish production (hydroponics, aquaponics) in connection with decentralized water treatment technology of grey, black, and rainwater.
- Hygienic standards of cultivation and safety of relevant micropollutants were achieved.
- Water and product quality were good in comparison with relevant national and European specifications.
- Production of liquid fertilizer by treating black water as "gold water" for hydroponic plant production.

Short title (native language):

Kombination von Abwasserbehandlungstechnologie mit Lebensmittelproduktion- ROOF WATER-FARM

Figure 4 SuWaNu Europe’s Practice abstracts in detail

3 The Practice Abstracts

3.1. Reclaimed water for irrigation of olive trees and grapes originating from the city of Iraklion, Crete (Iraklion water reuse project)

3.1.1. English description

This project focuses on using reclaimed water to irrigate cultivated areas with grapes, mainly raisins and currants, as well as grapes for wine production and table grapes in Crete, Greece. The reclaimed water is used also for the irrigation of olive trees, located at the southwest of the city of Iraklion, but to a lesser extent. The wastewater treatment plant was initially designed in 2012 for 170.000 population equivalents. The capacity will increase to 257.000 population equivalents by 2032. The wastewater treatment plant of Iraklion receives and treats urban wastewater from the greater Iraklion town complex.

The main outcome of this project is the irrigation of 570 hectares of agricultural land from the treated wastewater. Of all the crops, 62.61% is irrigated with reclaimed water which is an advanced water reuse solution. Additional irrigation sources are water stored in reservoirs, well water and water from drilling. The main value benefit is that the cost of reclaimed water is below 0.5 euro/m³, which is making better use of alternative water sources, and is cost effective for farmers.

Wastewater treatment consists of the following elements:

- Nutrient removal - (Filtration-flocculation unit)
- Pesticide removal
- Disinfection – (microfiltration, Ultraviolet disinfection (UV) with open type channel)
- Suspended solids removal

3.2. Agricultural water reclamation of sugar refinery process water (AquaRo II)

3.2.1 English description

The project is based on agricultural water reclamation of sugar refinery process water in Uelzen, Germany. The processed water is used for irrigation purposes, since sugar beets consist of about 75% water. A large fraction of this water is used as process water, a small fraction goes as vapour to the atmosphere. The farmers using the water mostly cultivate grain, energy crops, sugar beets and rape seed. All the farmers practice rotational farming. Regarding the irrigation practice the arable land is irrigated via hose drum and sprinklers. The total farming area provided with reclaimed water is about 2,500 ha.

Wastewater treatment consists of suspended solids removal – sedimentation. The distribution system consists of a 7,5 km pressure pipe which was installed for the charging of the storage reservoir. From the storage basin to the tapping points, the water is distributed via 17 km pressure pipes.

The type of agreement is as following: the farmers of the initiative receive 30 mm/ha reclaimed water and skip in return the groundwater extraction of 10 mm/ha which is now available for non-initiative farmers. The farmers that use the irrigation network pay for each m³ irrigation water (0.20 €/m³). The costs for charging the storage reservoir are paid by the sugar refinery. The implementation costs for building storage reservoir and distribution systems were 5.2 million euros. The capital costs are 60 €/ha per year.

3.3. Water reclamation of urban wastewater in Braunschweig (Wastewater Association Braunschweig)

3.3.1. English description

The project is focused on the water reclamation of urban wastewater by the Wastewater Association Braunschweig in Germany. The wastewater source is coming from urban wastewater from Braunschweig and is treated by the Steinhof wastewater treatment plant. The reclaimed water is first distributed by gravity-flow pipes to four pumping stations located in the agricultural fields of the Wastewater Association Braunschweig. In the field itself, a with a sprinkler is used for irrigation. The farmers using the reclaimed water mostly cultivate grain, energy crops, sugar beets and potatoes. All the farmers practice rotation farming.

The area provided with the reclaimed water is about 2,700 ha. Main beneficiaries of the project are more than 100 farmers which are provided with reclaimed water. The average crop yield of grain is about 30 ton/ha, the crop yield of energy crops (maize) is about 50 ton/ha.

The operational and maintenance costs of the reclamation facility in 2018 were about 11 million euros. The irrigation system costs about 6 million euros. The farmers receiving the reclaimed water pay 80-110 €/ha.

Wastewater treatment consists of the following elements: Nutrient removal (Struvite precipitation and nitrogen stripping) and suspended solids removal.

3.4. Reclaimed water for vineyard irrigation in Mediterranean context

3.4.1. English description

The project is focusing on the reuse of treated wastewater from the Roquefort des Corbières wastewater treatment station. The reclaimed water is used to irrigate vineyards in the town of Roquefort des Corbières in France. The operator of the plant is a company called BRL group, which operates the wastewater treatment and the reclamation plant. It is also responsible for the water quality, storage and water delivery to the plots.

The wastewater flows to a buffer container with a pump which charges a storage basin. Thereafter, the wastewater is drawn from the basin using a submerged pump and undergoes filtration and chlorination. The reclaimed water is distributed via a pressurized piping system. Irrigation is then performed using subsurface drip irrigation.

The reclaimed water is applied to the crops through drip irrigation. In general, the drip irrigation system is also used to apply fertilizers (fertigation) and phytosanitary products.

Operating expenses are around 250€/Ha/year. The extent of the agricultural land benefitting from the reclaimed water is 12 ha. The irrigated area is divided in smaller plots over nine different farms. The average yield for the wineries is about 70 to 80 hl/ha.

The farmers are organized within an irrigators union and are responsible for the disinfection of the irrigation pipes at the end of the irrigation season.

3.5. Irrigation with dam recharge and reclaimed water from urban wastewater treatment plant

3.5.1. English description

The project is located in Hisarya, Bulgaria, and is using reclaimed water from an urban wastewater treatment plant with dam recharge for irrigation. The distribution system with gravitational flow delivers water for the irrigation of permanent crops, maize, and vegetables (tomato, watermelon, etc.).

The water originates from the urban wastewater treatment plant of Hisarya, which started operation in 2011. By using municipal wastewater and nutrient removal, the reclaimed water is used to irrigate food crops which are to be eaten raw, processed food crops and permanent crops

The 'Irrigation systems' EAD (Maritsa branch) supplies and sells water for irrigation, industry, and fishponds. End-users pay an irrigation cost. The Minister of Agriculture and Food determines the cost for the next irrigational season issuing an order with the approved price for the service, this is done on a yearly basis. The price for the first watering is 3.58 euro/ha (VAT excl.), while for additional water quantities the price is 0.056 euro/m³. The irrigation association uses a private pumping station to transfer water quantities between users.

Analysis of the results coming from the Wastewater Treatment Plant-Hisaryas operation shows that it is designed and built future proof. Water is cleaned biologically, and the sewage sludge is composted with wood chips and straw in the same plant, the benefit of the project is that the microorganisms can purify the water sufficiently. The modern wastewater treatment plant has all the qualities to work reliably for many years.

3.6. Development of suitable techniques for reclaimed water in rural areas (RUR'EAUX)

3.6.1. English description

The Rur'eaux project located in the commune of Saint-Jean-de-Cornies is a pilot demonstrator for irrigation using treated wastewater in an agricultural and rural context. This project led by different project partners aims to compare different techniques of disinfection for treated wastewater adapted to small communities.

The wastewater comes from the wastewater treatment plant of Saint-Jean-de-Cornies which treats domestic wastewater. The impact of treated wastewater irrigation on soils, surface waters, plants, and finished products will be monitored throughout the project.

Beyond the technical and sanitary aspects of treated wastewater, the partners involved in this project wish to carry out agronomy monitoring on 3 identified uses:

- shared garden irrigation (drip);
- fodder irrigation;
- irrigation to produce biomass (wood).

The results obtained will enable to orient the actors (users and elected officials) in their choices of tertiary disinfection technology to reuse wastewater from vertical reed beds filters. Main expected outcomes of the project are to:

- **Test** different treatment channels, irrigation, and storage methods for mobilizing treated water
- **Validate** the relevance of the treatment technologies deployed on the pilot site, health, and agronomic monitoring protocols in order to establish good practices

- **Broadcast** the results of the experiments carried out, in order to duplicate this type of project in other rural areas in France

3.7. Demonstration of vineyard irrigation with reclaimed water (IRRI ALT'EAU)

3.7.1. English description

The project consists of reusing the treated wastewater from the Narbonne Plage which is operated by Veolia. A second wastewater treatment plant has been considered but finally aborted because of a high salinity content due to saltwater intrusion into the sewage network. Reclaimed water is distributed through a pipe network to the plots and the beneficiaries are intensively cultivated vineyards (wine production).

Results of the social acceptability study

- The results of the survey in the form of a questionnaire indicate good social acceptability for producers (technical and economic necessity) distributors (guarantee of wine quality, safety) and consumers.
- The different actors do not seem to be opposed to the project but request objective data, as well as educational communication adapted to each actor.

Strengths of the project:

- No additional withdrawals from natural water resources.
- A controlled, available resource (no conflict of use, no risk of restriction/water cut).
- The treated wastewater contains more nutrients for the development of the grapevine: "fertigation" than conventional water (groundwater or surface).

Encountered difficulties

- Cost of tertiary treatment processes works necessary to respect the quality levels imposed by regulations. This cost is increased tenfold because of desalination, in the case of the Gruissan station *
- Social acceptability of consumers.

* The salinity rate of the water from the Gruissan station is too high due to its location near the coast (contamination by seawater) and an insufficiently tight collection network. Desalination must, therefore, be carried out before disinfection.

3.8. Treated effluent as alternative water resource for greenhouses (Delft Blue Water)

3.8.1. English description

Delft Blue Water (DBW) is a project investigating purified urban water as an alternative source for the freshwater supply in the Delfland region. At the Harnaschpolder wastewater treatment plant near Den Hoorn, DBW used innovative technologies to investigate how high-quality irrigation water for greenhouse horticulture can be produced and at what cost. The possibility was also investigated to flush saline-filled ditches in Delfland with highly purified urban water.

As part of the research, tomatoes were grown in a 180 m² greenhouse, half of which received rainwater and the other half received class 1 irrigation water from DBW. Both water systems were separate. The researchers closely monitored water quality. In addition, they followed the development of the plant and tomato on crop growth, production, plant health and food safety.

Measurements have been made in the areas of (I) food safety, (II) plant health and (III) crop growth and crop production. These extensive measurements indicate that there is no significant difference between the two types of irrigation water sources – rainwater and the treated wastewater. The only exception to this is the sodium content measured during leaf and fruit analyses. The tomatoes grown on Delft Blue Water irrigation water contain on average 25% less sodium than the tomatoes irrigated with rainwater. The demonstration research has shown that the Delft Blue Water irrigation water is of high quality and is suitable for growing crops. This makes Delft Blue Water a potential alternative irrigation water source for the Delfland region.

3.8.2. Dutch description

Onder de naam Delft Blue Water (DBW) is onderzocht of gezuiverd stedelijk water kan dienen als een alternatieve bron voor de zoetwatervoorziening in de regio Delfland. Met innovatieve technologieën heeft DBW op de afvalwaterzuivering Harnaschpolder bij Den Hoorn onder andere onderzocht hoe hoogwaardig gietwater voor de glastuinbouw kan worden geproduceerd en tegen welke kosten. Ook is de mogelijkheid onderzocht om met vergaand gezuiverd stedelijk water verzilte sloten in Delfland door te spoelen.

Als onderdeel van het onderzoek werden in de Demokwekerij Westland in een 180 m² grote kas tomaten geteeld, waarvan de helft regenwater en de andere helft klasse 1 gietwater van Delft Blue Water kreeg. Beide watersystemen waren volledig gescheiden. De onderzoekers monitorden de waterkwaliteit nauwgezet. Daarnaast volgden zij de ontwikkeling van de plant en tomaten op gewasgroei, productie, plantgezondheid en voedselveiligheid.

Metingen hebben plaatsgevonden op het gebied van (I) voedselveiligheid, (II) plantgezondheid en (III) gewasgroei en -productie. Deze uitgebreide metingen wijzen uit dat er geen significant verschil tussen beide type gietwaterbronnen te zien is. Enige uitzondering hierop is het natriumgehalte dat gemeten is tijdens de blad en vrucht analyses. De tomaten die geteeld zijn op het DBW gietwater bevatten gemiddeld 25% minder natrium dan de tomaten geteeld op bassinwater. Met behulp van het demonstratieonderzoek is aangetoond dat het DBW gietwater van hoogwaardige kwaliteit is en geschikt is voor de teelt van gewassen. Daarmee is met Delft Blue Water een potentiële alternatieve gietwaterbron voor de regio Delfland gevonden.

3.9. Integrated Water Reclamation and Reuse (IWRR) Management Plan of Vitoria-Gasteiz

3.9.1. English description

The limited water resources available in Vitoria-Gasteiz watersheds during the summer season severely limit agricultural irrigation of the surrounding fertile plains. The lack of local aquifers capable of storing winter precipitations has traditionally resulted in strong competition for the highly regulated surface water flows assigned for drinking water supply. The Delfín Water Reclamation facility (entrusted to the Arrato Irrigation District) receives biological secondary effluent produced by the nearby wastewater treatment facility of the city of Vitoria-Gasteiz in

Spain. The reclaimed water is used for irrigation during the summer season of 10,000 ha of mostly processed vegetables (peas, beans and potatoes).

An irrigation pipe network was built to distribute the reclaimed water. The reclaimed water flow was initially allocated for irrigation of 4,000 ha (1,300 ha effective each summer season, under a once-every-three-summers regime) by continuous operation during the summer season. Optimal yearly operation of the water reclamation facility was limited by the ability of the system to store the reclaimed water produced during the fall, winter and spring seasons. In 2005, an off-stream storage reservoir of 7 hm³ was built within the limits of the irrigation area, to collect and store the reclaimed water flows produced during the non-irrigation season, so they could be used for irrigation during the summer season. However, several technical deficiencies were detected during the initial operation of the reservoir, preventing it from getting operational. That condition has kept the initial limit of 4,000 ha as the maximum surface area that can be currently irrigated with reclaimed water during the summer season.

3.10. Water and agricultural research platform. Low-cost water desalination and sensor technology compact module – DESERT

3.10.1. English description

The DESERT-prototype, a combination of water treatment technologies based on filtration and solar-based renewable energy, was employed to reclaim water for agricultural irrigation. Water reclaimed through the DESERT-prototype was employed to cultivate crops of farmers in the agricultural initiative in Campo de Cartagena in Spain, using drip and sprinkler irrigation methods. The Irrigation District of Campo de Cartagena has 10,000 members and covers 40,000 ha of irrigated land. Treated wastewater effluent has an urban origin and is mainly coming from small towns and golf courses in the area.

The treated effluent from the Roldán-Balsicas wastewater treatment plant is reclaimed using a prototype module and then used for agricultural irrigation by the Irrigation District of Campo de Cartagena. Cultivation techniques include horticultural crops (59 %), citrus trees (30 %), fruit trees (4 %) and greenhouses (7 %). Greenhouses cover about 1,300 ha of irrigated land, with most of that surface devoted to pepper cultivation; the rest of the crops are zucchini, tomato and flowers.

Main outcomes:

- Absence of pathogens and insignificant risks of infection in all DESERT water exposure scenarios
- Water quality levels, agronomical quality of crops, and health risk assessments all show that the DESERT prototype is appropriate add-on technology for safe water reclamation.
- Recontamination and cross-contamination can be prevented with the drip and sprinkler irrigation technique which supports and complements the DESERT reclamation technology in reaching the safety targets

Recommendation

- Public acceptance is a crucial factor for the success of the project and relies on appropriate risk communication and management

3.11. Agricultural irrigation with reclaimed water in Cartagena- Irrigation District no. 557 'Isidoro García Ráez'

3.11.1. English description

The project focuses on Agricultural irrigation with reclaimed water in Cartagena, Spain. The Irrigation District no. 557 'Isidoro García Ráez' has been using reclaimed water for more than 20 years, together with conventional sources of surface water available in the area. The most abundant food crops cultivated are horticultural crops like potatoes, broccoli, lettuce, celery, artichokes, and cauliflower that cover more than 60 % of the cultivated land, and citrus and olive trees that cover about 30 %. Orchards are managed under an intensive cultivation plan and water is provided by drip irrigation.

The main conclusions reached during the first crop season were:

- 1) High rainfall was recorded to evaluate the equipment which detects rapid changes of salinity and nutrients
- 2) Distribution of rainfall observed during the crop cycle resulted in great uniformity among plots, so it prevented the detection of any influence of water use on final production and masking the potential negative effects of salinization
- 3) There were some correlations found regarding the salinity indexes, which resulted in making additional soil and plant analyses and drone flights, to determine which salinity index provides the best results
- 4) Farmers should adopt the practice of applying an intense irrigation period after each crop cycle, to leach out the salts deposited and avoid its accumulation

To practice intensive and profitable agriculture, which is also respectful of the environment, innovative agricultural irrigation projects need to be implemented that use non-conventional water resources, such as reclaimed water, together with advanced information technologies.

3.12. First application and market introduction of combined wastewater treatment and reuse technology for agricultural purposes (RichWater)

3.12.1. English description

The RichWater approach is a highly promising method to save fresh water and fertilizers in agriculture by treating municipal wastewater, reusing it for irrigation purposes while keeping valuable nutrients in the effluent. Implementing the system in the agricultural production process results in an eco-friendlier use of water resources, cost savings for freshwater and fertilizer and the possibility for a commercial food producer to adjust the fertigation unit for individual needs using a mixture of fresh and treated water.

The experimental test site is less than one hectare. There is a strong involvement of the local community of irrigators, the 'Community of Irrigators' of Algarrobo which has a total irrigated area of 757 ha and includes 547 farmers. The reclaimed water is used to irrigate avocados, mangos and tomatoes. The RichWater approach is based on the upgraded technology from the Treat&Use system, of which the main results are:

- Results of crop production and yield are the same between using treated wastewater and clear water
- Use of wastewater for irrigation permits to save valuable water resources (e.g. aquifers)

- Low values of pathogens in water and fruit proof that TREAT&USE is a safe technology for wastewater reuse in agriculture
- The prototype can be upscaled to higher production rates, including the food industry uses
- It's technically possible to use wastewater directly from the sewer and provide it with the appropriate quality required by legislation
- The use of wastewater reduces the needs of additional fertilizer
- Low Operation and Maintenance and high automated control system allow an easy operation of the end-user with relatively low annual costs

3.13. Production and use of Waters for Reuse (ApR) in Alentejo irrigation- REUSE

3.13.1. English description

REUSE consists of a demonstration pilot for reclaiming water using technologies of treatment to reduce operational costs and increase its use in irrigation. The urban wastewater comes from the Wastewater Treatment Plant of Beja (Alentejo, Portugal). This distribution system consists of one mainline and one container. One farm (with pomegranate orchards) is irrigated with reclaimed water within the framework of a demonstration pilot of 0.5 ha by drip irrigation. Promotion and awareness campaign were made to promote water use efficiency in irrigation and demonstration of success cases in the reuse of water.

Main results and outcomes have been found out of the projects own research:

- The feasibility of using solar equipment in tests for solar disinfection of urban wastewater for irrigation purposes was verified.
- Laboratory and pilot tests have achieved load reduction values consistent with the quality objectives required for practical use.
- High synergistic effect on wastewater disinfection with UVA and UVB radiation, and the infrared radiation that increases the water temperature, accelerating the disinfection process.
- The temperatures reached through the panels have considerably reduced the disinfection times required.

3.14. Novel Methodology for the Promotion of treated wastewater reuse for Mediterranean crops improvement- MeProWare Portugal

3.14.1. English description

Treated wastewater was collected from a wastewater treatment plant situated in Lisbon. The wastewater treatment plant has primary, secondary and tertiary treatment. Sample collection was performed daily after a UV disinfection process and delivered for analyses on the same day. The experimental study site consists of two irrigation treatments (treated wastewater irrigation and water irrigation), each supplied to three contiguous vineyard rows. The irrigation system utilizes drip irrigation for irrigating the grapevines (Arinto variety) with the freshwater flow of 2.5 l/h.

Main results and recommendations

- Despite the differences observed in terms of quality between treated wastewater and conventional water, the evolution of water in the soil over time has remained the same in both plots.
- Despite the difference in water quality concerning the electrical conductivity of the soil, the values recorded by the probes do not present significant differences between the plots irrigated with conventional water and treated wastewater.
- In terms of crop monitoring, there were no differences in vegetative growth and berry quality
- Based on the results obtained in the 2018 vegetative cycle, it is concluded that irrigation of the vine with Treated Wastewater needs further studies. Although there are no differences in the results observed between grapevines irrigated with Treated Wastewater and conventional water, it will be important to continue with the tests on the “Demo Site - ISA” to verify the cumulative effect, both in soil, plant (Ecophysiology) and the final quality of the berry.

3.15. Novel Methodology for the Promotion of treated wastewater reuse for Mediterranean crops improvement- MeProWare Italy

3.15.1. English description

The experimental trial in Italy takes place in Acquaviva delle Fonti, a town in Apulia region, known for its table grapes and olives. Three water qualities are used for the drip irrigation of 2 to 3 ha of both the olive grove and the table grape orchard selected for the field trial: underground water from local wells treated wastewater from the municipal wastewater treatment plant and a blend of the two kinds of water, customized for optimal nutrient dosage.

Recently, the Apulia Region funded the construction of four reservoirs coupled with pumping units to achieve mixing of well water with treated wastewater from the wastewater treatment plant. These premises are managed by the agricultural cooperative La Molignana, whose members are local farmers participating actively in the project.

The Wastewater Treatment Plant effluents are delivered to a distribution system recently built by the municipality to serve a local cooperative of farmers (Cooperativa “La Molignana”). However, before connecting the plant to the distribution system some extra works were carried out to protect the irrigation network from possible malfunctioning/floods of the wastewater treatment plant. In particular, sluice gates were connected with turbidity probes placed at the outlet of the plant, to deviate the effluent to the normal discharge in case of lowered effluent quality.

The overall quality of the tertiary effluent is very high both in terms of microbiological and chemical-physical characteristics. Compared with the well water, the tertiary treated effluent has a higher content of organic substances and nutrients useful for plants growth.

3.16. Water reclamation for hydroponic system- HypoWave

3.16.1. English description

Municipal wastewater is treated with different processes to such an extent that it can be used to irrigate and fertilize lettuce in a hydroponic greenhouse. The first results show that good

growth of the lettuce plants can be achieved even with low nutrient concentrations in the water. Nitrogen, phosphorus and other nutrients can be provided from the wastewater and unwanted substances, in particular anthropogenic trace substances, micropollutants or pathogens, can be reduced.

The pilot plant and several case studies have shown the potential of the HypoWave process as an alternative cultivation method. With the reclaimed water of small communities of 500 and 1,650 person equivalent, an economic production can be achieved on 3,600 and 6,000 m².

Results of the main potential of the HypoWave project

- The efficient use of water in a hydroponic system can be up to a factor of 4-5 higher than in conventional agriculture.
- The system is free of nutrient losses, which means that conventional fertilizers can be substituted accordingly.
- Cultivation under low nutrient concentrations is possible.
- Possible savings in wastewater treatment

The use of hydroponic systems is currently viewed rather critically by many of the farmers surveyed, since farms have already invested in an efficient irrigation technology or because they do not want to take risks. For this reason, the case study also focuses on alliances in collaborative solutions. In addition to water availability, incentives can include unfavourable soil conditions, sustainable land use, increasing agricultural yields or expanding the product range. Also, water reuse offers certain security of supply, particularly during the increasingly dry and low-precipitation summer months.

3.17. Water reclamation of urban wastewater in Wolfsburg (Wolfsburger Entwässerungsbetriebe)

3.17.1. English description

The wastewater treatment plant Stahlberg (Wolfsburg, Germany) treats the urban wastewater coming from 90,000 households in Wolfsburg. In addition to wastewater from urban households, there are several indirect discharges like hospitals and dental surgeries. Most of the cities sewerage uses a separate system but a part of the city centre of Wolfsburg has a combined system which leads to a mixture of household wastewater and stormwater. The wastewater treatment consists of Nutrient removal (Struvite precipitation). The reclaimed water coming from the wastewater treatment plant Stahlberg is first distributed to farmers. The farmers using the reclaimed water mostly cultivate grain (40 %), energy crops (30 %), sugar beets (10 %) and rapeseed (10 %). All the farmers practice rotating farming. The reclaimed water is irrigated via a hose drum. The irrigation with reclaimed water is demand-oriented. The area provided with reclaimed water is about 1,550 ha. Wolfsburg drainage companies (Wolfsburger Entwässerungsbetriebe) provide farmers with reclaimed water. The farmers are fully responsible for the operation and maintenance of the distribution and irrigation system. Due to restrictions regarding micro pollutants, the irrigation with reclaimed water must be demand-oriented.

3.18. Modular wastewater treatment for aquaponic system- AWAREGIO

3.18.1. English description

Awaregio consists of modular wastewater treatment processes for the reuse of wastewater, nutrients and energy as an opportunity for small and medium-sized enterprises (SMEs).

A modular research plant including aquaponics and hydroponics was built on the area of the wastewater treatment plant “Moers Gerdt”. The wastewater treatment plant receives the municipal wastewater from 190,000 population equivalents including industrial wastewater. The modular research plant receives wastewater from the primary treatment stage. The initiative is an experimental small-scale set-up. The distribution system is developed in such a way that water can be provided to the 3 pilot sections. At the demonstration site, nutrient rich water from pisciculture (fish) is used to fertilise plants in an ebb and flow hydroponics system (plant production). After biological treatment (nutrient removal), the nutrient-poor water is recirculated. The modular research plant can produce various reclaimed water qualities adapted to the farmer’s need. Farmers with interest in aqua- and hydroponics are the main target group of the technology. The initiative’s focus was on the elaboration of a modular pilot plant which can produce different water qualities depending on the field of application. The pilot plant can deliver water for the following purposes: aquaponic fish farm, hydroponic market gardening and agricultural irrigation. The maximum flow rate of the pilot plant was 6 m³ per day.

3.19. Agro-industrial wastewater for irrigation- HYDROREUSE

3.19.1. English description

The main objective of the HYDROREUSE project is to develop new alternatives for the management of the main agro-industrial wastewater produced in the Alentejo region. For this purpose, an innovative treatment/reuse line was introduced that comprises low-cost and environmentally friendly technologies, namely new pre-treatment, innovative dual-function hydroponic system and oxidation. This approach allows for the recycling of water, organic matter and nutrients from pre-treated agro-industrial wastewater using a hydroponic system for the growth of tomato plants, which reduces the costs associated with commercial fertilization and allows the treatment of wastewater. The HYDROREUSE project operates in different and important sectors, namely, in the management of agro-industrial wastewater by reducing the pollution of these effluents through a biological system. Another important area comprises water management in agriculture, providing new sources of water and nutrients in regions characterized by a drought crisis such as the Alentejo region. This project also focuses on environmental sustainability through the reuse of pre-treated wastewater. The characterization of the fruits obtained in a hydroponic system fed with pre-treated agro-industrial wastewater will allow for determining the impact of this strategy on the quality of tomatoes and public health, and consequently the feasibility of reusing wastewater in the production of food crops.

3.19.2. Portuguese description

O principal objetivo do projeto HYDROREUSE é desenvolver novas alternativas para a gestão das principais águas residuais agroindustriais produzidas na região do Alentejo. Para o efeito, uma linha de tratamento/reutilização inovadora será proposta que compreende tecnologias de baixo custo e amigas do ambiente, nomeadamente pré-tratamento novo, sistema hidropónico de dupla função inovador e oxidação. Esta abordagem permitirá a reciclagem de água, matéria orgânica e nutrientes a partir de águas residuais agroindustriais pré-tratadas utilizando sistema hidropónico para o crescimento de plantas de tomate, o que diminui os custos associados à fertilização comercial e permite o tratamento de águas residuais. O projeto HYDROREUSE atua em setores diferentes e importantes, nomeadamente, na gestão de águas residuais agroindustriais por redução da poluição destes efluentes através de sistema biológico. Outra

área importante compreende a gestão de água na agricultura, fornecendo novas fontes de água e nutrientes em regiões caracterizadas por crise de seca como é o caso da região do Alentejo. Este projeto também foca a sua ação na sustentabilidade ambiental através da reutilização de águas residuais pré-tratadas. A caracterização dos frutos obtidos em sistema hidropónico alimentado com águas residuais agroindustriais pré-tratadas permitirá determinar o impacto desta estratégia sobre a qualidade do tomate e saúde pública, e consequentemente a viabilidade da reutilização de águas residuais na produção de culturas alimentares.

3.20. Combination of wastewater treatment technology with food production- ROOF WATER FARM

3.20.1. English description

Roof Water-Farm combines wastewater treatment technology with food production. Hydroponics and aquaponics are used as building-integrable, water-based farming strategies.

Domestic wastewater of 250 inhabitants is separated into two different flows: blackwater and greywater. Blackwater is wastewater from toilets and greywater is wastewater from washing machines, sinks, dishwashers containing lesser contaminants. Additionally, the rainwater of 2,350 m² roof area and 650 m² sealed area is used.

Hydroponic modules use liquid fertilizer resulting from the black water treatment to produce plants. Aquaponics is composed of the terms aquaculture and hydroponics and refers to the combination of fish and plant production in an integrated system. Products such as carp species, salad, and strawberries showed good performance.

The Roof water farm project resulted in:

- Demonstration of cultivation technologies of water-based plant and fish production (hydroponics, aquaponics) in connection with decentralized water treatment technology of grey, black, and rainwater.
- Hygienic standards of cultivation and safety of relevant micropollutants were achieved.
- Water and product quality were good in comparison with relevant national and European specifications.
- Production of liquid fertilizer by treating black water as "gold water" for hydroponic plant production.

3.20.2. German description

Roof Water-Farm kombiniert die Abwasserbehandlungstechnologie mit der Lebensmittelproduktion. Hydroponik und Aquaponik werden als wasserbasierte Landwirtschaftsstrategien verwendet, die in das Gebäude integriert werden können.

Das häusliche Abwasser von 250 Einwohnern wird in zwei verschiedene Flüsse unterteilt: Schwarzwasser und Grauwasser. Das Schwarzwasser ist das Abwasser aus Toiletten und das Grauwasser ist das Abwasser aus Waschmaschinen, Waschbecken und Geschirrspülern, die weniger Verunreinigungen enthalten. Zusätzlich wird das Regenwasser von 2.350 m² Dachfläche und 650 m² versiegelter Fläche genutzt.

Hydroponik-module verwenden den Flüssigdünger aus der Schwarzwasserbehandlung zur Herstellung von Pflanzen. Die Aquaponik setzt sich aus den Begriffen Aquakultur und Hydroponik

zusammen und bezieht sich auf die Kombination von Fisch- und Pflanzenproduktion in einem integrierten System. Produkte wie Karpfenarten, Salat und Erdbeeren zeigten eine gute Leistung.

Das Projekt Roof Water-Farm führte dazu:

- Demonstration von Anbautechnologien wasserbasierter Pflanzen- und Fischproduktion (Hydroponik, Aquaponik) in Zusammenhang mit dezentraler Wasseraufbereitungstechnologie von Grau-, Schwarz- und Regenwasser.
- Hygienestandards für Anbau und Sicherheit relevanter Mikroverunreinigungen wurden erreicht.
- Die Wasser- und Produktqualität war im Vergleich zu den einschlägigen nationalen und europäischen Spezifikationen gut.
- Die Herstellung von Flüssigdünger durch Behandlung von Schwarzwasser als "Goldwasser" für die hydroponische Pflanzenproduktion.

3.21. Water reuse for olive groves in Malia and Stalida, Crete

3.21.1. English description

The wastewater is coming from households and urban use which is received by the treatment plant in operation since 2008. The treatment plant receives the municipal sewage of the city of Malia, and Stalida coming from households and urban use. There is a storage tank where tertiary and disinfected irrigation water is stored. The pipeline irrigation system is of short length (approximately 500 meters) since the irrigation areas are next to wastewater treatment plants.

The final effluent is foreseen for the irrigation of olive trees, as well as greenery and ornamental plants. All areas use drip irrigation, there is no extensive irrigation, and it is mostly seasonal. The total irrigation area is 1,005 hectares.

The Wastewater Treatment Plant owner is the Water and Sewer Municipal Company of Hersonissos. The plant is operated by a concessionaire company which has the responsibility of:

- the operation, maintenance of installations and infrastructure,
- the maintenance and transfer of dehydrated sludge,
- daily, weekly and monthly follow-up reports,
- the 24-hour monitoring of the operation,
- the observance of safety and health measures,
- and the laboratory analyses

The owner has the responsibility of reclaimed water distribution works. The cost of reclaimed water is estimated to be less than 0.3 euro/m³.

Wastewater treatment consists of nutrient removal (Activated sludge treatment system, nitrification-denitrification, phosphorus removal), disinfection (UV and chlorination in effluent disposal treatment tank), and suspended solids removal (Aeration, secondary sedimentation).

3.22. Irrigation of vineyards with reclaimed water in Valflaunès

3.22.1. English description

The wastewater source in this project is the reclaimed municipal wastewater from the Valflaunès (France) wastewater treatment plant. The project consists of two stages, stage one will spread over two years. During this stage, the use of reclaimed water in vineyards will be demonstrated. In the second stage, the implementation of reclaimed water will further be extended to the remaining 12 ha of vineyards. The distribution system is 1,000 meters long: 500 meters for delivering water to the stage one plots and 500 meters more to reach the stage two plots. The entire distribution system will be pressurized. The wastewater treatment consists of nutrient removal, disinfection (Reed bed filter, UV disinfection and a Lagoon) and suspended solids removal (Disk filtration is used for suspended solids removal). The farming system is conventional vineyards which are equipped with drip irrigation.

Agricultural beneficiaries will cover a total of 14 ha: 2 ha in stage 1 (2020) and 12 ha in stage 2 (2022). Operating expenses are 100 000€ (for stage 1 of the project) and 200 000€ (for stage 2 of the project). The project has been put on hold as the profitability is too difficult to reach even stage two.

3.23. Reuse of reclaimed water coming from a centralized treatment plant for domestic septic tanks wastewater

3.23.1. English description

The wastewater treatment plant receives water with some sludge from individual septic tanks and a small collective wastewater treatment installation. The reclaimed water is stored in a 140 m³ storage tank before primary treatment. The water is afterwards distributed via a pressurized piping system that is around 2 km long to the plots. Irrigation is then performed using nozzles and micro-sprinklers delivering one feeding point for each tree. The farming system consists of forestry plantation (primarily poplar and eucalyptus) and the area irrigated with reclaimed water is about 3.2 ha. The fields belong to the community which is also the owner of the wastewater treatment plant. The fields supply firewood to the communal heat production plant.

The wastewater treatment consists of nutrient removal (treatment on reeds beds with a total surface area of 2,600 m²) and suspended solids removal (primary treatment with a central grooved disc filter). The system produces 6,300 m³ of reclaimed water each year.

The investment cost of the project is 1.72 million euros, while the maintenance cost comes at 31,000 euros/year. The energy expenses add up to 14,000 euros.

This project has several environmental benefits such as reducing sludge transport (100 to 120 km per day), avoiding direct discharge, and reducing surface water withdrawals.

3.24. New process for Optimizing Wastewater reuse from Mauguio to the Mediterranean Area- NOWMMA

3.24.1. English description

The NOWMMA project has the aim to develop a complete pathway of wastewater reuse in France, in answer to the regional authorities and the international level demands, notably amongst the Mediterranean basin. The water comes from the Mauguio domestic wastewater treatment plant, no industrial wastewater is connected. Reclaimed water was sent to the test fields by use of a very small distribution network of fewer than 50 meters in length. The irrigated plot is subdivided into three blocks each supplied with different water quality. Two water qualities come from the treatment unit, while the other represents a reference water quality for

the region. Irrigation application methods are tested on each block with a drip (below and above ground) and sprinkler irrigation.

The cost of the project is 2,887,000 euros over 3 years.

The project provided the major results regarding:

- water reclamation technologies performances
- drippers clogging
- Aspersation irrigation of aerosol

Over time, the expected results will permit to propose:

- An adjustable and exportable pathway to the whole Mediterranean basin with expertise acquired by all the partners.
- A group of products quickly marketable in the three next year following the project, accompanied by their “business model” and with a “roadmap”, which will be considered as decision support.
- Interaction with the regulations in France, Europe with the development of ISO norms for the wastewater reuse.

3.25. Reuse of reclaimed water for corn irrigation- SmartFertiReuse

3.25.1. English description

The SmartFertiReuse project is based on smart reuse fertigation solutions to simultaneously optimize crops demand for water and fertilizers, for better agricultural productivity at a lower environmental footprint. The solution will optimize fertilizer dosing and the quantity of treated municipal wastewater used for crops irrigation based on complex monitoring of soils and water (e.g. physicochemical and microbiological analysis for an environmental and health risks assessment), crops (e.g. crop growth observations and measurements, yield measurements just before harvest) and fertilizers. This smart solution will rely on a set of probes and on-line monitoring devices strategically distributed across the scheme (i.e. both in the ground and water) linked to a central management system. Operators will be able to run and adjust the fertigation system through a digital dashboard allowing for optimum fertigation conditions.

The service integrates the process chain which goes from the design of an operational system to deployment and piloting on the plot: production and distribution of water, irrigation management according to the needs of plants, monitoring, and control the quality of irrigation water. To do this, the wastewater leaving the factory is treated again via an additional system to ensure water quality that meets the criteria required, relating to the use of water from the treatment of urban wastewater for the irrigation of crops or green spaces. Agronomic monitoring at plant and soil levels makes it possible to adjust the dose of fertilizer according to the needs of the crops and the stage of development. At the same time, weather forecasts make it possible to assess the need for irrigation based on future rainy events.

3.26. Experimental site of Murviel-lès-Montpellier

3.26.1. English description

The reclaimed water originates from the domestic wastewater from Murviel-lès-Montpellier (France). The wastewater treatment plant is operated by SUEZ. A lagoon is used as storage, and

there is also a 4 m³ container for the temporary storage of small volumes. The water is distributed with pressurized pipes having a total length of just less than 1 km.

The experimental site contains various cropping systems. There are vegetables eaten raw such as salad or leek. They are grown on a raised bed under glass, as well as fruit trees (olive trees) and vineyards. The wastewater treatment consists of disinfection (micro-filtration) and suspended solids removal (lagoon-based system). The daily amount of cleaned water is around 200 m³. The experiment concerns two experimental sites: one plot where water is applied under controlled conditions (soil tanks) and an agriculture field under real conditions of 0.5 ha.

The agronomic performance of wastewater irrigation on lettuce and leek as well as crops and soil contamination by the reclaimed water:

- Soil: Increased salinity and problems for sensitive plants in time
- Nutrients: Accumulation of nitrogen in the soil which led to better crop yield. But this shows risks for the environment due to nutrient leaching
- Crop yield: Lettuces that were treated with wastewater treatment have a fresh mass more important of 40% than drinking water and 20% than raw wastewater. Leeks which were treated with wastewater treatment have a fresh mass more important of 50% than drinking water and 20 % than raw wastewater
- Microbiology: (for raw wastewater) : The decay of E. Coli in topsoil is low.
Internalization in the case of raw wastewater: E.Coli was present in lettuce and leek roots but not in the edible parts of the plants

3.27. Water reuse in the distillation process of essential oils in Trakia Land Distillery

3.27.1. English description

The distillation process of the rose blossoms produces liquid wastewater and solid waste. The wastewater originates from the following process streams:

- of rose blossom (rose marble)
- of cleaning water of equipment and premises. The water is discharged to the mixer tank via the building sewer
- wastewater from the boiler (used to extract the oils). The water is relatively clean but has a high temperature

The treated wastewater is collected in a tank. For a 90-day irrigation season, 360 m³ of reclaimed water is used for irrigation of ornamental shrubs and grasses in the property where the facilities of the distillation and extraction plant and the treatment plant are located. The total irrigation area of the grass and shrubs is 0.1 ha. The rest of the water is transported to a reservoir via a centrifugal pump and a pipeline of about 415 meters. The water is used to irrigate plantations of essential oil plants. Irrigation of herbaceous essential oil plants is done by sprinklers before and after each mowing. The reuse of water reduces the use of groundwater.

The farm cultivates essential oil crops such as roses, herbaceous oil plants that are irrigated with reclaimed water during the rose picking campaign. Some of the treated water is used for irrigation of ornamental shrubs and lawns. In total 8.5 ha of land is irrigated using reclaimed water.

The wastewater treatment consists of suspended solids removal. A separator removes the large amounts of oil and suspended solids from the wastewater. It is followed by a coagulation process, separating the insoluble matter. The quality of wastewater, after purification from the treatment plant, meets the quality requirements for irrigation water of agricultural crops according to Bulgarian legislation.

3.28. San Michele di Ganzaria phytodepuration plant

3.28.1. English description

Municipal wastewater is collected from the houses of San Michele di Ganzaria (Sicily). Due to the strict Italian laws regarding the use of reclaimed water and the extremely tight limits for water quality, it was necessary to adopt a method of tertiary treatments downstream of conventional wastewater treatment plants. Which is why Constructed wetlands were adopted, as a natural wastewater treatment system simulating natural wetlands, combined with conventional treatment plants.

The tertiary treatment included two horizontal subsurface flow constructed wetlands. The phytodepuration process (natural purification processes happening in natural wetlands) is monitored for water quality by chemical and microbiological parameters. The reclaimed water is used for irrigation of 80 ha, serving 10 local farms. The treated water is pumped to a nearby uphill reservoir, and from there distributed through underground pipes.

Scientific findings and recommendations for horizontal subsurface flow Constructed Wetlands:

- Efficient in removing the main chemical and physical pollutants
- Microbiological parameters met the Italian standards for agricultural irrigation use
- Sufficient removal of Salmonella achieved
- Escherichia coli was found, and its removal did not meet Italian laws
- The use for tomato crops showed good results (22% higher yields) irrigated with subsurface drip emitters
- The eggplants showed water stress due to clogging of the surface drippers (due to high levels of calcium carbonate and pH)
- The treated wastewater distribution significantly affected soil hygienic features, especially in the soil top layer. However, a soil quality recovery was observed during the winter periods.

3.29. Large-scale water reuse for agricultural irrigation in Milan from the Nosedo Wastewater Treatment Plant

3.29.1. English description

The water reuse project in Milan is a good example of successful cooperation between local authorities (Lombardy Region, Municipality of Milan), users (farmer's consortiums, non-profit associations) and the management teams of the recycling facility. Plant operators oversee the control of recycled water quality and volumes delivered for irrigation. The project funding and economic viability are ensured by public-private partnerships. Environmental, economic and social benefits have been recognised, thanks to the high-water quality and reliability of operation.

Major characteristics:

- Farmers association in charge of agricultural irrigation is Vettabbia Consortium (84 farmers, 90 farms)
- The irrigated area is 3700 ha
- Recycled water consumption 700 L/s max to irrigate 1700 ha (Vettabbia high); 3000 L/s for the remaining 2000 ha
- Type of irrigated crops: 45% corn, 15% rice, 40% grasslands and wheat
- Recycled water pricing: Farmers have a concession to use recycled water from the Lombardy Region upon a symbolic payment (1827 €/year)

Keys to success:

- Existence of a very old complex network of irrigation canals and agricultural activity near the city (fertile Po Valley)
- Delivery of high-quality recycled water to farmers almost free of charge with effective control of water allocation by two farmer associations
- Financial equilibrium, high treatment efficiency and reliability of operation, ensured by high qualified staff and public-private partnership
- Demonstrated environmental benefits for the restoration of surface water, groundwater and biodiversity
- Valorisation of historical heritage and peri-urban agriculture (“zero-kilometre products”)
- Public education programs and collaborations

3.30. Large-scale water reuse for agricultural irrigation in Milan from the San Rocco Wastewater Treatment Plant

3.30.1. English description

Major characteristics:

- Farmers’ association in charge of agricultural irrigation: Consortium di Bonifica Est Ticino Villoresi
- Irrigated area: 24,630 ha (total irrigated area 114,000 ha)
- Recycled water consumption: 30% of the water needed for the Cavi Litta area and 100 km of canals and ditches
- Type of irrigated crops: 45% corn, 15% rice and 40% meadows and grasslands (43% corn, 37% rice, and 20% grasslands for the total area)
- Recycled water pricing: The two farmers associations in charge of the operation of the two canals have in charge the cost of pumping (about 27,000 €/year)

Total transparency and collaboration with large public, non-profit organisations and stakeholders are realised through the following aspects:

- The constant presence of university students working on their graduation theses, in some cases assisted by the plant’s staff,
- Meetings and debates held by cultural or environmentalist associations,
- Sports and entertainment events at the park and the plant’s areas,

- Support of the activities of non-profit organisations and associations for environmental education,
- Promotion of peri-urban and organic farming and social rehabilitation of people at risk of social exclusion

3.31. Regenerative and nature-based water solutions- HYDROUSA

3.31.1. English description

HYDROUSA is an innovation action project which aims to revolutionize the water supply chain in Mediterranean regions by demonstrating innovative solutions for water/wastewater treatment and management, which will close the water loops and will also boost their agricultural and energy profile. There are six demonstration sites in three Mediterranean islands (Lesvos, Mykonos and Tinos) however HYDROUSA solutions will be additionally assessed in 25 early adopter cases.

HYDROUSA project has identified (15) target groups and grouped them into 5 classes: (i) local community, (ii) investors, (iii) Academic community and NGOs, (iv) policymakers and (v) public.

HYDROUSA water loops include water from non-conventional sources including wastewater, rainwater, seawater, groundwater and vapour water, all resulting in recovered and marketable products. Municipal wastewater is collected to be treated afterwards. Rainwater is collected to be directly used for irrigation. There is also a system implemented to collect fresh water out of seawater with a mangrove desalination system. A fog catcher is used to catch water of drinking quality straight out of the air. Water conservation solutions including aquifer storage and sustainable agricultural practices including fertigation are applied. From the reclaimed wastewater 1 ha of trees and permanent crops like forestry, berries and lavender are irrigated. The rainwater harvesting produces enough water to irrigate 0,4 ha of oregano and 0,2 ha of lavender.

A practical outcome to keep in mind: Some tourists have complained about a bad smell coming from the wastewater treatment plant.

3.32. A next generation of circular economy water systems and services- MULTI ReUse

3.32.1. English description

Treated wastewater is an important part of the water cycle. The quality of the treated wastewater is only sufficient to discharge the water into rivers, something that is acceptable from an environmental point of view but for the use in agriculture or industry, the water often is unsuitable. MULTI-ReUse closes this gap by developing and implementing new procedures for the reuse of service water. The aim of MULTI-ReUse is the development, demonstration, and evaluation of a modular water treatment system, to offer service water in different qualities and quantities for the different purposes and too competitive prices.

The focus is put on the development and testing of optimized treatment processes and the development of a new monitoring process to ensure the hygiene requirements for the quality of the reused water.

This project is developed in Nordenham, a small town in the north of Germany. Within the project, only a part of the cleaned wastewater is not discharged into the river but is further

treated using special cleaning processes, including prefiltration, ultrafiltration activated carbon, and UV disinfection. Monitoring is done by flow cytometry which is used for quick determination of microbiology and growth potential in the water.

These treatment processes result in different water qualities that can now be used in a targeted manner, depending on their quality. The treated wastewater can be used for groundwater enrichment, for agricultural irrigation or to be used in industrial processes.

3.33. Reusing agro-industrial wastewater for vegetable production- DEMOWARE

3.33.1. English description

The Capitanata site is situated in the Puglia Region in Italy. The site was located within the Fiordelisi, an agricultural and food manufacturing company. Fiordelisi's activity includes growing, processing, packaging and marketing of preserved, ready-to-eat vegetables. This involves the production of large quantities of wastewater that undergoes a purification process before being discharged according to local regulations. Therefore, the company is equipped with a wastewater treatment plant (WWTP). The WWTP was upgraded to produce effluents suitable for reuse, thus supplying the two types of treated wastewater used for crops irrigation during the experimental period, one produced by the conventional treatment system and the other by the upgraded configuration.

The intended water reuse is unrestricted irrigation of food crops, as well as saving water as a scarce resource, the closed-loop recycling of nutrients is a prominent aspect of this site. The WWTP can treat about 300 m³/d and has a conventional activated sludge system, a tertiary membrane filtration system, and on-line UV treatment. Effluents from the tertiary system can be stored in existing reservoirs and used for irrigation at test fields, where an additional on-line UV disinfection system is in place.

Project outcomes:

- Agro-industrial treated wastewater was reused for tomato and broccoli irrigation.
- The main physio-chemical properties of wastewater met the Italian standards for irrigation reuse.
- Quantity and quality of crops were not affected by wastewater.
- No impact of wastewater on chemical properties of irrigated soil was observed.
- Low level of faecal indicator was found in plants, tomato fruits and broccoli heads.

3.34. Purified water from the food industry for agriculture- F2AGRI

3.34.1. English description

Food processing industry Ardo treats and delivers the water. The company's wastewater comes from the washing and blanching of vegetables and the cleaning of the processing units.

Ardo uses annually 600 000 m³ of water for processing vegetables. Farmers currently use mostly surface water for the irrigation of vegetable crops. Farmers with fields adjacent to watercourses place a reel in the surface water and pump the water directly on the fields. Farmers who do not have access to a watercourse, get surface water with a dung cart.

Around Ardo, an underground pipeline network of high pressure will be constructed over an agricultural area of 670 hectares. The effluent of Ardo will be stored in a buffer basin of 110 000 m³ until the crops are in need of water. The pipeline network currently covers 32 km but will be further optimized in terms of the participating farmers. This network will be divided into several blocks so that there could be irrigated simultaneously in the different blocks.

The water is supplied to vegetable crops which are irrigated with sprinklers during the irrigation season.

A cooperative organisation called 'Inero' with 47 participating farmers was set up. This cooperative is the basis for the day to day business of the irrigation network and is responsible for investments and maintenance in the pumps and hydrant networks. Farmers can reserve online a timeslot and volume for irrigation. 49 farmers are currently involved, covering an agricultural area of 500 hectares.

Ardo has the ambition to install floatable solar panels on the surface of the buffer basin. Beside power production, this would also reduce water evaporation and algae growth.

3.35. Reclaimed water for fruit tree irrigation (Jumilla wastewater treatment plant)

3.35.1. English description

Households of Jumilla town and wineries in the area provide the wastewater to be reclaimed. ESAMUR is the public entity in charge of operation and maintenance for the wastewater treatment plant. The reclaimed water is supplied to 1,329 hectares of agricultural land and 924 different farms. The irrigated cultures are pear (45 %), peach (32 %), apricot (12 %), olive (5 %), plum (3 %), grapes (2 %) and almond (1 %). Sub-surface irrigation and drip irrigation are applied. Also, deficit irrigation practices are applied and studied within the framework of a LIFE project.

The project started with the setup of demonstration plots with sensors to measure soil and plant water status.

The expected results:

- Irrigation water saving by 30% with the adoption of deficit irrigation compared to the current irrigation regime
- Reducing energy consumption by 30%
- CO2 emissions due to current energy consumption arise to 0.70 ton/year/ha. Expected results are the decrease of the emissions by 30% with the sustainable irrigation regime by optimization of consumption
- The water leaching will be reduced, increasing the quantity of crop effective water and productivity of water. The expectation is that no irrigation water leaches or is reaching the groundwater
- The 30% decrease in irrigation water will decrease chemical fertilization by 30%, minimizing groundwater pollution by leaching of nitrates applied as fertilizer

3.36. Water reuse project of Hersonisos. Reclaiming municipal wastewater for the irrigation water of olive trees- Life initiative (2009-2013)

3.36.1. English description

The main results and outcomes from the project are the following:

Environment

An annual quantity of almost 200.000 m³ of reclaimed water utilized for the irrigation of olive groves in the area of “Agriana”. Water quality characteristics such as turbidity, solids and microbial concentration decreased in the effluent reducing problems such as clogging of irrigation pipelines and microbial contamination of soils.

Economic

The upgraded system will be useful and supportive for the future expansion of wastewater treatment to achieve license for “unrestricted irrigation” of reclaimed water for any crop irrigation including vegetables. The appropriate water pricing was also calculated for the first time. A technical study for the upgrading of the wastewater reuse and distribution system was conducted. The new wastewater distribution system includes a) the upgrading of tertiary wastewater treatment and b) the upgrading of the piping distribution network.

Public involvement

The project monitored the local community opinions and change of attitudes against wastewater reuse for irrigation. A positive change is proved by conducting a continuous informative campaign (through surveys including farmers, local people, local authorities and visitors; through an informative campaign which included open day events, seminars, leaflet distribution, educational activities, newsletters).

Education

A comprehensive educational training programme consists of Worksheets and Information sheets, as well as clarifications for the teachers was conducted in local schools. Teachers have gained new experience, knowledge and motivation for water recycle and reuse.

3.37. Reuse of water from the wastewater treatment plant in Thessaloniki

3.37.1. English description

Results:

1. Irrigation water quality: Wastewater could be safely used without posing a high risk to the soil, crop, irrigation systems and human health. Only rational use of the effluent and systematic monitoring of the system can ensure sustainability and long-term safety
2. Soil: Effluents from near-coast cities and wastewater treatment plants often have a high salt content. Levels of soil salinity must be monitored, and long-term soil monitoring should be undertaken.
3. Trace elements: The trace elements concentration in the soil and plant tissues were quite low ensuring safe long-term use for crop irrigation
4. Microorganisms: There was no significant health risk from the use of this effluent. Pathogenic microorganisms in the chlorinated effluent were well within the limits.
5. Drip irrigation/Clogging problems: All the tests for the drip irrigation system have shown no clogging after three years of continuous use

6. Crop yields:
 - a. Sugar beet: no difference between effluent and freshwater
 - b. Cotton: The wastewater has resulted in a higher yield than the freshwater. There were significant differences in lint, fibre length, micronaire and mean maturation date
 - c. Corn: corn irrigated with the WWTP effluent was higher. Significant differences in corn yield and crop height have been observed between furrow and drip irrigation. Furrow irrigation has produced 10% more corn yield than drip irrigation. But the statistical analysis of the corn yield and crop height has shown that the higher the plants, the less seed that is produced
 - d. Rice: no difference between effluent and freshwater

3.38. Water reclaimed for irrigation from the Castellón wastewater treatment plant

3.38.1. English description

The reclaimed water originates from the Castellón wastewater treatment plant. There are some problems with high salinity (3 g/l) and boron toxicity in the effluent. Which is why the water is mixed with surface water for agricultural application. The reclaimed water is mixed with surface water in a water pool close to the wastewater treatment plant. Then it is transported by an irrigation network to the local stations where nutrients are added according to the set recipes. A fertigation network distributes the nutrient solution to the fields and 2,000 hectares are irrigated with the reclaimed water, divided over approximately 2,000 farms. The irrigated fields are mostly citrus trees and the irrigation community commonly applies fertigation.

The wastewater treatment consists of nutrient removal, UV disinfection and suspended solids removal.

The irrigation community has a cost exchange between the city council and the irrigation community. Farmers are owed to raise their water concession and use of high-quality surface water to the city council, and farmers receive water from the reclaimed water facility at no additional cost. Farmers only pay the costs they had for surface water. The operation and maintenance costs are over 0.02 €/m³.

3.39. Olive trees sustainable irrigation model using reclaimed water- REUTIVAR

3.39.1. English description

The main expected results derived from the actions to be carried out in the REUTIVAR project are:

- Reduction of existing algal biomass in sedimentation and accumulation ponds
- Reduction of costs associated with the use of algacides in sedimentation and accumulation ponds
- Reduction of the clogging of the filtration system by microalgae
- Reduction of the concentration of E. coli in the influent to the reclamation system
- Optimization of the filtration system to the thickness and energetic consumption degree

- Optimization of water and fertilizer consumption in irrigation
- Determination of the benefits obtained in terms of reducing the use of irrigation water, savings in fertilizers and impact on productivity
- Reduction of expenses derived from the periodic cleaning of the irrigation system
- Reduction of the risk and costs associated with the process through the "multiple barrier approach"
- Creation of a model of sustainable irrigation of the olive grove using reclaimed water
- Extrapolation of the model to other areas / rural areas of Andalusia with the need to implement the process or optimize the existing ones
- Contribute to the promotion of synergies and the transfer of knowledge and innovation among the stakeholders involved in the sector
- Contribute to the implementation of the current Hydrological Plans of the Guadalquivir Hydrographic Confederation and the regional Ministry of Environment and Territory Planning, where 20 and 150 Hm³, respectively, of reclaimed water, are destined, mainly for the irrigation of olive groves.

3.39.2. Spanish description

Los principales resultados previstos derivados de las actuaciones a ejecutar en el proyecto REUTIVAR son:

- Reducción de la biomasa algal existente en las balsas de sedimentación y acumulación
- Reducción de los costes asociados al uso de alguicidas en las balsas de sedimentación y acumulación
- Reducción de la colmatación del sistema de filtración por microalgas
- Reducción de la concentración de E. coli en el agua influente al sistema de regeneración
- Optimización del sistema de filtración a grado de micraje y consumo energético
- Optimización del consumo de agua y de fertilizantes en riego
- Determinación de los beneficios obtenidos en términos de reducción del uso del agua de riego, ahorro en fertilizantes e impacto en la productividad
- Reducción de gastos derivados de la limpieza periódica del sistema de riego
- Reducción del riesgo y de los costes asociados al proceso mediante el "enfoque de barreras múltiples"
- Creación de un modelo de riego sostenible del olivar mediante el uso de aguas regeneradas
- Extrapolación del modelo a otras zonas/áreas rurales de Andalucía con necesidad de implementación del proceso u optimización de los existentes
- Contribuir al fomento de las sinergias y transferencia de conocimientos e innovación entre los distintos actores involucrados en el sector
- Contribuir a la implementación de los actuales Planes Hidrológicos de la Confederación Hidrográfica del Guadalquivir y de la Consejería de Medio Ambiente y Ordenación del Territorio, donde se destinan 20 y 150 Hm³, respectivamente, de aguas regeneradas, principalmente para el riego de olivar.

3.40. Sub irrigation system supplies wastewater from beer brewery (BoerBierWater - F2Agri)

3.40.1. English description

Cooperation is set up to discuss the construction, maintenance, management and the distribution of the water. This cooperation was named BoerBierWater. The cooperation consists of local farmers, brewery Bavaria, ZLTO, the municipality of Laarbeek, Waterschap Aa & Maas, Agrifirm and the local bank Rabobank.

The treated residual water from beer brewery Bavaria is used as the water source for sub-irrigation. Measurements of the effluent indicated high concentrations of sodium, phosphate and chromium. The water is delivered by a controlled level sub-irrigation system. This system is composed of subsurface drains connected to each other by a collector drain.

The farming system consists of a pilot study which involves installing a drainage pipe system on a parcel of grassland.

This form of irrigation is relatively new in the Netherlands. Therefore, the success of this test is not guaranteed, and it is impossible to say in advance what an optimal implementation is and what the effects on groundwater levels and chemistry are. The success depends on various factors, including the design of the drainage network, the quality of the effluent (clogging potential), the soil properties, the water management of the environment and the wishes and requirements of the farmer and the neighbours concerned. In addition, desired and undesired side effects can also occur. A desirable side effect can be an improvement in the surface water quality of the Goorloop, because the effluent is purified under the influence of soil passage. The results show that sub-irrigation improves the moisture provision for the crop.

3.41. Recovery of nutrients from slaughtering industry wastewaters for reuse in agriculture (Water2REturn)

3.41.1. English description

The prototype treats the wastewater from a slaughterhouse called 'Matadero del Sur', located in Salteras, near Seville (Spain). Nutrients recovered are turned into products with added value for the agrochemical industry and for the agricultural sector. The products produced are fertilizer and two different biostimulants.

Within the waterline, wastewater will be treated, and a nitrate concentrate will be obtained, from which an organic biofertilizer will be manufactured (Product 1). Within the sludge line, the sludge produced in the water line will be upgraded by following a fermentation process with *Bacillus*, resulting a solid fraction (Product 2) from which a biostimulant will be produced, and a liquid fraction, that will follow an anaerobic digestion process to produce energy (methane). Finally, within the algae line, the CO₂ released from the anaerobic digestion unit will be captured to produce algal biomass, that will be used to formulate a second biostimulant (Product 3). All products will be free of pathogens, heavy metals and emerging pollutants, and ready to be commercialized at EU and international level.

Water2REturn commercial outcomes will be:

- An integrated system to treat wastewater while recovering nutrients, customisable according to the needs of the end-user.
- 3 raw materials: nitrate and phosphate concentrate, hydrolysed sludge and algal biomass, the basis for further manufacturing agronomic products.
- 3 agronomic products: 1 organic fertiliser and 2 biostimulants, ready to be commercialised.

3.42. Water reuse for agricultural irrigation in Alicante (Rincón de León water reclamation plant)

3.42.1. English description

This project presents a real case of desalinated wastewater reuse, carried out in the "Rincón de León" wastewater treatment plant, in Alicante (Valencia Region, Spain). The objectives of the work are to analyse different alternatives of tertiary treatment for wastewater reuse and to define treatment costs, energy consumption and the cost recovery results.

The effluent quality at an affordable price is achieved by mixing water of three different qualities and therefore three different production costs. This is a good strategy for optimizing production as long as the quality required is variable. The advice for users is to plan their long-term needs and increase their storage structures to allow the plant to operate on a more regular basis.

The price is affordable for farmers, even though they have to pay a substantially higher amount than the average charged for surface water or groundwater for agricultural use in Spain. Water stress makes cheaper water resources unavailable and therefore makes wastewater reuse financially sustainable and its prices acceptable for users.

The process which requires the most energy is reverse osmosis, which requires triple energy than ultrafiltration. The process of coagulation+flocculation+filtration demands less power.

3.43. Water reclaimed for irrigation in Aguilas, Murcia

3.43.1. English description

The municipal wastewater treatment plant is operated by ESAMUR. From time to time, the Irrigation Community cannot use the reclaimed water due to problems on water quality. This is due to mass tourism and the rise in wastewater production that results in lesser treatment quality.

There is a pipe system from the wastewater treatment plant that transports the water to about 50 meters above sea level, from where it is distributed. The reclaimed water is then used in greenhouses with hydroponic crops. The Irrigators Community covers an area of 6,000 hectares divided over 900 farmers. The reclaimed water is used to irrigate 800 hectares of the irrigators' communities' grounds. The reclaimed water is provided to the farmers at a cost of 0.07 euros/m³.

The type of agreement in this project is made with the River Basin Authority of Segura river and sanitary control, and it is renewed every 15 days.

The wastewater treatment consists of nutrient removal (with Activated sludge), pesticide removal (with ultraviolet and advanced oxidation with ozone), disinfection (UV disinfection and advanced oxidation with ozone), and suspended solids removal (sand filter, coagulation and flocculation).

3.44. Water reuse in Asprovalta, Municipality of Volvi, Thessaloniki

3.44.1. English description

The municipal wastewater treatment plant of Asprovalta city in Greece receives and treats mainly urban wastewater. The treated effluent goes directly to the river or to the nearby land area by surface irrigation. Reclaimed water is used to irrigate different natural vegetation areas, with bushes, native trees and olive trees. The irrigated agricultural land (120 hectares) is located next to the treatment unit and receives the reclaimed water directly.

The plant was designed initially for a population equivalent of 10,860 with a maximum treatment capacity is 40,000 population equivalent. The population in summer increases of 100%.

The plant has following characteristics: a) Total incoming load (Kg BOD₅/d): mean annual: 2,800 max annual: 3,200, b) Incoming sewage load (Kg BOD₅ /d): mean annual: 2,000 max annual: 2,400, c) Inlet load sewage sludge (Kg BOD₅/d): mean annual: 800, max annual: 800, d) Total incoming flow to treatment plant (m³/d): mean annual: 50, max annual: 600

The Wastewater Treatment Plant of Asprovalta is owned and operated by the Water and Sewer Municipal Company of Volvi. The cost of reclaimed water is estimated at 0.6 euro/m³. The wastewater treatment consists of nutrient removal (Nitrification, denitrification and biological phosphorus removal), disinfection (Chlorination), and suspended solids removal (Aeration and secondary treatment with sedimentation).

The implementation of the generated knowledge of the SuWaNu Europe project could add significant value by informing the residents about the benefits that will arise in the agriculture of the area and tourism activities. Thus, their concerns (e.g. decrease of commercial value of houses and bad smell of the treatment plan) may be bent.

3.44.2. Greek description

Η μονάδα επεξεργασίας λυμάτων του Δήμου Ασπροβάλλας λαμβάνει και επεξεργάζεται αστικά λύματα. Τα επεξεργασμένα λύματα πηγαίνουν απευθείας στο ποτάμι (σε εποχικά ρέματα ή στον Στρυμόνα). Το ανακτημένο νερό χρησιμοποιείται για την άρδευση διαφορετικών περιοχών φυσικής βλάστησης, με θάμνους και ελιές. Η αρδεύομενη γεωργική έκταση (120 εκτάρια) βρίσκεται δίπλα στη μονάδα επεξεργασίας και λαμβάνει απευθείας το νερό που ανακτήθηκε.

Η μονάδα σχεδιάστηκε αρχικά για ισοδύναμο πληθυσμού 10.860 με μέγιστη ικανότητα θεραπείας 40.000 ισοδύναμο πληθυσμού. Ο πληθυσμός το καλοκαίρι διπλασιάζεται. Η μονάδα έχει τα ακόλουθα χαρακτηριστικά: α) Συνολικό εισερχόμενο φορτίο (Kg BOD₅/d): Μέση ετήσια: 2.800 & μέγιστη ετήσια: 3.200 β) Εισερχόμενο φορτίο λυμάτων (Kg BOD₅/d): Μέση ετήσια: 2.000 & μέγιστη ετήσια: 2.400 γ) Λυματολάσπη αποχέτευσης (Kg BOD₅/d): Μέση ετήσια: 800 & μέγιστη ετήσια: 800 δ) Συνολική εισερχόμενη ροή στο εργοστάσιο επεξεργασίας (m³/d): Μέση ετήσια: 50 & μέγιστη ετήσια: 600.

Η μονάδα της Ασπροβάλλας ανήκει και λειτουργεί από τη Δημοτική Εταιρεία Νερού και Αποχέτευσης της Βόλβης ενώ το κόστος του ανακτημένου νερού εκτιμάται σε 0,6 ευρώ/m³. Η επεξεργασία λυμάτων αποτελείται από απομάκρυνση θρεπτικών ουσιών (νιτροποίηση, απονιτροποίηση και απομάκρυνση βιολογικού φωσφόρου), απολύμανση (χλωρίωση) και απομάκρυνση αιωρούμενων στερεών (αερισμός και δευτερεύουσα επεξεργασία με καθίζηση).

Η υλοποίηση του έργου SuWaNu Europe θα μπορούσε να προσθέσει σημαντική αξία στην περιοχή ενημερώνοντας τους κατοίκους για τα οφέλη που θα προκύψουν στη γεωργία και στον τουρισμό περιορίζοντας έτσι τις αντιδράσεις τους καθώς θεωρούν ότι ο τουρισμός της περιοχής επηρεάζεται αρνητικά από την άσχημη μυρωδιά του σχεδίου επεξεργασίας.

3.45. Reuse of wastewater from olive tree industry for irrigation using 'dry drainage' (H2OliveTree)

3.45.1. English description

Wastewater source is the water used in the olive cleaning process. This is caustic water with a high salt concentration. This wastewater will be used to irrigate olive trees. This project studies the effect of the use of wastewater coming from the olive industry. This water is high in caustic soda and brine. Therefore, "dry drainage" will be tested. This implies that some area of fallow land operates as evaporative sinks drawing a flux of water and salt from the irrigated fields.

Each test will use a 5 m³ tank that will be filled from the rafts with a tank truck. By irrigation programmer and solenoid valve, drip irrigation will be applied. Water will be distributed through distribution pipes and drip holders with built-in drippers.

The use of reclaimed water as described in this initiative has been approved by the Regional Government after some research. It is already under exploitation in Marchena and other locations.

The use of water of reduced quality in agriculture is viable if plants tolerant to salinity are irrigated, the irrigation is managed carefully, as well as leaching from excess soil salts.

The main objectives of the project have been achieved. The reduction of the volumes of saline water stored in the ponds, the reduction of the water footprint of the olive dressing industry and, as a third point, the increase in the productivity of olive groves in the area. Something that has been achieved, after two campaigns, is a follow-up in 8 farms and with the evaluation of the results obtained, maintaining above all, an exhaustive control in the evolution of the saline concentrations of the soil and the plant, as well as other parameters.

3.46. Torrevieja wastewater treatment plant. Irrigators Community of Margen Derecha of Segura River

3.46.1. English description

The Irrigators Community is using reclaimed water from three wastewater treatment plants that treat municipal wastewater. There is a pipe system from the wastewater treatment plant with direct distribution into the Irrigators Communities network to the farming plots. Drip irrigation is used in an intensive agricultural system. Commonly grown cultures are orchards (citrus) and vegetables (artichoke, lettuce, tomato, pepper and other), which are grown on 3,433 hectares of land irrigated with reclaimed water, divided over 460 farmers.

The farmers are grouped into an irrigation community called 'Margen Derecha of Segura River'. There is an agreement between the Irrigators Community and the River Basin Authority of the Segura river to use reclaimed water. The members of the irrigators' community pay on average 0.2 €/m³ for all sources of water. In this case, the irrigators community mixes several water sources: from surface water, groundwater, reclaimed water, transfer water from the Tagus-Segura river, and in very dry periods, from desalinated water plants. The cost is an average of all these water sources.

Wastewater treatment consists of nutrient removal (using filtration by physical sieves, degreasing and decanting), pesticide removal (Ultraviolet and ozone), disinfection (UV disinfection), and suspended solids removal (Filtration and coagulation).

3.47. Reclaimed water in Callosa de Segura- Callosa de Segura wastewater treatment plant

3.47.1. English description

Wastewater coming from 5 municipalities into the wastewater treatment plant of Callosa de Segura. The company that oversees the wastewater treatment plant is Global Omnium Medio Ambiente.

The water is pumped from the wastewater treatment plant to the fields. Treatments are carried out to prevent algae and microbiological growth. The crops grown are fruit trees (lemon and orange – citrus), almond, arable crops, vegetables (lettuce, artichoke, tomato), which are grown on a total of 2,960 hectares and irrigated with reclaimed water, divided over 1,654 farmers.

The wastewater treatment consists of nutrient removal (using prolonged aeration), disinfection (chlorination) and suspended solids removal (coagulation). There is an agreement with the River Basin Authority of Segura River to use reclaimed water. Pipes and pumping station are subsidized by the Regional Government. Operational and maintenance costs are 0.092 €/m³ which are paid by the Irrigators Community. Every Farmer in each irrigators' community must pay a fee.

The fee normally is based on 2 concepts:

- a contribution to water use services (dams, state canals, etc.) from the public domain which is collected by irrigators communities and later paid back to the State
- the inside costs of irrigators communities (personal cost, energy, facilities, etc)

3.48. Reclaimed water for orange orchards in Sagunto (Valencia, Spain)- Sagunto wastewater treatment plant

3.48.1. English description

In this project, the water originates from the Sagunto wastewater treatment plant. The distribution system consists of pressurized pipes which flow from the wastewater treatment plant to the filter plant and water is pumped into a water reservoir (of a volume of 10,000 m³) before it enters the Irrigators communities' network. After this water (reclaimed water) is into the system, it is mixed with other water sources and kept in 2 water reservoirs.

The wastewater treatment consists of nutrient removal (including decantation and prolonged aeration), and suspended solids removal (including physical sieves and a degreaser). The wastewater treatment plant involves a primary and secondary treatment as described below. No tertiary treatment or disinfection is provided.

The farming system grown using the reclaimed water consists of orchards with orange trees. The reclaimed water is used for the irrigation of 2,800 hectares, divided over 3,070 farmers.

There is an agreement with the Regional Government of Valencia and with the River basin Authority of Jucar river for the use of reclaimed water. The total implementation cost of the project was 18 million euros. No information about the cost of the water was provided.

3.49. Water reuse and aquifer storage for greenhouse irrigation (SUBSOL)

3.49.1. English description

In three years SUBSOL, pilots have evolved in full-scale applications, replication pilots were started at various sites in Europe, and follow-up projects were initiated worldwide. The SUBSOL reference sites in The Netherlands have evolved from pilots to full-scale applications. Three years of testing, monitoring and evaluation have demonstrated the robustness of the systems. Experiences from the reference sites have been put in practical, step-by-step implementation guides, that facilitate future adopters in the uptake of subsurface water solutions (SWS). SWS systems have helped sustain irrigation water supply to greenhouse farmers during the prolonged drought of 2018, and neighbouring farmers have inquired for similar systems.

SUBSOL has also developed a knowledge environment, including a knowledge base with descriptions of technologies and references, a toolbox with SWS tools to support application, design and operation of SWS technologies, as well as a marketplace of SWS. The knowledge base includes step-by-step implementation guides, various policy briefs to acquaint policy and decision-makers with SWS. Knowledge sharing, capacity building as well as trust-building activities (promotion events, workshops) were carried out worldwide. These dedicated missions have shown a large interest of regional and local stakeholders in the practical applicability of SWS, but also indicated potential market uptake barriers including permitting. There is a strong need for local proof of concept, and to develop local field pilots. It is crucial to actively involve policymakers and other stakeholders in setting up pilots, such that questions and issues related to policy and regulations are addressed from the very beginning.

3.50. Sub-irrigation with treated wastewater in Haaksbergen (Landbouw op peil)

3.50.1. English description

The project results in an overview of promising applications of underground water storage for the high sandy soils and the low Netherlands. The project provides insight into several selected promising applications, and the effects and effectiveness of underground water storage based on experiences from various practical applications.

This project provides practical experience in underground water storage (both technical and process-related) as part of the production process of drinking water, process water, drought mitigation or water management strategies for a resilient water system. The drinking water sector and area partners work together in the drought control.

The monitoring of the field experiments had the following results:

- Sub-irrigation contributed to an increase of the groundwater level and the soil moisture content in the root zone, by that reducing drought stress of the crop.
- The sub-irrigation mainly takes place on the higher zones of the plot and hardly or not at all in the lower zones.
- Water quality measurements above the drains show that effluent spreads to a limited extent in the direction of the root zone.
- The leftover parts of medicines do not reach significantly to the root zone of the crop within a growing season, but it does reach the shallow groundwater.

- The reports elaborate further on the distribution of the effluent water towards surface water, deep groundwater, drinking water and topsoil towards the crops.

4. Conclusions

As foreseen in Horizon 2020 thematic networks, SUWANU Europe is compiling existing scientific knowledge and best practices across Europe. The dissemination of the knowledge acquired into easily understandable end-user material such as short, informative recommendations and solutions (“practice abstracts”) is of utter importance and complements other project results such as leaflets, fact-sheets, guidelines and audio-visual material (photos, video clips, etc.).

The result of the deliverable 4.8 is the collection and presentation of the project abstracts compiled within the SUWANU Europe project. Initiatives implementing water reuse, including those related to EIP-Agri Operational Groups, were compiled and published on the EIP-AGRI website. As of the 31st of August 2020, the Suwanu Europe project along with its first set of 50 practice abstracts was published on the EIP-AGRI database containing all the necessary information.

Practice abstracts enable: (1) to contact partners and incentivise efficient knowledge exchange, and (2) to disseminate the results of the project in a concise and easy understandable way to practitioners. Furthermore, the practice abstracts are using a direct and easy understandable language while pointing out entrepreneurial elements which are particularly relevant for practitioners by focusing on the main results and outcomes of the activities as well as pointing out the main practical recommendations where applicable.

Within the first set of 50 practice abstracts there are three different Operational Groups which are the following: 1.23 Reuse of reclaimed water coming from a centralized treatment plant for domestic septic tanks wastewater, 1.25 Reuse of reclaimed water for corn irrigation-SmartFertiReuse, 1.39 Olive trees sustainable irrigation model using reclaimed water-REUTIVAR.

EIP-AGRI promotes agricultural innovation by supporting the bottom-up creation of a multiplicity of Operational Groups, tackling the needs and opportunities of farming practice. Operational Groups are intended to bring together multiple actors and stakeholders to advance innovation in the agricultural and forestry sectors. SUWANU Europe project promotes the interaction with and between different Operational Groups since both projects strive for the creation of innovative solutions by tackling practical problems within water reuse and by creating knowledge which is freely available for everyone to use.

The first set of practice abstracts contain the projects from 9 different countries in Europe, with Spain being the country with the highest amount of practice abstracts (14 practice abstracts, or 28%), followed by France (8 practice abstracts, or 16%), Germany (7 practice abstracts, or 14%) and Greece (6 practice abstracts, or 12%). The countries with the least practice abstracts are Belgium (one practice abstract) and Bulgaria (two practice abstracts). The high number of Mediterranean countries presented within this report correlates with the fact that those countries are in an increasing water-scarce region with an intensive agricultural activity and therefore have more incentives to reuse.

This can be illustrated with examples found at the Spanish coast between Almería and Valencia and the examples in France which are mostly located on the coast of the Mediterranean Sea. The islands of Greece contain several middle-scale initiatives, while Germany, even though it is not recognized as a water scarce region, harbours some fully operational and large-scale initiatives with important demonstrative value in agriculture.

The use of the EIP-AGRI hence facilitates the exchange of knowledge along with the contact between potential partners in innovation projects. This material will be made available beyond

the lifespan of the project through the main existing dissemination channels which farmers often use, as well as through the EIP-AGRI website.

References

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