WIRE

Water & Irrigated agriculture Resilient Europe

Project and Demo Sites 2017

EIP Water

Boosting opportunities – Innovating water


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Foreword

The big challenge of sustainable irrigation in Europe is addressed by the WIRE Action Group under the European Innovation Partnership on Water[1]. **WIRE** stands for **W**ater & **I**rrigated agriculture **R**esilient **E**urope. The WIRE Action Group is committed to unlocking the potential and accelerating uptake of innovative irrigation technology and improving agricultural water management in line with the objectives of the Water Framework Directive, promoting the EU green economy while preserving and increasing the employment in agriculture and related sectors.

WIRE currently has 56 partners from nearly all the sectors involved in irrigated agriculture, ranging from science, companies dealing with irrigation technology and management, advisory services, representatives of the farming sector at European and national level, as well as water managers. Together they cover over 90 % of irrigated area in Europe.

As a group of interested stakeholders WIRE promotes the involvement of end-users into the development of hard and soft innovative products and concepts. It aims at allowing their customisation, focusing on practical solutions to overcome operational and structural farming problems, increasing performances of cropping systems and techniques, creating new job and business opportunities in rural areas and in the whole complex of economic activities induced by irrigated agriculture.

The very fragmented irrigation sector makes it difficult to bring together supply and demand and to disseminate innovations across the EU. Thanks to the commitment of the WIRE partner it was possible to compile 54 pilot and demo sites from across the whole EU in this brochure. All of them are accessible sites that can be visited on request in view of facilitating the exchange amongst interested persons and to boost the uptake of innovation in irrigation. The examples presented allow an insight into innovative irrigated agriculture that increases water productivity, food safety, and overall water use efficiency through the application of soft and hard technologies or by proposing structural and systemic changes in irrigation concept and management. The diversity of the sites presented contributes to a better understanding of the realities and complexity of irrigated agriculture which is a prerequisite to develop realistic joint approaches for practical improvements.

We wish you an interesting reading.
The WIRE partners

1 http://www.eip-water.eu/working-groups/wire-water-irrigated-agriculture-resilient-europe-ag112

WIRE Scientific background and competences

Topics like “pollution by fertilizers and agrochemicals” and “water abstraction” are embedded in most of the activities WIRE members are carrying out, starting from precision agriculture and irrigation and ending with agricultural water governance. As a matter of fact, WIRE members are undertaking actions increasing water productivity and use efficiency, reducing transport losses, avoiding percolation and leaching from the volume of soil colonized by plant roots, impacting on both the key problems aforementioned.

In order to provide a schematic description of the activities and potential of WIRE tackling water pollution and abstraction issues related to agriculture, have been identified height main action lines. These action lines are covered by WIRE members’ activities and expertise but, who hold the excellence at EU and International level through internationally recognized outstanding scientific and practical results. The list, of course, is not exhaustive. An in-depth analysis and description requires more than a paragraph, due to the complex interrelations between water and whatever crop husbandry strategy and operation.

1) Water Productivity: WIRE members have huge experience in developing and applying the “more crop per drop concept”, increasing yield and its quality per unit of water. This aspect has been studied since long time, and researches are still ongoing, under its many facets from, i.e., crop genetic, root development and uptake effectiveness, resources and energy uses, to the technological aspect.

2) Water use efficiency: WIRE members are working on optimizing the crop transpiration, mainly the productive fraction, thus increasing the efficiency of each unit of water transpired by the single plant or of field evapotranspiration. WIRE members are also involved in upscaling results obtained at field level to district and basin level.

3) Soil management and hydrology: WIRE members have experience in assessing water management relation with conservative agriculture techniques, minimum tillage, organic matter increase and soil carbon storage, soil water storage, shallow aquifers recharge, water infiltration from canal networks, etc. Assessment and modelling of circulation of pollutants in the soil (vadose zone) are among the WIRE members activities.

4) Plant and soil biota resistance and resilience: WIRE members are studying the water/soil nexus developing strategies, solutions and technologies to increase soil health and water storage capacity and the plant root system health. Healthy roots in a healthy soil will increase crop resistance and resilience to stresses, parasites and diseases thus reducing agrochemical inputs.

5) Fertigation and nutrients recovery: WIRE members are pioneering the joint supply of water and nutrients since the technique very first steps. Correct application of fertigation can reduce fertilizers losses up to 95% and significantly mitigate the risk of unwanted percolation. The use of recycled water or compost from urban wastes or water recirculation in greenhouses are techniques favouring nutrients recovery. WIRE members have experience and technologies to apply it.

6) Irrigation strategies: WIRE members are studying Deficit Irrigation applications, refining the concept and its applicability. Projects carried out by WIRE members are dealing with coupling Irrigation strategies with technologies and ICT platforms making them effective and applicable.

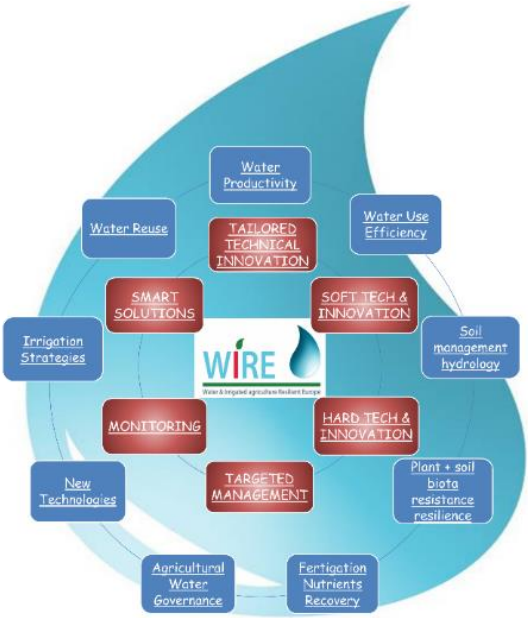
7) New technologies: The set of new technologies WIRE members are developing, studying, assessing or applying is quite large. WIRE cover the full range from irrigation technologies (drip, variable rate irr., etc) to any kind of sensors and remote sensing monitoring schemas and ICT, IoT and Big Data.

8) Agricultural water governance: WIRE involves institutional agricultural water manager, for instance ANBI the Italian National Association of Land Reclamation Consortia, or those scientific institutions in charge to support public bodies and decision/policy makers at local or national level. Thereby, WIRE has in depth knowledge of the agricultural water governance problems, barriers and bottlenecks, infrastructures, etc. This action line includes as well aspect like socio-economic impacts, life cycle assessment and cost benefit analysis, performance analysis and benchmarking.

WIRE AG for its characteristics and membership composition can be considered as a "permanent Focus Group" which efforts are devoted to the water component of precise agriculture and irrigation management.

Moreover, WIRE is working on water in agriculture and irrigation at different levels:

i) research and technological development on water/soil/food nexus (EU, national and local projects, industries and SMEs);
ii) water reuse and circular economy (joint effort of scientific institutions, industries/SMES, public bodies and stakeholders);
iii) education, training, dissemination & communication (universities and schools, extension services, associations & stakeholders);
iv) impact assessment and awareness raising (scientific institutions, public bodies, industries and SMEs, stakeholders and their associations);
v) innovation facilitator and new technologies uptake in the everyday practice (joint effort of scientific institutions, industries/SMES, public bodies and farmers).



ACQUA CAMPUS - Permanent Exhibition on Irrigation Technologies

Promoter	*Consorzio di Bonifica di secondo grado per il Canale Emiliano Romagnolo-CER*
Period	*Since 1989*
Location	*Italy - Emilia-Romagna - Bologna*
Objective	*Dissemination and training on High Efficiency Irrigation Technologies and Strategy*
Target Audience	*Farmers, Technicians, Students, Policy and Decision Makers, Scientist/Researchers*
Level	*International, National, Regional*
Accessibility	*Open days are organised from March until October. On date visit organized on request*
Contact	*genovesi@consorziocer.it*

Demonstration Site description

The permanent exhibition on irrigation technologies aims providing farmers and technicians with up to date information about on shelf irrigation technologies. Water saving novel technologies are presented to Farmers, Stakeholders and Extension Services drawing attention on the opportunities to improve irrigation water management at field or farm scale. Irrigation technologies are showed off in open field and fully operating. More than 100 models of drippers, 80 mini and micro sprinklers, movable sprinkler solid sets, pumps, filters, fertigation dosing or injection pumps are displayed and upgraded every year. In a dedicated area, expressly devoted to agricultural water manager, are showed equipment for irrigation network as meters, valves, pressure-reducing valves, automation systems and flood or sluice gates. Visitors are offered with a collection of publications popularizing micro irrigation devices bench test results, most of them included in the show, studies on irrigation technical-economic aspects and management and on water saving. Students from High School and Agricultural Universities can take practical classes on irrigation technologies. The permanent exhibition offers the opportunity to the local, national and international water stakeholders to disseminate basic operational knowledge addressing a more efficient water use besides the water distribution.

Results obtained so far

Creation of water saving awareness and culture among end users. Fast and wide dissemination of novel irrigation technologies, boosting adoption of efficient technologies and consequent water saving at watershed scale.

Success factors

Training by demonstration and opportunity to check devices while operating. Direct contact with experts and manufacturer. Involvement of private companies manufacturing irrigation equipment in a public private partnership (PPP).

Performance indicators

Since 1989 an average of 20 groups/350 persons per year attended the Open Days (10 events per year), totalling about 10000 farmers, technicians and students, water managers.

Repeatability & Applicability

Similar exhibition on irrigation technologies can be easily set up everywhere. Permanent exhibitions on irrigation technologies were set up in other Italian regions (Campania, Molise, Apulia, Sardinia) under CER supervision.

Further references

www.consorziocer.it/it/p/acquacampus/

Optimising the use of irrigation water resources for cherry orchards in the valle del Jerte

Promoter	Agrupación de cooperativas del Valle del Jerte, with CICYTEX agricultural research center
Period	*Since 2010*
Location	*Valle del Jerte (ES) 40° 8'29.08"N 52'31.83"W*
Objectives	*To promote the efficiency of water use under the conditions of the Valle del Jerte. To increase productivity and improve fruit quality. To develop irrigation techniques and transfer information to farmers*
Target Audience	*Farmers, technicians, students*
Level	*International, national, regional*
Accessibility	*Visits organized on request, web page and irrigation manual.*
Contact	julia.martin@ac-vallejerte.es;

Winner of the 2014 European Award for Cooperative Innovation, section "Bioeconomy / Resource Efficiency" handed out by Cogeca

Project description

The project involves the development of irrigation strategies adapted to the cherry crop in mountain regions, where resources are limited by the difficulty in the water regulation. To perform an efficient water management to improve productivity and quality of a very important crop in this area. The project has been developed in different cherry farms with different varieties and climatic conditions. Different irrigation strategies were established on pre-harvest and post-harvest stages with the aim of finding the irrigation strategy that more could be adjusted to the area.

Results obtained so far

- Pre-Harvest Irrigation management = no water stress: Improve final fruit size; Longer harvest period
- Saving of 75% of the water applied during the post-harvest period: Water savings; Reduction of double fruits; Vigour control
- Efficient water management protocols: Irrigation scheduling manuals; Tree water status thresholds for deficit irrigation strategies; Information available to irrigation communities for programming irrigation seasons

Success factors

The interest of the agrupacion de coperativas del valle del Jerte to the efficient water management. Cooperation among public research institutions and the cooperative of farmers represents one of main success actors. Water management of the farmers and Information available to irrigation communities for programming irrigation seasons.

Repeatability & Applicability

The information generated from this project is reflected in the general recommendations irrigation which will benefit the more than 3,500 cooperative members, local farmers and irrigation communities.

Further references

Cherry crop Irrigation manual: www.ac-vallejerte.es/

Exhibition on water and nutrient application strategies

Promoter	*Yara GmbH & Co.KG Research Centre Hanninghof Dülmen, Germany*
Period	*Since 2010*
Location	*NW Germany*
Objective	*Optimizing crop nutrition and water availability*
Target Audience	*Farmers, students*
Level	*International, National, Regional*
Accessibility	*On date visit (May-July) organized on request*
Contact	*Anke.Kwast@yara.com; Joachim.Lammel@yara.com*

Demonstration Site description

Experimental field plots and demonstration trials on irrigation and crop nutrition provide visitors with insights into new technologies for efficient irrigation/fertilizer supply strategies.
Operation of the ZIM contact water sensor is illustrated. Rain-out shelters in combination with varying fertilizer application strategies and fertigation trials both in combination with soil water sensors and remote sensing devices can be seen during a field tour. Relationships between crop growth and water use are illustrated by pot experiments during a greenhouse tour.
A summary and overview about strategies to optimize fertilizer use and water-use efficiency is presented and water and nutrient management is related to environmental indicators (carbon and water footprints of cropping systems). Students can be provided with updates on field water balance approaches and benefits of decision support tools aiming at improvements of the classical FAO56 irrigation approach.

Results obtained so far

Creation of water saving awareness and relevance of crop nutrition under varying water availability.

Success factors

Field trials in different cropping systems indicate substantial options to improve water and nutrient use efficiency in combination.

Performance indicators

Between 100 and 200 visitors of the demonstration site during the cropping season

Repeatability & Applicability

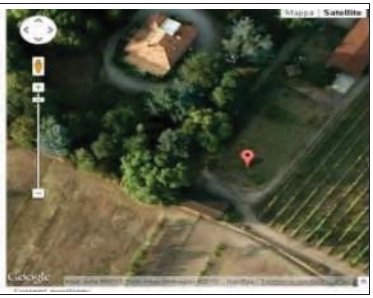
On-going activities in different countries and in different crops indicate general validity of developed technique and concept

Further references

http://www.yara.com/media/news_archive/water_scarcity_platform.aspx, http://yara.zim-plant-technology.com/de/

Irrigation management service

Promoter	*Associazione Nazionale Bonifiche Italiane (ANBI); Consorzio di Bonifica - CER*
Period	*Since 1995 (formerly IRRINET)*
Location	*Emilia-Romagna +11 regions in Italy*
Objective	*Sustainable irrigation management*
Target Audience	*Farmers and Extension Services*
Level	*National, Regional*
Accessibility	*Web based service*
Contact	*genovesi@consorziocer.it*



Project description

IRRIFRAME is an expert system for Irrigation Scheduling backed by the results of more than 50 years of research on plant/water relation and sustainable irrigation management. The project is carried out with the aim to progressively reduce water use for irrigation without harming farmers' income while saving water, thus optimising water productivity. IRRIFRAME is among the tools provided to farmers in the frame of Emilia-Romagna Action Plan for Rural Development 2007-2013, since 2012 ANBI oversees the system diffusion at national scale. The service is web and GIS based, freely available and provides an 'irrigation advice' for many water demanding crops making use of several data sources as meteorological and soil data from local services and crop parameters as defined by CER, including application of the most effective crop tailored irrigation strategy. The crop water balance is calculated at daily step and at field scale and to the crop characteristic, simulated or inputted by the farmer. Since 2009 it implements economic calculation of the irrigation profitability assessing the economic benefit related to the next irrigation. Users are provided with optimal irrigation volume and interval, via web or mobile phone text message.

Results obtained so far

In 2017, about 60% of Italian irrigated land has been managed by IRRIFRAME saving about 100 million m^3 per year. In the first semester of 2017, 500 new users registered to the system.

Success factors

The key element which made this initiative successful is the simple, user friendly, informative system that has been set up for farmers to decide when and how much to irrigate. This visual tool is accessible without charge and is tailored for a large number of crops.

Performance indicators

User's feedback are utilised to evaluate service effectiveness.

Repeatability & Applicability

IRRIFRAME can be easily transferred wherever the data to run the expert system are currently available. However, those parameters set up and validated in Italy might need to be locally calibrated.

Further references

http://www.irriframe.it

Water and Energy Advanced Management for Irrigation (WEAM4i)

Promoter	*Sergio de Campos, ADASA Sistemas*
Period	*Since November 1st, 2013; Duration: 42 months*
Location	*Demo sites: Aragon (Spain), Lower Saxony (Germany) and Alentejo (Portugal).*
Objective	*Develop an innovative water & energy smart grid*
Target Audience	*Irrigation and agriculture community.*
Level	*National, Regional*
Accessibility	*Different techniques for resource efficiency, in addition to an ICT platform based on a Service Oriented Architecture (SOA), for hosting the DSS applications, while, at field level, the existing local irrigation systems will remain.*
Contact	*Maria Navarro (Meteosim)* mnavarro@meteosim.com *Sergio de Campos (Adasa)* sdecampos@adasasistemas.com

Project description

WEAM4i (Water and Energy Management for Advanced Irrigation) is a European project co-funded by the European Union under the 7th Framework Program within ENV-2013-WATER-INNO-DEMO-1. The aim of the project is to improve the efficiency of water use and reduce the costs of power irrigation systems. The WEAM4i consortium is led by companies Meteosim and ADASA Sistemas, and is composed of 17 members from different fields - business, research, irrigation communities and public agencies and organizations - from five European countries (ES, DE, PT, NL, FR). The project addresses two of the priorities outlined by the EIP Water: 'Water- Energy Nexus' and 'Decision Support Systems (DSS) and monitoring'. WEAM4i is developing a smart irrigation management network acting interactively on the rational use of water and energy; that is, demand-based management able to optimize the available offer. In this way, irrigation systems will benefit from the water storage capacity of farming communities and will consume the energy they need when it is cheaper. An integration model based on a service-oriented ICT platform will be used to obtain a prototype that allows applications to help in decision making related to irrigation at the field.

Results obtained so far

Project results were tested and evaluated in three regions of the European Union covering a wide range of crops, water resources and energy markets: Aragon (Spain), Lower Saxony (Germany) and Alentejo (Portugal).

Success factors

Achieving a sustainable management for irrigation while reducing energy costs through the user friendly, informative system supporting irrigation associations and farmers deciding when and how much to irrigate. Irrigation communities have already shown their interest and they are actively cooperating.

Performance indicators

User's feedback will be utilised to evaluate system effectiveness.

Repeatability & Applicability

A smart network for the management of irrigation will act interactively on the rational use of water and energy. It will be possible for this network to be used in different agricultural regions throughout Europe.

Further references

www.weam4i.eu

Development of a model for the sustainable management of the aquifers - GESAP

Promoter	*CIHEAM-IAMB*
Period	*Since 2010*
Location	*Apulia Region (Southern Italy)*
Objective	*To define and implement innovative management options to mitigate the environmental impacts of groundwater pumping in coastal aquifers.*
Target Audience	*Water Users Associations and Water Management Organizations*
Level	*Regional*
Accessibility	*Scientific publications*
Contact	*lamaddalena@iamb.it*

Project description

The main goal of Gesap was to define and implement an innovative management tool to mitigate the environmental impacts of groundwater pumping in coastal aquifers. The aquifers withdrawals have been studied and estimated, and protection policies have been proposed in order to reduce the pressure on groundwater resources. The acceptability of the proposed protection policies by farmers has been analysed developing Bayesian Belief Networks, used to simulate the groundwater exploitation attitude of the farmers and their reactions to the introduction of new protection policies. The project has been carried out in the Apulia Region, in a scenario of water resources exploitation and where the introduction of regulation and control of the water use is inserted in a conflict framework. For this reason, a preliminary analysis of the socio-economic implications related to the implementation of protection measures has been mandatory.

Results obtained so far

The main result of the project was the development of a GIS-based Decision Support System (DSS) for the identification of the areas characterized by the higher pressure on groundwater and the lowest degree of acceptability.

Success factors

The interest showed by Water Management Organizations in using the DSS for the sustainable management of the coastal aquifers in Apulia region.

Performance indicators

Involvement in the participative process of the higher number of representatives of the different institutions and organizations related to the groundwater management and use in the Apulia region.

Repeatability & Applicability

The developed DSS can be easily applied in context different from Apulia region thank to the user-friendly interface and the implementation in the GIS module.

Further references

Portoghese I., D'Agostino D., Giordano R., Scardigno A., Apollonio C., Vurro M. (2013). An integrated modelling tool to evaluate the acceptability of irrigation constraint measures for groundwater protection. *Environmental Modelling & Software*, 46, pp. 90–103.

Giordano R., D'Agostino D., Apollonio C., Lamaddalena N., Vurro M. (2013). Bayesian Belief Network to support conflict analysis for groundwater protection: The case of the Apulia region. *Journal of Environmental Management*, 115, pp. 1-14.

Permanent Exhibition on Irrigation Technologies

Promoter	*Centro de Investigaciones Científicas y Tecnológicas de Extremadura (CICYTEX)*
	Since 1990
Location	*Guadajira- Badajoz (SPAIN)*
Objective	*Dissemination and training relating to High Efficiency Irrigation Technologies*
Target Audience	*Farmers, technicians, students*
Level	*International, national, regional*
Accessibility	*Open days are organised from March until end of October. Visits can be organized on request.*
Contact	*carlos.campillo@gobex.es; cicytex@gobex.es*

Demonstration Site description

CICYTEX carries out various research projects related to the efficient management of the irrigation and fertilization on the most important crops grown in Extremadura (plums, cherry, processing tomatoes, vines, olives and broccoli). The main lines of research undertaken are: crop eco-physiology; deficit irrigation strategies; the use of models for the management of irrigation and fertilization; and the use of sensors to support the management of irrigation schedules, all studied in the context of regional, national and international projects. Much of this work is undertaken at CICYTEX's experimental farm (200 ha) and implies the continuous transfer of research information. CICYTEX organizes open days, technical seminars, conferences and specialized forums at which researchers explain the field tests carried out, their objectives, the technology used and the main results obtained. Our irrigation and fertilization research group also provides information and advice to the agriculture and food sector about emerging technologies with the aim of providing guidance about the crops and techniques best suited to their needs. CICYTEX offers university students and training centres the possibility of doing practical work to complete their training. We also conduct on-going irrigation research in the following fields: Plums (38°51'22.83"N 6°40'19.13"W); Olives (38°51'18.77"N 6°40'14.26"W); Vines (38°51'38.95"N 6°40'0.62"W) and Vegetables (38°51'23.26"N 6°40'1.54"W)

Results obtained so far

Deficit irrigation strategies; the efficient management of water in the cultivation of the main irrigation crops; the rapid and extensive dissemination of novel irrigation technologies; initiatives to promote the adoption of more efficient irrigation and fertigation technologies.

Success factors

Training through demonstrations and providing opportunities to check devices while conducting operations. Direct contact with experts and manufacturers. The involvement of private manufacturers of irrigation sensors in public- private partnership (PPP).

Performance indicators

Since 1980, an average of 10 groups/100 people per year have attended the Open Days (5 events per year): a total of about 2500 farmers, technicians and students.

Repeatability & Applicability

CICYTEX collaborates with commercial organisations in field operations. The work done on these plots supports the development of new technologies and their adaptation to large-scale agricultural exploitations.

Further References

http://cicytex.gobex.es/

Technology and process innovations for irrigation reuse of treated municipal and agro-industrial wastewaters in order to achieve sustainable water resources management – PON_INTERRA

Promoter	*University of Bari*
Period	*Since 2010*
Location	*Apulia Region (Southern Italy)*
Objective	*Promoting a larger implementation of the irrigation reuse of agro- industrial and municipal treated wastewaters at a regional and national scale.*
Target Audience	*Farmers, Water Users Associations and Water Management Organizations*
Level	*Regional*
Accessibility	*Web site, scientific publications*
Contact	*lamaddalena@iamb.it*

Project description

The research project IN.TE.R.R.A is aimed at the study, experimentation and implementation of innovative and sustainable technological and managerial strategies, which favour a widespread implementation of the re-use through irrigation of urban and agro-industrial treated waste water.

Results obtained so far

The results obtained expected from the project concern: *a)* the technical/economic optimisation of the management of waste water purification systems through the simplification of purification processes; *b)* the definition of guidelines for the irrigational re-use of water with different microbiological charges depending on the type of farming (food and otherwise) and agronomical management; *c)* the verification of the effectiveness of rapid, low-cost tests for the evaluation of soil and water in terms of eco-toxicity; *d)* the creation of a system of telecontrol via Internet of the qualitative parameters of water produced for irrigational use; *e)* the development of participatory processes and information methodologies and the involvement of the stakeholders (agriculture, system managers, institutions and consumers) for shared management of the resource; *f)* the potential heightening of current microbiological limits together with the adoption of innovative and sustainable technologies for the purification and refinement of urban and agro-industrial waste would make re-use for irrigational purposes practical.

Success factors

Cooperation among public research institutions and private small enterprises represents one of main success factors together with the multi-disciplinary approach that allowed to face with all the main critical issues of the reuse of wastewater in the agricultural sector.

Performance indicators

The amount of treated waste water utilised in the agriculture sector of the region represents the main indicator to evaluate project' results effectiveness.

Repeatability & Applicability

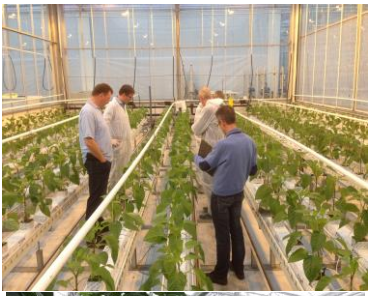
The IN.TE.R.R.A concept can be transferred and applied in other contexts where the use of unconventional water is a solution to be explored. The agronomic and technical options proposed to treat and use waste water can be tested in other areas while both the tests for soil and water ecotoxicity and the remote-control system can be easily transferred and applied since they are low- cost and user friendly.

Further references

www.**pon-interra**.it/

Innovation and Demonstration Centre Water

Promoter	*Wageningen University & Research, business unit Greenhouse Horticulture*
Period	*2013 - ....*
Location	*Greenport Westland-Oostland / Bleiswijk, The Netherlands*
Objective	*Development and demonstration of water technology and water efficient growing systems and methods & knowledge exchange and communication concerning solutions for sustainable, zero-water discharge greenhouse horticulture*
Target Audience	*Farmers, advisors, suppliers, installers, officials, students*
Level	*International, national, regional*
Accessibility	*Open days are organised year round; visits, external presentations and publications are organised on request and by invitation*
Contact	*ellen.beerling@wur.nl*



Demonstration Site description

The main goal for the IDC Water is development of solutions for water-related issues in the horticultural sector, in close collaboration with technology suppliers and other stakeholders. With open days, workshops and presentations, developed technology is demonstrated to end-users, to bring newly developed techniques and strategies from TRL 1-5 towards TRL 6-9 and implementation in commercial greenhouses. Main innovation goal is improvement of water-use-efficiency, by improving water quality, water management and production systems.

Results obtained so far

Developed and demonstrated technologies and strategies (2013-2017):

- Strategy for zero water discharge greenhouse cultivation of fruit-vegetables (demonstrated with sweet pepper and cucumber), using current best practices. Comparison with common practice on production, product quality, water and nutrient-use-efficiency and costs;
- Innovative water-efficient growing systems (e.g. leafy vegetable and cut flower production on water substrate);
- Technology for the elimination of pathogens, growth inhibitors, organic matter etc., to improve the quality of recirculating nutrient solution and take away reasons for water discharge (e.g. heaters, UV(+H_2O_2), ozone, ECA-water, filters);
- Technologies for optimising nutrition and irrigation (e.g. ion-specific sensors, WC/EC sensors);
- Purification technology for elimination of pesticides and nutrients from discharge water (e.g. carbon, AOP, RO, selective sodium removal).
- Demonstration and test centre for sensors for nutrients and pesticides (2017-2019).

Success factors
Involvement and support of relevant stakeholders is important to enhance market uptake of newly developed technologies and strategies. In the IDC Water, technologies and strategies are developed in close collaboration with technology suppliers, end-users and governmental agencies (public-private partnerships).

Performance indicators
Annually about 30 publications, 20 presentations and more than 1000 national and international visitors via open days, specific group tours, discussion meetings or general visits to Wageningen University & Research, business unit Greenhouse Horticulture.

Repeatability & Applicability
Demonstration of water-use efficient horticulture can be set up in other horticultural areas worldwide. Involvement of regional suppliers and governments is crucial, and solutions should be tuned to regional climatic and socio-economic circumstances

Further references
www.glastuinbouw.wur.nl, www.glastuinbouwwaterproof.nl, www.agrisensus.eu

Eurostar Project – Intelligent Reclaimed Irrigation System - IRIS

Promoter	*Centro de Edafología y Biología Aplicada del Segura (CEBAS-CSIC)*
Period	*Since 2011- 2015*
Location	*Murcia (Spain)*
Objective	*Wastewater irrigation reuse*
Target Audience	*Waste-water treatment services and Farmers*
Level	*International*
Accessibility	*Web based service*
Contact	*www.iris-project.eu*

Project description

The objective of the project is to develop and disseminate an Intelligent Reclaim Irrigation System (IRIS) which converts wastewater compounds into renewable sources for agriculture. The wastewater is treated with a combination of electro flocculation, digestion and membrane technology.

Results obtained so far

The studies are carried out on a plastic greenhouse with screen and heating system, irrigation and different automatisms. Tomato and pepper plants were grown under greenhouse conditions to determine the effects of different irrigation water sources and growing media on growth, yield and fruit quality

Success factors

The technology converts raw domestic wastewater into irrigation water containing fertilizers, CO_2 and biogas which will be used under greenhouse production. The prototype will integrate all the food cycle, transforming a waste into a renewable source for agriculture production.

Performance indicators

Quality and safety analysis in the treated wastewater treated and in the crops. Amount of fertilizers saved by the use of nutrients from wastewater reuse.

Repeatability & Applicability

IRIS is used in a unique pilot plant established in Murcia, but the system should be transferred to other places in the word because the depuration prototype is mouldable and easily transportable.

Further references:

http://www.iris-project.eu

Online Professional Irrigation Scheduling Expert System - OPIRIS

Promoter	*Centro de Edafología y Biología Aplicada del Segura (CEBAS-CSIC)*
Period	*Since 2013-2016*
Location	*Murcia (Spain) + 4 other locations in Europe*
Objective	*Precision irrigation scheduling*
Target Audience	*Farmers and Extension Services*
Level	*International*
Accessibility	*Web based service*
Contact	*www.opiris.eu*

Project description

OPIRIS is a online precise irrigation-scheduling algorithm based on a combined interpretation of soil and plant-based or weather sensors. Plant-based or weather readings will help identifying when to irrigate and soil-based reading will be used to compute how much water to apply. The algorithm can read, analyse and interpret real-time data coming up from physical sensors installed in the field or greenhouse and connected to the OpIRIS through a device-to-web datalogger. This option will enable the user to experience the use of precise irrigation technology through an affordable economic investment with a direct professional support from the OpIRIS distributors.

Results obtained so far

The project's consortium involves scientific researchers (OpIRIS-Researchers), commercial operators (OpIRIS-Operators), agricultural producers (OpIRIS-Testers) and European associations (OpIRIS-Advertisers). They are working in a participatory fashion to develop, test and validate a successful product ready for commercialization. Field trials have been installed in Estonia, Greece, Portugal, Spain and UK. Greenhouse and open field orchards has been established.

Success factors

The key element which made this initiative successful is the precise informative system that has been set up for farmers to decide when and how much to irrigate. There are three types of approaches in order to adapt the system to the main necessities and capacities for each specific farmer.

Performance indicators

User's feedback are utilised to improve the system.

Repeatability & Applicability

OPIRIS is used actually in more of 10 different locations, but the system should be easily transferred to other places in the word. There are 2 European farmers' associations participating in the project (EIC and SEMIDE) to facilitate the direct dissemination of the results.

Further references:

http://www.opiris.eu

Efficiency-driven pumping station regulation in on-demand irrigation systems

Promoter	*CIHEAM-IAMB*
Period	*Since 2013*
Location	*Apulia Region (Southern Italy)*
Objective	*To identify a new efficiency-driven pumping station regulation aiming at maximum energy savings in on-demand irrigation systems.*
Target Audience	*Water Users Associations and Water Management Organizations*
Level	*Regional*
Accessibility	*scientific publication*
Contact	*lamaddalena@iamb.it*

Project description

In this study, a way to regulate the pumping station is applied. It is based on the criteria of maximizing the variable-speed pump efficiencies in on-demand irrigation systems served by an upstream pumping station. It thus relies on the principle that by maintaining the pumping system efficiency as high as possible, considerable energy saving can be achieved. The assessment of the best pumping station regulation method was based on the use of the characteristic curves of the network, on variable-speed pump techniques and on the recorded upstream network demand hydrographs. Such hydrographs play a decisive role in establishing how much energy can actually be saved. The proposed methodology has been applied to two Italian case studies, with the aim of quantifying the potential amount of energy saved.

Results obtained so far

The obtained results showed that energy saving is greater in efficiency-driven pumping station regulation because pumps provide exactly the required system discharge and pressure while keeping efficiency values as high as possible. This is the key point and the major breakthrough of the proposed methodology.

Success factors

In the investigated case studies, thanks to the results of this study, the Consortium of Capitanata could easily improve the operation of the system in the two districts where inverters were already installed.

Performance indicators

The quantification of the potential amount of energy saved in the agricultural sector of the region can represent the main indicator to evaluate the effectiveness of the study's results.

Repeatability & Applicability

The experience and the results of the study can be transferred and applied in other contexts

Further references

Lamaddalena N., Khila S. (2013). Efficiency-driven pumping station regulation in on-demand irrigation systems. Irrigation Science 31: pp. 395-410

KLIMZUG Groundwater Recharge with cleaned wastewater

Promoter	*Landwirtschaftskammer Niedersachsen and Bewässerungsverband Uelzen*
Period	*Since 2013*
Location	*Rosche, Northeast Lower Saxony, Northern Germany*
Objective	*Increase of water supply for irrigation; Use of groundwater body as storage capacity for irrigation water while using existing infrastructure*
Target Audience	*Water administration, water politicians and irrigation farmers*
Level	*National, regional*
Accessibility	*www.lwk-niedersachsen.de webcode 01025353 (only in German language)*
Contact	*Elisabeth.schulz@lwk-niedersachsen.de*

Project description

The project area is characterized by extended irrigation of farmland with a limited supply of groundwater. In the project, which was initially financed by the German ministry of education and research, up to 350.000 cubic meters of **cleaned wastewater of a small rural community** (ca. 6000 inhabitants) is no longer pumped downhill into the nearby small river but is now pumped 6 kilometres away and ca. 25 meters uphill to the site of a dry **coniferous forest (sandy soils with a distance of ca. 20 meters to groundwater**). There the water is spread on 35 hectares with the help of a robust system of plastic tubes lying on the surface and equipped with metal nozzles every 4 meters. The **operating expenses** (energy for pumping, technical supervision, monitoring) are paid by farmers (members of the Bewässerungsverband Uelzen) who as return are allowed to extract ca. 250.000 m³ additional groundwater (i.e. ca. 70% of the recharge) with the help of nearby existing irrigation wells.

Results obtained so far

The pilot passed its first years without important technical obstacles. The recharge was possible up to a night with -14° Celsius. The water authority gave a limited permit for infiltration for 20 years which can be withdrawn at any time if the monitoring results show unwanted effects.

Success factors

Openness of the water authorities to:

- "Private" use of the groundwater body as storage facility including compensating the farmers financial engagement **with** additional groundwater
- Infiltration of cleaned wastewater (which before ran into a small river)

Performance indicators

Monitoring results (groundwater quality, vitality of the coniferous forest, energy costs)

Repeatability & Applicability

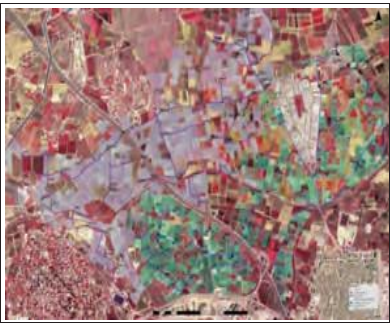
Main repeatable result is the use of the public groundwater body for storage of additional irrigation water, which is claimed from all kinds of private activities resulting in additional recharge (changed land use, measures for seepage of cleaned wastewater or other water...)

Further references

www.lwk-niedersachsen.de webcode 01025353(only in German language)

Permanent Exhibition on Irrigation Technologies

Promoter	*Instituto de Ingeniería del Agua y del Medio Ambiente (IIAMA)*
Period	*Since 2009*
Location	*Picassent, Comunidad Valenciana*
Objective	*Optimization of water, Fertilizers and energy use in Water Users Association (WUA)*
Target Audience	*Farmers, Technicians, Students*
Level	*International, National, Regional*
Accessibility	*Visits with the WUA technicians are organized under request*
Contact	*mijibar@dihma.upv.es ; fmartine@hma.upv.es*



Demonstration Site description

The total irrigated area in the pilot site of is 180 ha composed of 500 plots. The average plot area is 3598 m^2. The irrigation network had 62 multi-outlet hydrants and a total of 342 intakes. The network topology is branched. A multi- outlet hydrant has several intakes, a common solution adopted by engineers for network design when plot size is small. In this way, network pipe lengths are shorter and more economic. Thus, users connect their drip irrigation subunits to the water supply system through water intakes. The average hydrant elevation is 90.8 m and it ranges from 111.5 m to 79 m. The total delivery network length is 14426 m. Water is stored in a pond fed by a canal. Its elevation was 114.4 m and it was 3 m above the pumping station. The system regulation is carried out by three equal vertical multistage pumps powered by an engine of 45 KW. Two of them are Fixed Speed Pump and the other one is a Variable Speed Pump (VSP). All users are charged according to their water consumption with a fixed price per m^3. Collective fertilization is performed for all users. The cropped area is composed of orchards and the predominant crop is citrus (95 %). The complete area is drip irrigated. Pumps are monitored on real time with energy analysers. There are 12 moisture probes disseminated thorough the WUA and one cosmic ray probe. Crop water requirements are estimated by several methods, remote sensing included.

Results obtained so far

Energy savings up to 36.3 % were achieved by increasing the total volume supplied by gravity, decreasing the injection pump head, and improving the pump performance. Stimulation of a water and energy saving awareness and culture among end users by means of proper management.

Success factors

The involvement of technicians and final users in the application of the technologies and irrigation strategies. For this fact training and demonstration were a key aspect.

Performance indicators

Five senior researchers from agronomic, hydraulics and remote sensing disciplines are involved in scientific issues. Two PhD students have Picassent as case study. Several students per year MSc students use Picassent data for their thesis. Picassent has been used as training site for a two weeks-course organized jointly with the Universidad Tecnologica de Chile

Repeatability & Applicability

These techniques and methodologies can be applied in pressurised irrigation networks anywhere.

Further references

www.crpicassent.com/,

Jimenez-Bello M.A, F. Martinez Alzamora, V. Bou Soler and H.J. Bartoli Ayala 2010, Methodology for grouping intakes

of pressurised irrigation networks into sectors to minimise energy consumption, Biosystems Engineering 105 (2010), pp. 429–438
Jimenez-Bello M.A, Martínez, Fernando Bou, Vicente Bartolín, Hugo 2010 Analysis, assessment, and improvement of fertilizer distribution in pressure irrigation systems Irrigation Science (2010) 29:45-53
Jiménez-Bello M.A., Martinez Alzamora. F., Castel J.R., and Intrigliolo D.S 2011Validation of a methodology for grouping intakes of pressurized irrigation networks into sectors to minimize energy consumption. Agricultural Water Management.http://dx.doi.org/10.1016/j.agwat.2011.10.005
Jiménez-Bello M.A., Ballester C. , Castel J.R., and Intrigliolo D.S. 2011. Development and validation of an automatic thermal imaging process for assessing plant water status. Agricultural Water Management 98-10 (2011), pp 1497-1504
García Prats, Guillem Picó, Martínez Alzamora, Jiménez Bello (2011). Rasgeminec Model for Sectoring Optimization in Pressurized Irrigation Networks Using Simulated Annealing .doi:10.1061/(ASCE)IR.1943- 4774.0000452

Agricultural Water Use - CLIMAWARE

Promoter	*CIHEAM-IAMB*
Period	*Since 2010*
Location	*Apulia Region (Southern Italy)*
Objective	*To develop a tool for assessing the quantitative effects of climate change on water balance components and water use in the agricultural sector*
Target Audience	*Water Users Associations and Water Management Organizations*
Level	*Regional*
Accessibility	*Web site, scientific publications*
Contact	*lamaddalena@iamb.it*

Project description

CLIMAWARE EU project case study on Agricultural Water Use allowed to assess and define the quantitative effects of climate change on water balance components and agricultural water use, supporting the adoption of adaptation measures. A coupled hydro-economic model, integrating a hydrological GIS based model and a non-linear optimization model encoded in GAMS was developed. The hydrological model allowed defining the water balance components (groundwater recharge, surface runoff, river flow, etc) at regional scale, referring in particular to water demand for irrigation scope. The integration with the economic model allowed simulating the real farmers' decision process in response to any changes both in the constraints and in the boundary conditions. The tool provides a comprehensive information framework including: water balance components, crops irrigation requirements, farmers' choices in terms of cropping patterns and techniques; economic results (revenue, costs and incomes); environmental impacts (use of factors and resulting pressures on the system).

Results obtained so far

The integrated model has been applied to the Apulia Region, southern Italy, where agriculture is the primary user of water and the primary economical resource. Results refers to irrigation water demand and availability under climate change future scenarios, and the definition of different adaptation measures.

Success factors

Technical assistance and knowledge transfer processes together with the integration of the stakeholders' objectives and knowledge in a shared strategic vision resulted to be a crucial issue to facilitate the achievement of the adoption of effective adaptation measures.

Performance indicators

The stakeholders involved in the project activities are utilised to evaluate the effectiveness and the usefulness of the proposed tool and of the identified adaptation measures.

Repeatability & Applicability

The integrated model can be applied in other case study areas as far the required data are available.

Further references

http://www.uni-kassel.de/fb14/wasserbau/CLIMAWARE/home/project.html

1) Thirel G., D'Agostino D., Dorchies D., Flörke M., Kehr K., Perrin C., Scardigno A., Schneider C., Theobald S., Träbing K. (2014). The Climaware project: Impacts of climate change on water resources management – regional strategies and European view. EGU General Assembly 2014, Wien, Austria.
2) D'Agostino D.R., Scardigno A., Lamaddalena N., El Chami D. (2014). Sensitivity Analysis of Coupled Hydro-Economic Models: Quantifying Climate Change Uncertainty for Decision-Making. Water Resour Manage DOI 10.1007/s11269-014-0748-2

WATERSTORE 2 - Reconciling Agriculture with environment through a new water governance in coastal and saline areas

Promoter	*Veneto Agricoltura (Canale Emiliano Romagnolo CER, Industrial Engineering Department University of Padua, Location Action Group East Venice Area)*
Period	*3 years: 1st November 2012 until 31st October 2015*
Location	*Vallevecchia, Caorle (VE)*
Objective	*Test the effectiveness of climate change mitigation solutions in coastal areas*
Target Audience	*Local stakeholders*
Level	*Regional , National,*
Accessibility	*Web based service*
Contact	lorenzo.furlan@venetoagricoltura.org

Project description

The environmental problem addressed by the project is the reduction in available fresh water in coastal areas (caused by variation in rainfall intensity, quality of fresh water, salt wedge penetration, loss of soil fertility, salinization and desertification risks). The project actions will provide the data needed to evaluate the effects of the choices concerning the use of water resources and will fine-tune an operational model that mitigates the effect of climate change and can be replicated in other coastal areas. The projects activities are as follows: *i)* Designing, implementing and managing an advanced system for collecting and supplying fresh water featuring high automation level; *ii)* Defining and implementing a farming system based on the production potential of the farm and considering also water characteristics; *iii)* Launching and keeping negotiation tables with the purpose of sharing strategies for water management with local stakeholders and evaluating the perception of project results; *iv)* Monitoring the effects of the project on farming productions and their respectively linked economic activities as well as on the environment and natural ecosystems; *v)* Disseminating project results via information materials as well as by organising conferences and seminars.

Results obtained so far

Water distribution pipelines; water-supply engineering; water quality monitoring station; automated system for water management;

Notice boards containing general information about the project have been realized and places; n. 60-70 local stakeholder involved in the project; project's leaflets drafted and printed both in Italian and English; short project description; the brochure "Sustainable agriculture" 2013 in Vallevecchia, produced by Veneto Agricoltura;

Technical- scientific documents (Informative paper for stakeholders; Preliminary project of water management system; Executive plan of water management system; Approach to Multifunctional Cropping System; Environmental impact: first monitoring report) and several maps of the Vallevecchia area and of the hydraulic realizations;

Web GIS containing the territorial information about the localization of canals and automatic weirs, hydraulic interventions, monitoring stations and all other information related to the project realization.

Success factors

The key element which made this initiative successful is the participative process involving local stakeholders (around 100 per year). This method implies the organisation of negotiations tables with local stakeholders aiming to share the project results and discuss about strategies for the management of water. Everyone can request to participate in this process.

Performance indicators

Concrete models to store rainwater, monitor chemical-physical parameters (mainly salt concentration), reuse the quality water to improve soil and agricultural products, yield mapping, measure the effectiveness of climate change and solutions to adapt agriculture techniques in areas lying below sea levels.

Repeatability & Applicability

The model proposed by Waterstore2 has a high potential to be replicated as a whole or partially, as innovative parts/tools in other national and European similar areas.

Further references

http://www.wstore2.eu/

HELPSOIL - Helping enhanced soil functions and adaptation to climate change by sustainable conservation agriculture techniques

Promoter	*Lombardy Region (partners: Piemonte Region, **Veneto Region,** Emilia Romagna Region, Friuli Venezia Giulia Autonomous Region, Regional Agency for Services to Agriculture and Forestry (ERSAF), Centro Ricerche Produzioni Animali (CRPA), **Veneto Agricoltura**.Co-financing body: Kuhn- Italia srl.)*
Period	*4 years: 1st July 2013- 30-June -2017*
Location	*The whole Po plain (an area of some 46 000km2 and the Alpine and Apennine foot-hills)*
Objective	*Facing climate change through a more resilient and sustainable agriculture*
Target Audience	*Farmers and agronomists, associations and companies operating in the agriculture sector*
Level	*Regional, National*
Accessibility	Web based service
Contact	*alberto_lugoboni@regione.lombardia.it*

Project description

In the river Po plain, the organic carbon stock stored in soils varies from 34-60 tonnes per hectare (t/ha). The potential for further uptake if soils are managed appropriately is estimated to be at least 12.8 t/ha of CO2 equivalent. Furthermore, increasing the organic content of soil improves the physical and chemical qualities of soils, leading to enhanced fertility and better absorption of nutrients. This helps ensure that crops can resist environmental stresses, reduces erosion and soil susceptibility to compaction, improves the ability of soils to act as a filter and buffer against pollutants, and boosts soil biodiversity. Better soil management can therefore contribute significantly to increasing the resilience of terrestrial ecosystems in the face of climate change.

Results obtained so far

Implementation in 20 demonstrative farms (5 of them are in the Veneto Region) conservation agriculture practises to improve soil ecological functions (organic carbon sequestration, increase of fertility and edaphic biodiversity, protection against erosion) and increase sustainability and competitiveness of farming systems.
Monitoring indicators of soil ecosystem functions to assess the environmental benefits provided by the implemented practices.

Success factors

The key element which made this initiative successful is the involvement of all the stakeholders in the management and implementation of the project actions. Communication and dissemination actions as envisaged by the project (field days, newsletters, seminars and conferences, etc.) have been designed to promote opportunities for technical growth and exchange of knowledge. The results of the project will be implemented by the Regional rural development plans. The agricultural techniques are tested in each demonstrative farm.

Performance indicators

Test and demonstrate innovative solutions and soil management practices to improve the ecological functions of soil - organic carbon sequestration, soil fertility and biodiversity, protection against erosion - in a number of farms, with the goal of increasing agricultural sustainability and competitiveness;

Integrate conservation practices and innovative techniques in order to Increase the efficiency of irrigation; improve the efficiency of fertilisers, in particular livestock manure; and limit the use of pesticides.
To develop indicators of soil ecosystem functions and new techniques to assess the environmental benefits of the practices tested by the project.

Repeatability & Applicability

The integrate conservation practices with suitable techniques aiming at: increasing water use efficiency for crop irrigation; improving fertilization efficiency, in particular livestock manure; controlling pesticides and plant protection products**.**
And the guidelines for the application and dissemination of Conservation Agriculture practices (including AEM measures in Rural Development Programmes 2014-2020 could be applied in each region partner of the project (Veneto, Emilia-Romagna, Friuli Venezia Giulia, Piemonte e Lombardia).

Further references

www.lifehelpsoil.eu

In-Farm remediation by solar photocatalysis of agro-waste water with pesticides from remnants, cleaning and rinse

Promoter	Murcia Institute of Agri-food Research and Development IMIDA
Period	2014 - 2018
Location	Murcia (Spain)
Objective	In-Farm remediation of agro- waste water
Target Audience	Farmers, Extension Services and Administrations
Level	National, Regional
Accessibility	Website and visits to locations
Contact	fulgencio.contreras@carm.es

Project description

The project will demonstrate a technically, economically and ecologically feasible method by which pesticide residues contained in the waste water produced by farms can be neutralised. The use of innovative equipment will allow pesticide remnants in containers and treatment tanks and rinse water from tanks after cleaning of machines and equipment to be dealt with.

The project will develop a **pilot waste-water decontamination facility** to be tested on five farms. It will use a solar photocatalysis degradation process. The system uses solar energy (UV irradiation), sodium peroxodisulphate ($Na_2S_2O_8$) and a catalyst (TiO_2 and ZnO). The catalyst is recovered at the end of the process for its re-use. Treated waste water is no longer contaminated and can be used again for any purpose (e.g. irrigation).

Expected results

The main result of the project will be the development of an on-site waste-water decontamination plant able to completely degrade pesticides without generating any other residue.

The main expected long-term achievement of the project is the implementation of the Aquemfree system in medium-

size and large farms, which would provide a solution for 80-90% of this environmental problem, at least in Mediterranean farms thanks to their solar irradiation conditions.

Success factors

Multi-actor approach: manufacturers and potential final users are involved in the project. Research institutions: IMIDA and University of Murcia

Potential final users: FECOAM (Murcia Federation of Agricultural Cooperatives) System manufacturer: Novedades Agrícolas S.L.

Performance indicators

The project includes the evaluation of the **prototypes** from the technical, environmental and economic points of view.

Repeatability & Applicability

The final objective is to have a commercial system ready in the farms.

Further references

Natural treatment systems for wastewater reuse in irrigation

Promoter	*Department of Agri-food and Environmental Systems Management, University of Catania*
Period	*Since 2001*
Location	*Sicily, Italy*
Objective	*Sustainable water reuse in irrigation*
Target Audience	*Authorities, companies, public and private agencies working on water management, students, farmers*
Level	*National, Regional*
Accessibility	*Upon request*
Contact	*attilio.toscano@unict.it*

Demonstration Site description

The permanent exhibition on natural wastewater treatment systems aims to providing technicians, students and farmers with up to date information about these sustainable systems and their capability to produce unconventional water source for reuse in irrigation. Two natural wastewater treatment systems at full-scale and pilot-scale are in Eastern Sicily. The full-scale natural wastewater treatment system is used for tertiary treatment of secondary effluent from a conventional wastewater treatment plant. It is made of 4 horizontal subsurface flow (H-SSF) constructed wetlands (CWs) (about 2,000 m^2 each), functioning in parallel, followed by three batch wastewater storage reservoirs (S). The natural wastewater treatment system at pilot scale consists of a lagoon system (of about 50 m^3) followed by a wastewater storage pond (of about 100 m^3), functioning in series, that treat part of CW effluent. Treated wastewater is used for irrigation of energy (*Arundo donax*) and food crops using micro irrigation techniques. Students, scientists, politicians, decision makers and technicians on water management can take a practical class on natural wastewater treatment systems visiting the permanent exhibition (full and pilot scale plants). The permanent exhibition offers the opportunity to local, national and international stakeholders to access operational knowhow on more efficient wastewater treatment and reuse in irrigation.

Results obtained so far

To increase knowledge on natural wastewater treatment and irrigation with treated wastewater in the Mediterranean area. The plants were used within the FP7 research project WATER4CROPS.

Success factors

Training by demonstration and opportunity to visit the natural wastewater treatment systems while operating. Direct contact with UNICT experts.

Performance indicators

Since 2001 an average of 100 persons per year (students, scientists, politicians, technicians) visit the natural wastewater treatment and reuse systems and attend workshops where UNICT experts explain technical, operational and management aspects on natural treatment systems for wastewater reuse in irrigation.

Repeatability & Applicability

Similar exhibition on natural treatment wastewater systems can be easily set up where there are available marginal lands. Permanent exhibitions on natural treatment systems were set up in other part of Sicilian region (Catania, Grammichele, Noto) under UNICT supervision.

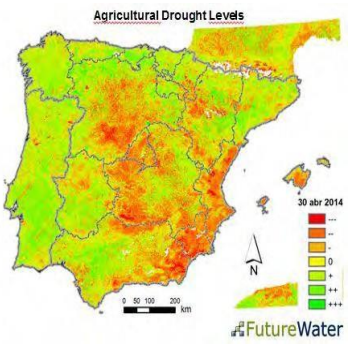
Further references

-Toscano A., Hellio C., Marzo A., Milani M., Lebret K., Cirelli G.L., Langergraber G.(2013), Removal efficiency of a constructed wetland combined with ultrasound and UV devices for wastewater reuse in agriculture, Environmental Technology, Volume 34, Issue 15, pp 2327-2336

-Aiello R., Cirelli G.L., Consoli S., Licciardello F., Toscano A. (2013). Risk assessment of treated municipal wastewater reuse in Sicily. Water Science & Technology, 67(1), pp. 89-98

GESEQ: A toolbox for integrated management of droughts

Promoter	*FutureWater*
Period	*Since 2013*
Location	*Iberian Peninsula; Segura River Basin (SE Spain)*
Objective	*Developing a Decision Support System for Drought Management*
Target Audience	*Water decision-makers; Agricultural Associations; Insurance Companies*
Level	*Regional, Basin-scale*
Accessibility	*Monitoring tool: web-based service Decision Support System: under contract*
Contact	*j.hunink@futurewater.es* *s.contreras@futurewater.es*



Project description

The GESEQ project aims to develop a prototype of a Support System for Drought Management integrating a set of tools for: a) the detection, surveillance and monitoring of drought periods, b) the prediction and spatial analysis of drought impacts, and c) decision support to water managers on the most effective management strategies to mitigate drought consequences. The GESEQ system connects data available in the cloud (satellite data, and ground-based monitoring networks) with a set of environmental simulation models, and the human-decision sphere. It uses a combination of GIS applications, satellite data acquisition, assimilation and processing tools. The GESEQ system consists of two main components: (1) an operational real-time Drought Monitoring tool that generates maps of indicators, indices and alert levels and provides clear- cut information on the nature of each drought period, and (2) a Drought Prediction tool providing short- term and seasonal predictions on drought impacts and the effectiveness of possible management strategies to prevent and minimize them. At present, first component has been set up at the national level (Spain and Portugal) providing information since 2002 up to nowadays, while the second one is being parameterized and tested in the Segura River Basin.

Results obtained so far

The prototype is still under development and a first version of the platform is online. Partial but promising results have been obtained and presented in international meetings and in the media. New relationships have been found between meteorological drought with agricultural impacts.

Success factors

GESEQ is an operational and integrated Decision Support System which provides straightforward information on the drought conditions of a region through a simple and interactive web-mapping platform. Based on this information, a predictive tool has been linked to predict the impact of droughts and different management strategies on the water availability of a particular basin. GESEQ toolbox will be an effective platform for water decision makers, agricultural associations, and insurance companies.

Repeatability & Applicability

The GESEQ Drought Management System is designed and developed as a versatile and flexible decision support system that can be implemented in other drought-prone regions after local calibration and tailoring. Especially the Predictive Drought module requires local data to meet adequately the end-users needs

Further references

Project website: http://www.futurewater.es/home/proyectos/geseq/
Press release: http://www.futurewater.es/2014/05/
Publication: Contreras, S., Hunink, J. Drought effects on rainfed agriculture using standardized indices: A case study in SE Spain. International Conference Drought R&SPI. Valencia, 2015. Accepted.

Pilots on water management

Promoter	*Marijke Dierickx*
Period	*Since 2002*
Location	*PCS Ornamental Plant Research*
Objective	*Sustainable and innovative water management*
Target Audience	*Growers of ornamental plants, Technicians, Students*
Level	*International, National, Regional*
Accessibility	*Open days are organised for growers. Visit can be organized on request.*
Contact	*Marijke.dierickx@pcsierteelt.be*

Demonstration Site description

PCS Ornamental Plant Research has different pilots for water management:

1.Constructed wetland: The constructed wetland is part of the PCS-infrastructure which is necessary to comply with legislation on nutrient-leaching to surface water. It is also a demonstration set-up as this technique is not yet often implemented in practice. Since 2001 data on denitrification is collected. PCS has a two-fase constructed wetland with fase 1 ‚percolation' and fase 2 ‚root zone'. In the percolation fase, ammonium is converted into nitrate, in the second fase, nitrate is reduced till nitrogen gas. Brochure on construction, working principle and efficiency of constructed wetland at PCS: (Aanleg enwerking van een rietveld' in Dutch);

2. P-FILTER AFTER CONSTRUCTED WETLAND: Although denitrification is sufficient when using a constructed wetland, the P-content of our waste water (of ornamental crops) is still above the EU-limit for discharge in surface water. Therefore, we included a P-filter after the constructed wetland. The pilot-installation (2013) performed very well and from 2014 on we will test a larger scale P-filter to dephosphatate all our waste-water. Since 2013 data on dephosphatation are collected.

3. BIOBED SYSTEM: A closed biobed system in which soil organisms enable biodegradation of crop protection products (pesticides) in waste water. The cleaning water of the spraying tank and the rests of spraying solutions are purified by the biobed system. Since 2001, PCS has a biobed system for their waste water. In 2014, a new biobed system was constructed at PCS.

4. RECYCLING SYSTEM: On PCS Plant Oramental Research, there are lot of other techniques/installations to visit: quick test for Pythium and Phytophthora in recirculation- or irrigation water / disinfection of irrigation water: UV, slow sand filter, alternative methods/closed growing systems and recirculation / storage capacity of rainwater / irrigation on plant demand based on sensor technology / bioremediation, avoiding contamination with crop protection products / waste water: reduction and processing / reducing nutrient leaching in closed growing system, enhancing nutrient use efficiency / constructed wetland/ Prevention and decontamination of bacteria films and algae in irrigation systems.

Similar demonstration sites are available through Sister Institutes PCA Potato Research and PCG Vegetable Research for vegetable horticulture and agriculture.

Results obtained so far

The pilots are demonstrated during several dissemination activities and guided visits. The annual number of visitors of the pilot (research, practitioners, education, farmers, ..) is 500 visitors for guided tour/year; including participants to information sessions: 1000 visitors/year

Success factors

The pilots will demonstrate and stimulate growers to invest in more sustainable production. Nutrient leaching to surface water and discharge of waste water will reduce.

Performance indicators

Due to a more sustainable production in agriculture and horticulture, the quality of the surface water in Flanders improves every year.

Repeatability & Applicability

PCS has expertise in building Low entry demonstration sites that ensure implementation of innovative technology on the farm. Sufficient attention is given to technological efficacy vs economic feasibility, i.e. is the investment cost justified for the intended goal. PCS has year-long technical expertise to find solutions to grower challenges in water management.

Further references

www.pcsierteelt.be adviesdienst water ; www.waterportaal.be
Publications in grower magazines (in Dutch) e.g., Sierteelt & Groenvoorziening Presentations at grower-info-sessions
Brochure: Recirculation in greenhouse horticulture (in Dutch)

Permanent testing field on irrigation management strategies

Promoter	*Landwirtschaftskammer Niedersachsen*
Period	*Since 1995*
Location	*Suderburg, Lower Saxony, Northern Germany*
Objective	*Testing and Dissemination of Irrigation management*
Target Audience	*Advisors, farmers, students, researchers*
Level	*International, national, regional*
Accessibility	*Open days are organised or on request*
Contact	*ekkehard.fricke@lwk-niedersachsen.de*

Demonstration Site description

The permanent experimental field on irrigation aims providing advisors, researchers, farmers, students, water politicians and public with information about important questions of irrigation management and irrigation steering. Water saving novel concepts are examined to be evaluated for end users and Extension Services drawing attention on the opportunities to improve irrigation water management at field or farm scale. The ongoing1 new results of the more year testing of new strategies, cultures, varieties, percolation, nutrient losses etc. are published annually and spread among the Lower Saxony irrigators community and other interested persons. The results are especially the basis of an economic evaluation and also offer the opportunity to the local, national and international water stakeholders to provide basic knowledge addressing a more efficient water use.

Results obtained so far

Stimulation of a water saving awareness and culture among end users. Fast and wide dissemination of novel irrigation strategies and irrigation management technologies.

Success factors

Long-term availability of a research site working at a scientific basis.

Performance indicators

Immediate introduction of the results to the irrigators through integration into the Lower Saxony irrigation counselling system, accompanied by annual conferences and annual publishing.

Repeatability & Applicability

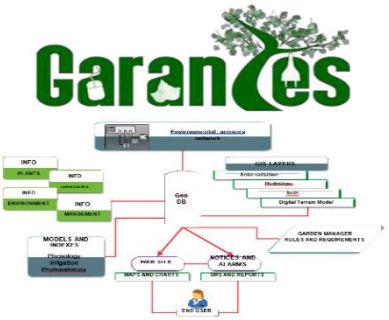
Upcoming new aspects of irrigation strategies and management are picked up continuously and transformed into scientific on field research.

Further references

http://www.lwk-niedersachsen.de

Decision support system for irrigation and pest management: GARANTES

Promoter	*Consiglio Nazionale delle Ricerche (CNR-IBIMET) and Consiglio per la Ricerca e la sperimentazione in Agricoltura (CRA-VIV)*
Period	*Since 2012*
Location	*Tuscany, Italy*
Objective	*Sustainable irrigation and pest management*
Target Audience	*Farmers, gardeners and extension services*
Level	*National, regional*
Accessibility	*Web based service*
Contact	*piero.battista@cnr.it* *sonia.cacini@crea.gov.it* *daniele.massa@crea.gov.it*



Project description

GARANTES is an integrated system for the optimized irrigation and pest management of green urban and private areas, gardens and nurseries. GARANTES consist of i) a wireless net of sensors for the environmental monitoring that records information about climate parameters such as radiation, air temperature and humidity, soil temperature and humidity, rain depth and wind velocity; ii) a database that contains information about plant irrigation requirements and their susceptibility to pathogens; iii) a computer program for the elaboration of all collected environmental parameters. Basing on models and algorithms for estimating plant water requirement and pathogen occurrence, GARANTES is able to trigger irrigation when necessary and give information about the possible presence of pathogens harmful for the cultivated plants. The application of GARANTES would support irrigation and plant protection with the final aim of optimizing the use of irrigation water and agrochemicals use.

Results obtained so far

GARANTES allowed, in the last years, to save 20-50% irrigation water (depending on season), with respect to standard timer-based irrigation control.

Success factors

The key element that makes the system reliable and effective in crop management is the estimation of plant needs on the basis of parameters measurable through crop sensors.

Performance indicators

Water use efficiency, amount of water and agrochemicals used per year. Comparison between sites managed by GARANTES and sites managed by standard practices.

Repeatability & Applicability

GARANTES is a modular system potentially unlimited. Some algorithms could require recalibration for specific climate conditions and/or plant species.

Further references

http://www.garantes.it/

Instituto Superior de Agronomia (ISA), Universidade de Lisboa

Promoter	*Water, Natural Resources and Climate at Biosystems Engineering Centre host by Instituto Superior de Agronomia (ISA) at Universidade de Lisboa*
Period	*ISA exists since 160 years and has focused experimental research on this topic for more than 30 years.*
Location	*Lisboa, Portugal*
Objective	*Sustainable irrigation management*
Target Audience	*Students, researchers, farmers and extension services*
Level	*National*
Accessibility	*Scientific and technical publications, seminars, courses, open-days*
Contact	*Contact person in this context: isabelferreira@isa.ulisboa.pt*

Project description

Several tools for water management in irrigated agriculture have been developed using information from literature as well as our own results of more than 30 years of research on plant water relations, water use and irrigation management. The practical aim is to increase the irrigation efficiencies at different space scales (irrigation project to plot level) and increase irrigated areas while reducing water use for irrigation without significant loss of yield quality and quantity. As normal for a university institution the research results become public via publications, courses, and seminars at national and international level, serving a larger audience. The outcomes from ISA experimentation and research serve also as basis to local organisms in direct contact with farmers which provide information based on web and GIS (e.g COTR www.cotr.pt), freely available for members, providing a friendly 'irrigation advice' for locally representative crops, making use of meteorological data and soil data provided by such local services. Optimal irrigation volume and interval for each crop is provided for average conditions. The crop water balance can also be calculated at field scale on a daily basis and adapted to the crop and farmer practices, with data simulated or inputted by each farmer. ISA had intensive field experiments in several regions and for several crops, providing information to sustain such routines and also discuss alternative approaches. In case of the region where COTR operates, and in many other cases, a routine process includes open-days and seminars for final users, visits to the fields and public presentation of final results with discussion involving technicians and farmers.

Results obtained so far

Students preparation; scientific and technical publications, seminars and courses for final users (more than 100 in the last 6 years), research, experimentation and demonstrative projects focusing this topic (more than 20 in recent years by the group: 7 professors + Ph D students and other collaborators). Non-quantifiable in terms of saving water.

Success factors and Performance indicators

Research made by a group of agronomy engineers with irrigation science background (agricultural engineering specialization in a 6 years degree course as the basis of the academic preparation) provides conditions for an adequate, interdisciplinary and sound based approach, not only to help users in deciding when and how much to irrigate but also in analysing environmental impacts, hydraulics infrastructure design and management, equipment's performance and social aspects related with irrigation issues.

Repeatability & Applicability

The research approach used ensures its maximum repeatability and applicability, by avoiding experimental practices which give answers of limited application out of the range of conditions for which they were obtained.

Further references

Selected publications focused on irrigation scheduling applications with a first author from this ISA team (only those with Ferreira M.I. as co-author (2008-2013)).

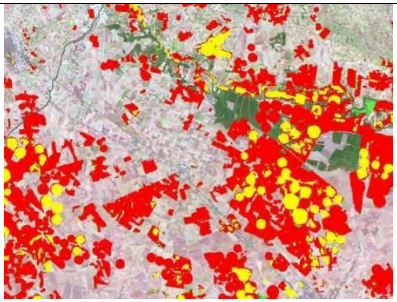
Paço T., Ferreira M.I., Pacheco C.A. 2013. Scheduling peach orchard irrigation in water stress conditions: use of relative transpiration and predawn leaf water potential. Fruits 68 (2):147-158. (http://dx.doi.org/10.1051/fruits/2013061)

Ferreira, M.I., Silvestre J., Conceição N., Malheiro C. 2012. Crop and stress coefficients in rainfed and deficit irrigation vineyards using sap flow techniques. Irrigation Science 30 (5): 433-447.
(http://link.springer.com/article/10.1007%2Fs00271-012-0352-2).

Paço T.A., Ferreira, M.I., Rosa R.D., Paredes P., Rodrigues G.C., Conceicao N., Pacheco C.A., Pereira L.S. 2011. The dual crop coefficient approach using a density factor to simulate the evapotranspiration of a peach orchard: SIMDualKc model versus eddy covariance measurements. Irrig Sci (DOI 10.1007/s00271-011-0267-3).

Satellite-assisted irrigation management and farm advisory webGIS SPIDER-SIRIUS

Promotor	*Universidad de Castilla-La Mancha, Instituto de Desarrollo Regional and AgriSat s.l.*
Period	*1998 to present (regional operational project ERMOT); 2002 to present (EC projects DEMETER, PLEIADeS, SIRIUS and serveral national projects)*
Location	*Spain (starting in La Mancha, now extending nationwide), operational service or pilots in Southern Italy, Portugal, Turkey, Greece, Romania, Morocco, Egypt, Mexico, Peru, Brazil, U.S., India*
Objective	*Sustainable irrigation water management and river-basin governance*
Target Audience	*Water managers at all levels (national, river-basin, aquifer, irrigation scheme, farm holding); Farm Extension and Irrigation Advisory Services*
Level	*Local, Regional, National*
Accessibility	*webGIS*
Contact	*Anna.Osann@uclm.es; Alfonso.Calera@uclm.es*



Project description

The FP7 project SIRIUS has developed efficient water resource management services in support of food production in water-scarce environments. It addresses water governance and management in accordance with the vision of bridging and integrating sustainable development and economic competitiveness. The project has developed new services for water managers and food producers, including maps detailing irrigation water requirements in different areas, crop water consumption estimates, and a range of additional information products in support of sustainable irrigation water use and management under conditions of water scarcity and drought. Applying an integrated approach based on public participatory geographic information systems (ppgis) and social multi criteria evaluation, SIRIUS has developed a GMES/Copernicus service that considers the interrelated economic, environmental, technical, social and political dimensions of the food-water challenge.

Success factors

The system is intuitive, easy to use, and provides accurate numerical information along with spatial visualization, personalized for each parcel (based on actual observations of crop status, which is more accurate than average per-crop values). Users at all levels (after receiving some training) have experienced the power of the tool/system to help them save water, and thus, money, while maintaining or even increasing their yields.

Performance indicators

Performance has been assessed using validation criteria of accuracy, reliability, repeatability, water and energy savings potential. An integrated multi-criteria analysis framework has been developed and implemented to assess technical, economic, social, and environmental efficiencies.

Repeatability & Applicability

Transferability has been demonstrated in 13 countries on 4 continents. A framework for adaptation to local conditions as well as local calibration/validation has been developed.

Further references

www.sirius-gmes.es; www.agrisat.es

Model-based irrigation in butterhead lettuce

Promotor	*Inagro*
Period	*Since 2013*
Location	*Flanders – Belgium*
Objective	*Sustainable irrigation management*
Target Audience	*Growers and Extension Services*
Level	*Regional*
Accessibility	*Free, upon request*
Contact	*pieter.vanhassel@inagro.be*

Project description

The aim of this project is to predict evapotranspiration in butterhead lettuce. Therefore, a model, based on the model of Penman-Monteith, developed in 1997-2001 will be overhauled. This model uses a sub-model to calculate the vertical projection instead of the leaf area index and uses a sub-model to calculate the stomatal resistance. Although tested for many years, this model was only validated in winter conditions and for plants being mainly in the heading stage. It also requires measurement of several microclimate variables (RH, air and leaf temperature, irradiation, net radiation; see picture). In order to obtain a good prediction of evapotranspiration the model will be validated in and, if necessary, adjusted for summer conditions. Also, the contribution of each sensor will be evaluated, in order to eliminate it if possible. This would reduce the application cost of the model for growers and increase the feasibility. In 2016-2017 the optimised model will be tested in practice.

As an experimental setup, mini-floating units are installed, each having 6 plants growing. In each growing cycle, mass losses are monitored continuously, together with micro-environmental conditions (picture). Since evaporation in floating systems is usually limited, a cloth mimicking the soil was positioned upon the foam, with the edges hanging down in de nutrient solution. The water absorbed by capillarity is evaporated between the plants.

Results obtained so far

In 2014, the experimental design was optimized: the colour of the cloths was adjusted to obtain an albedo comparable to that of the soil, suitable measures to prevent algae and salt deposits on the cloths were evaluated and oxygen supply was improved. A first test of the model showed that the sub-model for calculation of the transpiring plant surface might have to be reconsidered.

Success factors

There is a large interest of growers in systems predicting water usage, as a reference for irrigation. Optimal irrigation can reduce disease damage and improve crop quality and yield. Moreover, it can increase water use efficiency, and reduce leaching of nitrate. New national regulations in the frame of European directives about soil water quality could enhance the need for growers to use irrigation models. However, as rentability of vegetable growing actually is quite low, final application will depend largely on the cost of it. This will, in turn, be determined mainly by the achieved reduction of needed sensors.

Performance indicators

Application of the evapotranspiration model by growers will be the best indicator for its success.

Repeatability & Applicability

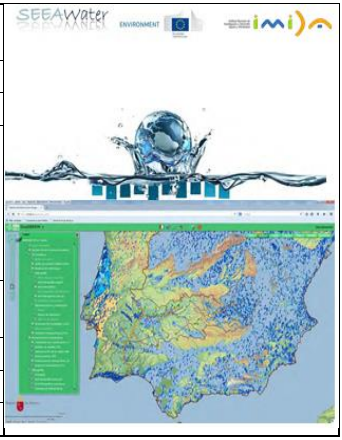
If successful, the model can be used to irrigate butterhead lettuce in many other regions with minor adjustments. Also, the knowledge gathered will allow transferability to other crops.

Further references

None so far.

New developments in Water Accounts Implementation in Guadiana river basin (GuaSEEAW+)

Promoter	Murcia Institute of Agri-food Research and Development IMIDA
Period	2013 - 2015
Location	Murcia (Spain)
Objective	WebGIS: To support implementation of environmental-economic accounts, the System of Environmental-Economic Accounts for Water (SEEA-Water), a SEEA sub-system, provides compilers and analysts with agreed concepts, definitions, classifications, tables, and accounts for water and water-related emission accounts.
Target Audience	Administrations
Level	International, national
Accessibility	Website and WebGis
Contact	smontesinos@geodim.es manuel.erena@carm.es



Project description

The Preparatory Action on development of prevention activities to halt desertification in Europe will fund New developments in Water Accounts Implementation in Guadiana river basin (GuaSEEAW+). The project aims to continue obtaining new, current and detailed information on water resources to demonstrate water saving potential by the identification of management, technical and economic measurements with the view to halting desertification in Europe. GuaSEEAW+ is a continuation of GuaSEEAW project carried out during previous call http://ec.europa.eu/environment/water/blueprint/balances.htm, in which 13 SEEAW tables were implemented at monthly resolution and several indicators were obtained from these tables to improve water saving.

Results obtained so far

The main result of the project will be the development of an on-site waste-water decontamination plant able to completely degrade pesticides without generating any other residue. The main expected long-term achievement of the project is the implementation of the Aquemfree system in medium-size and large farms, which would provide a solution for 80-90% of this environmental problem, at least in Mediterranean farms thanks to their solar irradiation conditions.

SEEAW is an information system that feeds knowledge into decision-making process, assisting policy makers in taking informed decisions on:

a) Allocating water resources efficiently.
b) Improving water efficiency.
c) Understanding the impacts of water management on all users.
d) Getting the most value for money from investment in infrastructure.
e) Linking water availability and use.
f) Providing a standardized information system which harmonizes information from different sources, is accepted by the stakeholders and it's used for the derivation of indicators.
g) Getting stakeholders involved in decision-making.

SEEAW comprises five categories of accounts: Physical supply and use tables and emission accounts, Hybrid and economic accounts, Assets accounts, Quality accounts and Valuation of water resources.

Success factors

Multi-actor approach: final users, research institutions an SME are involved in the project.

Research institutions: IMIDA
Final users: Guadiana river basin Office; Spanish Ministry of Agriculture (MAGRAMA); National Statistics Institute (INE).
SME: SM GEODIM (Project coordinator), ZETA AMALTEA

Performance indicators

The project includes the evaluation of the prototypes from the technical, environmental and economic points of view.

Repeatability & Applicability

The final objective is will implement water resources balances at the local scale and monthly resolution elaborated in the framework of the SEEAW, as well as the identification of new measures that allow an optimal water management in Guadiana international river basin, for last hydrological year (2010 -2011).

Further references

Website: http://www.seeawater.eu
WebGIS: http://iderm.imida.es/guaseeaw_plus/

Sistema de Información Agraria Information de Murcia
Murcia Agriculture Information System

Promoter	Murcia Institute of Agri-food Research and Development IMIDA
Period	Permanent
Location	Region of Murcia (Spain)
Objective	Irrigation adisory system
Target Audience	Farmers, Extension services and administrations
Level	Regional
Accessibility	Website and visits to locations
Contact	fulgencio.contreras@carm.es

Project description
SIAM is a Water Demand Management Tool to improve the efficient use of water in agriculture with:
- Agrometeorological Station Network (49 stations in irrigated areas)
- Software developed by IMIDA and Computer System
- Technical Team

Through a daily automatized data acquisition and validation protocol, the agrometeo-database is updated and available on the Internet on an open and cost-free approach. Agrometeorological reports are generated on demand, including ETo, by choosing the station/s, the parameter/s, and the period. Real time data are also available.
Personalized irrigation and fertilization plans: Tailor-made irrigation programs for farmers/technicians, by choosing location, crop, phenological phases, irrigation system, period…

Results obtained so far
During the 90's the system was developed and implemented to promote and improve the efficient use of water in agriculture, in special targeted to drip irrigation (120.000 ha). Nowadays it is widely used by farmers and advisors.

Success factors
Promotion and training program for years among potential users. Experimentation program to test and validate the results of the irrigation programs. The interface was recently renewed to make it easier and more comfortable to use.

Performance indicators
In 2012 – 2014 SIAM had 1178 users (Farmers and agri-business companies, R+D institutions, administration…) from more than 10 countries in Europe and America in 54.000 sessions.

Repeatability & Applicability
SIAM can be transferred to other regions to improve water use efficiency through the adaptation to crops and phenology. It can be made at different levels of complexity, from data management to the complete system.

Further references
http://siam.imida.es/

Dissemination activities in Arenales aquifer

Promoter	*Tragsa*
Period	*Since 2002*
Location	*Segovia province, Castille and Leon, Spain*
Objective	*Dissemination of MAR activities and its inclusion in water management, as well as the advantages for irrigation in the area*
Target Audience	*Farmers, Students*
Level	*National, Regional*
Accessibility	*Two Workshops have been recently celebrated with a presentation specific for the wire topic*
Contact	efernan6@tragsa.es

Recharge device

Demonstration Site description

Since 2002, when MAR activities began in this sector of Arenales aquifer, (considered a construction for the general interest of the nation), recharge activities have been accomplished by means of the irrigation community, who counted on the support, when they required it, from the technicians involved in the studies and construction work. After a decade, some articles and books as well as abundant information have been published, specially directed to technicians and researchers, but there are still many users and farmers who ignore a great part of this activity. Within this context, this workshop, that has been called MAR4FARM is specially dedicated to farmers as main user of groundwater resources, in order to solve some doubts, they could have (avoiding technical language), as: what were these building works made for? Why is it profitable for agriculture? How does the aquifer behave? What should know a farmer on water managing? These questions plus all those that might arise, will be debated by the technicians participating in the project, works, irrigation community board, municipalities, Douro river and Junta de Castille and Leon basin civil servants, as agents more dedicated to the activity, together with farmers, the real part of this story.

Results obtained so far

The awareness process on energy saving by means of alternative resources has started, as irrigation with electricity obtained from solar panels. Some members in the irrigation communities attended the workshop, receiving advise on the pros and cons of the activity.

Success factors

Training by demonstration and opportunity to check other farmer´s experience. Direct contact with installers and manufacturer. Involvement of private companies and spin-off companies from technological centres for energy savings.

Performance indicators

Indicators are related to the irrigation community evolution: number of farmers, hectares in irrigation and the evolution of the number, etc. The indicators system is being currently developed.

Repeatability & Applicability

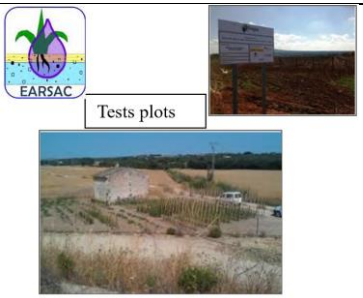
Similar workshops can be easily set up in other villages of Arenales aquifer selected by its feasibility. The study of the potential tax of return should be performed.

Further references

http://www.dina-mar.es

Dissemination activities in Majorca island (EARSAC pilot)

Promoter	*Tragsa*
Period	*Since 2012*
Location	*Majorca island, Spain*
Objective	*Dissemination of advantages and cons observed after three years of irrigation with regenerated water in different crops*
Target Audience	*Farmers, population in general*
Level	*National, Regional*
Accessibility	*Two articles have been recently published at National scope*
Contact	efernan6@tragsa.es



Demonstration Site description

EARSAC project (Spanish Government support, CP 34-21.043) studies the effect due to irrigation with reclaimed water proceeding from waste water treatment plants, on plants, soils and aquifers. The approach is considered as a whole. The demo sites are three orchards distributed in Majorca Island (Spain) but one in special is under well controlled conditions (Maria de la Salut).

Results obtained so far

By the moment have been tested different scenarios of irrigation with and without fertilizers in different crops. No workshops have been performed apart from internal meetings.
Two articles have been published in 2014 in the irrigation national conference (June) and National environmental conference (November).

Success factors

Irrigation with reclaimed water is currently a hot spot, especially from the points of view of its psycho-social perception and the presence of emergent pollutants. The pilot adopts Spanish regulation on irrigation, regarding quality standards. No affection on soils, aquifers and plants have been detected so far. A bigger effort must be made to find out the pros and cons of this “new water” source.

Performance indicators

A broad number of indicators are being designed right now, exposed in the second article (Spanish language):
http://www.conama2014.conama.org/conama10/download/files/conama2014/CT%202014/1896711840.pdf

Repeatability & Applicability

Similar experiences can be easily set up in other Mediterranean areas. It is not so clear for other climate sceneries.

Further references

http://www.conama2014.conama.org/conama10/download/files/conama2014/CT%202014/Paneles/1896711840_panel.pdf

Permanent Exhibition on Irrigation Technologies

Promoter	*Empresa de Transformación Agraria, S.A.*
Period	*Since 2006*
Location	*Castilla & Leon Region , Spain*
Objective	*Efficiency in irrigation areas*
Target Audience	*Water management actors, water authorities, irrigation areas, farming, and Scientifics and ICT industry.*
Level	*International, national, regional*
Accessibility	*Publications, innovation trials, visit on request*
Contact	*siglesia@tragsa.es*

Pumping station in Porma Area

Demonstration Site description

OPTIREG "Efficient management in irrigation areas", offers solutions in the irrigation sector researching more deeply into technological innovations in irrigation. OPTIREG started in 2013 and wants to involve and optimize management and decision making processes increasing efficiency hydropower. As immediate outcome it also increases economical profitability in irrigation agriculture. To achieve innovation management in irrigation, OPTIREG has created four scenarios. These are scheduled along the following years and interrelated. These scenarios are: 1) renewable energy 2) energy market models; 3) water efficiency; 4) energy efficiency.

There is a *demo sites in Leon*, addressing 2) energy market models3) water efficiency and 4) energy efficiency, that is de water community from "Lef side of Porma River" in which, Tragsa, during six years, has obtained an optimum amount of water and energy balance. User communities follows a dynamic demand schedule model instead of a fixed scheduled model designed out of user needs and request.. This demo site have a) organised irrigation demand, b) contracted power reduction, c) unitary price energy reduction, d) energy dynamic buying in global markets.

There are another *demo sites about renewable energy in irrigation areas of Rioja, Navarra, Castilla León, Almería and Valencia*. In this areas have been realised technical-economic projects on the use of renewable energy to irrigate. There is a comparative study between the utilization of renewable energy or conventional energy.

Demo sites in Castilla León and Rioja are about energy efficiency. In this areas an exhaustive study about energy consume in the irrigation network have been made. The kilowatts used for irrigation have considerably decrease.

Results obtained so far

Energy consumption savings (kwh/m3) up to 22%.
Energy cost savings (€/kwh) over 15%
Studies in pilot areas about renewable energy in irrigations
Water efficiency through remote sensing: EO (Earth Observation and Satellite Data) UAV and RPAS
Water efficiency through field sensors
Energy efficiency software.

Success factors

The prototype created in Porma region, can be easily replicated in other irrigation areas. The key element which made this project successful is the smart management in irrigation areas. The success factors are savings and better water/energy balance with the following milestones:

1) Establishing criteria for implementation of renewable energy end 2015.
2) Energy cost savings in three national irrigation areas mid-2016.
3) Energy consumption savings over 22% in the demo site in León end 2015.
4) To fix the Kc of each crop to plot level mid-2016.

Performance indicators

The performance indicator are:

1) Implementation of renewable energy in irrigation areas.
2) A publication of alternative energy contracting for the irrigated areas and guidelines to follow for the best option in each irrigation area.
3) A publication of Energy saving measures in irrigation areas
3) Energy Consumed ratio optimization / Pumped Volume (kwh/m3)
4) To apply the right amount of water at the right moment in each cultivation.
5) Mobile Apps

In addiction:

- Real-time detection of incidents at minimum cost.
- Operation control in irrigation area in an integrated way.

Repeatability & Applicability

This models is extrapolated to each irrigation area, consider the specification in each area and to have in consideration the regulation and laws in energy and water in every country.

Further references

http://www.congresoriegos-aeryd.org/; http://smartopendata.net:8788/geoserver/OPTIREG/wcs; www.databio.eu

MEGA: Remote Monitoring and control Technologies: Interoperability

Promoter	*Estación Experimental Aula Dei. CISC Empresa de Transformación Agraria, S.A.*
Period	*Since 2010, launched as permanent facility.*
Location	*Zaragoza, Spain*
Objective	*Harmonization and validation of water technologies, disseminate and promote remote control systems on irrigation networks.*
Target Audience	*One Collective Distributed Networks, manufactures remote control systems, farmers,, Water Authorities, ITC providers.*
Level	*International, national, regional*
Accessibility	*Publications, innovations trials, visit on request*
Contact	*rsalvador@eead.csic.es; siglesia@tragsa.es*

Trial laboraty MEGA model

Demonstration Site description

The infrastructure is composed of a hydraulic network that can be managed by remote control systems. This infrastructure represents a real irrigation area in small scale. The hydraulic network is composed by two pumping stations and water tanks which simulates the capture and storage point. The control head is the beginning of the irrigation network that reproduces 20 hydrants (in reduced dimension) of a pressurized collective irrigation network. The hydrants govern two block hydraulic valves (representing a very simple plot) and the pipe finish in a closed water cycle pipe. Each hydrant has an individual closet to arrange the remote control and telemetry systems to test. The remote control system can govern the 20 hydrants and their block hydraulic valves, including the open and closing of the valves, the pumping stations (measured of volume and drive the variable speed of the pump) and the reading of the hydrant volumes by pulses, flow sensors and pressure transducers measurements. A control house lodge the centralization equipment of each remote station that communicate with its slave as well with a computer that executes a version ad hoc of management program (specialized database for WUA). The centralization equipment and the management program communicate using the developing proposed in the MEGA project. MEGA is a collective ammonization work between different remotes from different manufacturers. MEGA has been developed for Tragsa Company that has been supported for water agencies, remote manufacturers and management programs design in irrigation areas.

Results obtained so far

In general, the result obtained is the dissemination of novel irrigation technologies, boosting adoption of the more efficient technologies to promote sustainable use of water and energy to optimize the economical productivity. Specific results: 1) Tragsa has built a trial laboratory in EEAD´- CSIC involved leaded by Tragsa; 2) There is a draft model MEGA. This draft has been presented in TC23/SC18 in ISO; 3) Tragsa design and maintenance a Web about the project: www.iwaterrm.com

Success factors

Main goal is standardization of new technologies related with telemetry and remote control system to apply in irrigated agriculture. Training by demonstration and opportunity to check devices while operating. Direct contact with experts and manufacturers. Training by demonstration and opportunity to check devices while operating. Direct contact with experts and manufacturers. Specific success factors: i) Remote manufacturers adopting MEGA model in their products end 2015; ii) Management program for irrigation adopting MEGA model in theirs products end 2015; iii) MEGA according to AENOR and ISO end 2016

Performance indicators

The performance indicator are: 1) Percentage increase in MEGA model adoption; 2) Creating a standard from model MEGA consistent with ISO; 3) Percentage increase user of web site.

Repeatability & Applicability

Permanent exhibitions on telemetry and remote control irrigation technologies were not set up in other regions.

Further references

- Resolutions 31st Meeting ISO/TC 23/SC18 - Orlando, US, 3 Nov 2012
- Resolutions 33st Meeting ISO/TC 23/SC18 – Madrid, Spain, 28 May 2015
- Resolutions 34st Meeting ISO/TC 23/SC18 – Montpellier, France, 25 May 2016
- Resolutions 35st Meeting ISO/TC 23/SC18 – Fort Collins, USA, 17 June 2017
- An IoT based reference architecture for smart water management processes (JOWUA)
- An Internet of Things-based model for smart water management (PITS)

Reclaimed Water Use at Farm and Irrigation District in Miraflores (Spain)

Promoter	*Centro de Edafología y Biología Aplicada del Segura (CEBAS-CSIC)*
Period	*Since 2010*
Location	*Comunidad Regantes Miraflores (Jumilla, Murcia, Spain)*
Objective	*Dissemination and training on Reclaimed Water Use at Farm and Irrigation District scales*
Target Audience	*Water authorities, farmers, technicians, students*
Level	*International, national, regional*
Accessibility	*Visits organized on request.*
Contact	emilio@cebas.csic.es; jalarcon@cebas.csic.es

Demonstration Site description

Area of 1,329 ha cultivated with pear (45%), peach (32%), apricot (12%), olive (5%), plum (3%), vineyard (2%) and almond (1%). Water need is covered by 3.851 million m3/yr pumped up from underground water sources and 1.5 million m3/yr of reclaimed water from Jumilla Waste-Water-Treatment-Plant. In this demo-site area of Miraflores, a continuous demonstration of research, development and technological innovation on wastewater reuse is promoted. Different irrigation strategies, such as regulated deficit irrigation and precision irrigation attending leaf stem water potential and gas exchange rates, are applied. At the end of each irrigation season some gravimetric soil samples are taken at different depths to determine the accumulation of salts. Besides, the agronomic quality of treated wastewater effluent from the sewage treatment plant is registered by the use of a multi-parametric probe at the entrance of treated wastewater to the orchard to continuously measure T^a, pH, electric conductivity, dissolved oxygen, redox, turbidity and organic matter. These values compared with the minimum quality standards help deciding whether it is wealth and sustainable to use this water for irrigation or not. At the same time, the macronutrient (NPK) levels available from treated wastewater effluent are measured to accordingly adjust the ongoing fertilizers program. The goal is to optimize nutrient supply to the crop and achieve greater efficiency and thereby avoid excessive application of fertilizers causing leaching and/or negative effects on crop growth and the surrounding environment.

Results obtained so far

Stimulation of a waste-water treated reuse among end users. Fast and wide dissemination of reclaimed water irrigation technologies, boosting adoption of the more efficient best management practices.

Success factors

Involvement of end users in the application of sustainable irrigation practices by training and demonstration of the best management reclaimed water use. To promote the safe and efficient use of treated waste water in fruit crop production. Involvement of private companies and water authorities in the development and application of new irrigation systems and devices.

Performance indicators

Since 2010 more than 800 end users (mainly farmers from Miraflores irrigation district) have attended workshops, courses and open days in order to receive training performances related to the use of treated wastewater for irrigation. These training performances are also open to technicians, students and water authorities. A book entitled “Estudio de la viabilidad de uso de las aguas regeneradas procedentes de la EDAR de Jumilla en la Comunidad de Regantes Miraflores” has been published in 2012.

Repeatability & Applicability

Similar exhibition on wastewater irrigation technologies can be set up in other places, but the performance on this type of exhibition is not very easy because it is necessary to involve water authorities (related to WWTP management), end users (farmers’ cooperative) and research/technological supports. Besides the reclaimed water use for fruit crop

productions needs a big area of exhibition. In fact, we do not know another demo-site similar to this one in Europe.

Further references

Nicolas E., Pedrero F., Alarcón J.J., Mounzer O., Martínez V., Nortes P., Alcón F., Egea G., de Miguel M.D. Estudio de la viabilidad de uso de las aguas regeneradas procedentes de la EDAR de Jumilla en la Comunidad de Regantes Miraflores. Editor: CEBAS-CSIC; ETSIA-Cartagena
Cartagena (Spain), 2012. ISBN: 978-84-96997-76-9

Fiordelisi demo-site for agro-industrial wastewater reclamation for reuse in irrigation

Promoter	*Istituto di Ricerca Sulle Acque del Consiglio Nazionale delle Ricerche (IRSA CNR)*
Period	*Since 2011*
Location	*Puglia (South East Italy)*
Objective	*Test innovative approaches and technologies for agro-industrial wastewater reclamation*
Target Audience	*Agro-industry, water technology companies, research institutions*
Level	*International, national, regional*
Accessibility	*Visits organized on request*
Contact	*alfieri.pollice@ba.irsa.cnr.it*

Project description

Fiordelisi is a SME dealing with the production and transformation of horticultures, including conservation and packaging for delivery mainly towards the international market. The company owns large extensions of cultivated land and a factory where the products are prepared for direct consumption. It is located in a region (Puglia, South Eastern Italy) that, albeit being historically vocated to agriculture, lacks primary water resources. In the whole region, permanent rivers are absent and the groundwater is heavily affected by seawater intrusion due to overexploitation. In this context, all opportunities of limiting the consumption of natural water are critical, and the availability of alternative resources may become a competitive advantage for a business which strongly depends on the sustainability of the water balance. The company has its own wastewater treatment system, mostly treating wastewater from the industrial processing of vegetables (washing, conditioning, cooking, etc.), except a small contribution from the toilets. Treated volumes, strongly dependent on the production processes, are about 300 m3/d on average. The plant is based on a conventional activated sludge system. However, in order to better comply with the local standards for discharge and possibly recover the effluents for irrigation, this plant was upgraded with a tertiary membrane filtration system. Effluents from this tertiary treatment can be stored into existing reservoirs and used for irrigation at test fields owned by the company, where an on-line UV disinfection system has also been placed. This closes the loop and provides an optimized application of the principle of multiple use of water resources. As a matter of fact, in this scheme the same water volumes are used twice, first within the industrial transformation process and then for irrigating the crops that are subsequently processed.

Results obtained so far

On-going research projects are revealing the applicability of tested technologies for the production of effluents suitable for irrigation.

Success factors

The main innovation proposed at this site is the evaluation of the integration of treated wastewater reuse into the company's production process, and in particular the assessment of savings in terms of primary resources. This can be further extended towards a general assessment of the influence of wastewater treatment for reuse on the various factors affecting the company's performance, including energy efficiency, management and operation, external services, etc.. In other words, the sustainability of the proposed approach can be evaluated by running long-term and well monitored experimental activities at a relevant scale.

Performance indicators

The whole wastewater treatment and reuse system can be monitored in terms of: (i) process parameters at both the

activated sludge and membrane filtration plants, (ii) water quality at the different treatment levels, (iii) soil and crops quality, also with reference to possible accumulation of microbial indicators, organic and inorganic contaminants (including chemicals used in agriculture, salinity, metals, etc.).

Repeatability & Applicability

The approach adopted at this demo-site can possibly be reproduced at similar agro-industrial sites.

Further references

www.irsa.cnr.it

Castellana Grotte demo-site or municipal wastewater treatment for reuse in irrigation

Promoter	*Istituto di Ricerca Sulle Acque del Consiglio Nazionale delle Ricerche (IRSA CNR)*
Period	*Since 2011*
Location	*Puglia (South East Italy)*
Objective	*Test non-conventional technologies for municipal wastewater treatment for irrigation*
Target Audience	*Water utilities, municipalities, farmers, water technology companies, research institutions*
Level	*International, national, regional*
Accessibility	*Visits organized on request*
Contact	*alfieri.pollice@ba.irsa.cnr.it*

Project description

The municipal wastewater treatment plant of Castellana Grotte (a town located in Puglia, South Eastern Italy) hosts two large pilot scale installations for experimental testing non-conventional technologies specifically aimed at producing effluents to be used for irrigation. The demo-site includes a test field located immediately outside the treatment plant where horticultures can be grown for testing irrigation with different water sources. The two pilot plants are based on different treatment technologies and treat wastewater flows that are taken from the main plant at different points. The first plant is based on the technology IFAS-MBR (Integrated Fixed film Activated Sludge – Membrane BioReactor), and treats sewage after preliminary screening. The IFAS technology is based on the presence of plastic carriers in the aerobic bioreactor. These carriers promote biomass accumulation in the form of biofilm, and biological processes are carried out synergistically by the suspended biomass and the biofilm, resulting in limited biomass growth. Coupling the MBBR with an MBR has further potential benefits, since the membrane bioreactor allows optimal control of suspended biomass in terms of sludge retention time, possibly resulting in reduced production of partially stabilized sludge. Moreover, membrane separation results in high quality effluent in terms of suspended solids, favouring the adoption of UV disinfection technologies. In fact, the outlet of this plant is connected to a UV disinfection system that is activated when the irrigation line is switched on ("on demand" disinfection). The second pilot plant is based on the FDG technology (Filtro a Dischi a Gravità, Gravity Disk Filter). It treats a fraction of the secondary effluent taken downstream the secondary settling tank of the main wastewater treatment plant. Therefore, the FDG provides a tertiary physical treatment allowing for improved removal of residual suspended solids. The system is based on cloth filtration that is operated through a set of disks submerged into the tank. Also in this case a UV system is placed downstream and treats the effluent when irrigation is performed.

Results obtained so far

On-going research projects are revealing the applicability of tested technologies for the production of effluents suitable for irrigation.

Success factors

On-going research projects are revealing the applicability of tested technologies for the production of effluents suitable for irrigation.

Performance indicators

The whole wastewater treatment and reuse system can be monitored in terms of: (i) process parameters at both pilot plants, (ii) water quality at the different treatment levels, (iii) soil and crops quality, also with reference to possible accumulation of microbial indicators, organic and inorganic contaminants (including chemicals used in agriculture, salinity, metals, etc.).

Repeatability & Applicability

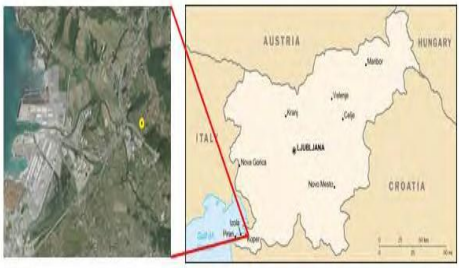
The approach adopted at this demo-site can be reproduced at virtually all municipal wastewater treatment facilities where effluent reclamation for irrigation is proposed.

Further references

www.irsa.cnr.it

Infrastructure unit for irrigation of olive orchard in Slovenia

Promoter	*University of Primorska and University of Ljubljana*
Period	*2009-2012; 2014-2017 (projects)*
Location	*Slovene Istria, Slovenia*
Objective	*Efficiently used water for irrigation of olive trees*
Target Audience	*Farmers, technicians, students, scholars*
Level	*Regional, national*
Accessibility	*On date visit organised on request*
Contact	*marina.pintar@bf.uni-lj.si; maja.podgornik@zrs.upr.si*



Location of the infrastructure unit for irrigation of olive orchard in Slovenia

Demonstration Site description

The experimental site was established in 2009 in private olive orchard (cv. 'Istrska Belica', owned by Angelo Hlaj) located at Slovene Istria (Dekani village: 45°33,541'N, 13°47,637'W; 96 m altitude). The climate is Mediterranean with a mean annual precipitation of 953 mm (20 – year average, 1991-2010). The daily mean temperature varied between 4.1ºC in winter (January) and 22.5ºC summer (July). Well designed and controlled drip irrigation systems was imposed to apply different amounts of water. Different irrigation treatments consist of a rain-fed control, 100 % of ETc control considering soil water content, and different reduced amount of water. The aims of the research project is to study the impact of water stress on growth and fertility of olive trees and to determine the optimal irrigation treatment for the optimal yield.

Results obtained so far

Analyses have shown some positive effects of irrigation at reduced dose of covering plant evapotranspiration under standard conditions (ETc) on olive oil quality.

Success factors

Establishment of technological guidelines for irrigation of olives in the region. The pilot experiment will demonstrate and stimulate growers and experts for more sustainable (including economically sound) production and more efficient water use for irrigation. Consequently, the negative impact of olive production to water quantity and quality will reduce.

Performance indicators

Number of farmers following established technological guidelines for irrigation of olives in the region.

Repeatability & Applicability

Results from this experimental site with different reduced irrigation treatments in olive orchard can be used as a base for irrigation experiment for any other crop in the same area or for olive tree treatments in any other olive growing appropriate areas.

Further references

http://www.sicris.si/search/prj.aspx?lang=eng&id=6621&subopt=400

Pilots on sustainable water management

Promoter	*Inagro vzw / npo*
Period	*Since 1956(previously named POVLT)*
Location	*Roeselare, Flanders, Belgium*
Objective	*Sustainable water management*
Target Audience	*Outdoor and greenhouse vegetable growers, potato growers and extension services*
Level	*National, regional*
Accessibility	*Free, upon request*
Contact	*dominique.huits@inagro.be*

Demonstration Site description

Inagro has several pilots for testing sustainable water management:

- Inagro has a long term experience and testing capacity on recycling of nutrient solutions for different crops in hydroponic systems (endives, strawberry, tomatoes, lettuce on Mobile Gulley system (MGS), ...) and aquaponics. Inagro has the capacity to combine the recycling of nutrient water with test capacity for different disinfection techniques (e.g. UV and slow sand filtration). In this way, the discharge of drainage water can be avoided;
- Inagro has the equipment for tests about plant based irrigation in arable crops and in vegetables. In the experimental greenhouse, an experimental set-up with lysimeters allows comparison of actual evapotranspiration of lettuce with modelled data. The use of tissue to mimic soil water loss, allows separate estimation of evaporation and transpiration.

Inagro also focusses on avoiding contamination of surface and ground water with PPPs (Plant Protection Products) through correct management of contaminated liquids during filling and cleaning processes of spray equipment on farm. Management of contaminated liquids (spray remnants) is critical and therefore, Inagro tests, demonstrates and uses different systems to treat cleaning water of the sprayer used in field trials. Inagro has experience in:

- Bioremediation systems, such as the phytobac and biofilter. Bioremediation systems consists of a biological active matrix which retains the PPPs into organic matter or soil particles, where microbial degradation of the PPPs occurs.
- Sentinel®, which is a chemico-physicochemical system to clean spray remnant water.
- Inagro is also testing the fyt-o-cleaner®, which is a system to treat spray remnant water based on oxidation reaction techniques and UV.

Results obtained so far

Many projects on the recycling of nutrient water, on plant based irrigation and on cleaning of waste water after crop protection.

Success factors

Inagro has a long-term experience in introducing agricultural research results and new techniques in practice and has a strong collaboration with farmers and regional stakeholders.

Performance indicators

Flemish agriculture is rather intensive with limited availability of suitable water for irrigation and with severe legislation on water environment.
Water use efficiency, water reuse and water cleaning systems are common and are continuously ameliorated.

Repeatability & Applicability

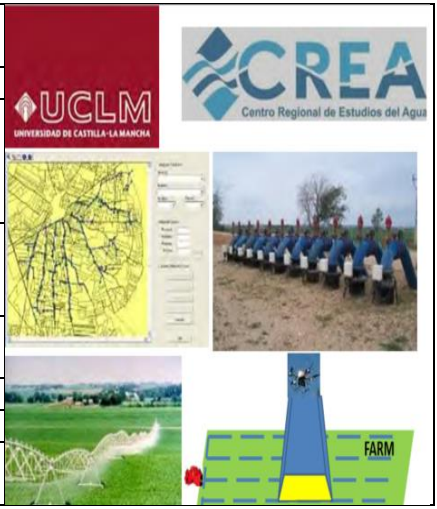
Upcoming new aspects are picked up continuously, scientific research is translated for applications by farmers.

Further references

www.inagro.be

Integration of Tools for Efficient Water and Energy Use in Irrigation

Promoter	*Regional Centre of Water Research (CREA) Castilla-La Mancha University (UCLM)*
Period	*Since 1996*
Location	*Starting in Castilla-La Mancha, now extending at international level (Italy, Portugal, Argentina, Brazil, Chile, Mexico and others)*
Objective	*Present the integrated tools and models developed for sustainable water and energy management in irrigation*
Target Audience	*Technicians, Students, Farmers, and Irrigation Advisory Services*
Level	*International, national, regional*
Accessibility	*Free, upon request*
Contact	*Jose.tarjuelo@uclm.es* *Miguelangel.moreno@uclm.es*



Demonstration Site description

A set of tools and models have been developed to apply mainly in areas with scarcity and high prices of water due to energy costs, that can be grouped into:
a) Tools and models for saving water and selecting the proper crop pattern at the farm level, with the aim of optimizing economic water productivity and minimizing the environmental impact.
b) Tools and models for improving irrigation infrastructure design and management as a whole, based on water and energy savings irrigation networks, b-3) optimization of design, sizing and regulation of pumping systems.
c) Actions to reduce energy consumption and/or cost such as the use of benchmarking techniques, and energy audits.
Transversal activities such as: 1) to promote the usage and usefulness of Irrigation Advisory Services (IAS) to transfer and share real-time information with farmers; 2) to create a network of leaders among farmers and technicians who can act as examples for farmers; 3) to use web-based GIS platforms for information and technology transfer to end users in a feedback process.

Results obtained so far

Water and energy engineering (http://crea.uclm.es)
• Web-GIS tools MAWE to monitor and manage large-scale water distribution networks
• Web-GIS tools SIGREG to manage irrigable areas
• Web-GIS tools AS, MAEEB, and DOS to optimize the design, sizing and regulation of pumping systems
• PRESUD, DOP, DEPIRE and DC-WAT tools to optimally design and sizing irrigation systems
• Water and energy analysis of irrigable areas (Benchmarking techniques)

Crop Science
• Very high resolution remote sensing (VHRRS) to for water and energy saving
• Crop phenology analysis of the main crops and determination of accurate actual ET
• MOPECO model to determine optimal cropping pattern, considering optimized regulated deficit irrigation and crop, water, environmental, and socio-economic constrains
• Irrigation Advisory Service (IAS) of Castilla-La Mancha http://crea.uclm.es/siar

Success factors
Direct contact with farmers and use of friendly tools and models that have been set up for technicians and farmers to improve water and energy use in irrigation.

Performance indicators
Permanent user's feedback through the Web-GIS platform to evaluate effectiveness and use of integrated tools and models.

Repeatability & Applicability
The integrated tools and models can be transferred and applied in pressurized irrigation systems anywhere.

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Domínguez A., de Juan J.A., Tarjuelo J.M., Martínez R.S., Martínez-Romero A. 2012. Determination of optimal regulated deficit irrigation strategies for maize in a semi-arid environment. Agricultural Water Management. 110, 67-77

Water management in Mediterranean orchards

Promoter	*Università degli Studi della Basilicata DICEM*
Period	*Since 1999*
Location	*Basilicata*
Objective	*Disseminate optimal irrigation management aimed at improve water use efficiency*
Target Audience	*Farmers, extension services, policy makers, environmental associations, companies for the management of water resources,*
Level	*National, Regional*
Accessibility	*Scientific and dissemination publications; open days, seminars and visits (under request)*
Contact	*bart ol omeo.di chi o@uni bas.i t*

Demonstration Site description

DiCEM has several demonstration sites for optimal irrigation management studies in fruit tree orchards located in Southern Italy (Basilicata region). Studies are mainly devoted to the assessment of tree productivity and vegetative growth under irrigation management aimed at improve water use efficiency mainly in peach, olive, apricot, kiwifruit. Sites host a series of technological supports (e.g. various soil moisture probes and weather stations) used for daily soil water budget calculation which employ dedicated software and specific web-based platform. Interactions at the sites with farmers and staff member of the Regional Extension Service are routinely used to both collect needs and exchange knowledge.

Results obtained so far

- Reduction of annual irrigation volume supplied;
- Definition of specific KC to be adopted after harvest in peach;
- Improvement of water use efficiency;
- Involvement of farmers in use of new technology for monitoring of soil moisture;
- Reduction of environmental impact (salinization) of poor quality irrigation water;
- Improved knowledge in irrigation issues of technician of growers' association.

Success factors

Relevance of the theme; Dissemination actions performed (seminars; open days; visits to the experimental orchard; publications); Direct involvement of the different stakeholders (farmers, policy makers, researchers, technicians).

Performance indicators

- Irrigation water volume saved;
- Increased yield produced per unit of irrigation water supplied;
- New KC to be adopted locally;
- Less variable within-irrigation of soil moisture.

Indicators for the efficiency of project result disseminations

- Number of participants to dissemination actions;
- Number of publications at National and International level.

Repeatability & Applicability

Due to consolidated interactions with Growers' Association, innovations are disseminated to a large number of farmers and stakeholders.

Further references

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Wastewater Reuse for Olive Irrigation (OLIVE-WASTEWATER)

Promoter	*Dipartimento delle Culture Europee e del Mediterraneo: Architettura, Ambiente, Patrimoni Culturali – Università degli Studi della Basilicata–DICEM, University of Basilicata*
Period	*Since 1999*
Location	*Basilicata*
Objective	*Encouraging reuse of urban wastewater for irrigation of orchards*
Target Audience	*Farmers, extension services, policy makers, environmental associations, companies for the management of water resources, companies for wastewater depuration*
Level	*International, National, Regional*
Accessibility	*Scientific and informative publications; open days, seminars and visits (under request)*
Contact	bartolomeo.dichio@uni bas.it

Demonstration Site description

The site is located in Southern Italy (Ferrandina Municipality, Matera Province, 40°29'51.74"N 16°27'27.25"E). Since 1999, the municipal wastewater is treated by means of a prototype operating with an innovative treatment process. The innovation allows the protection of certain compounds/nutrients (such as organic matter and nitrogen) during the wastewater depuration, so that they can be used as fertilizing substances. The innovated process allow also the reduction of the economic cost due to the disposal of biological sludge as end-product of standard treatment processes. The recycled wastewater is then conveyed through a dedicated pipeline to a close olive orchard and supplied by drip irrigation. The olive grove combines additional sustainable management practices (no-tillage, retention of crop pruning residuals) aimed to increase soil water holding capacity and tolerance to erosion.

Results obtained so far

At field scale the main results obtained are the following: a) improvement of soil fertility (soil structure; water holding capacity; mineral element availability along soil profile) and reduction of mineral fertilization input; b) reduction of soil erosion processes; c) improvement of plant productivity and commercially valuable fruit parameters; d) improvement of farmer's income and consequent social and environmental advantages (reduction of migration, control activity on the territory by the olive farmers, landscape conservation).

Success factors

Relevance of the theme; Uniqueness of such a long-term experience in Italy and (to our knowledge) in Europe); Dissemination actions performed since experiment start by means of seminars; open days; visits to the experimental orchard; Regional, National and International congress attendance; publications at National and International level; Direct involvement of the different actors involved (farmers, policy makers, researchers, technicians).

Performance indicators

Indicators for the efficiency of the orchard management (wastewater use + sustainable soil management techniques): Soil – Water – Fruit chemical, physical and microbiological analyses; Yield measurement and fruit quality.
Indicators for the efficiency of project result disseminations: Number of participants to seminars, open days, visits to the experimental orchard; Number of publications at National and International level.

Repeatability & Applicability

The results of this project are very consolidated and have an high repeatability in many European country. The reuse of wastewater, tested at field scale (less than 1 hectare), could be applied at larger scale. Small villages (around 10,000 inhabitants) located in hilly marginal areas and served by a wastewater treatment infrastructure can be the opportune

contexts to apply such model within sustainable economic margins. We hypothesized the model application to the territory of Ferrandina municipality (about 9500 inhabitants) making the existent depuration treatment scheme suitable for wastewater disinfection by low cost simplified schemes (not in accordance with the Italian Technical Guidelines for Wastewater Reuse) and its distribution for the safe irrigation of olives. Particularly, the plant is placed on the top of the hill allowing water distribution to the olive orchards on the hill slopes by gravity (no water pumping costs). Considering the seasonal irrigation need of an olive orchard, it could be possible to irrigate more than 200 ha. The Regional Government will financially support that large-scale adoption of technology used at the site through a dedicate Project.

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Site-Specific Variable Rate Irrigation

Promoter	*Institute for Sustainable Agriculture, Spanish National Research Council*
Period	*2015*
Location	*Spain/Andalusia*
Objective	*Testing and demonstrating potentialities of Site-Specific Variable Rate Irrigation*
Target Audience	*Farmers, Irrigation Dealers and Manufacturers, Technicians, Researchers*
Level	*National, Regional (with International links)*
Accessibility	*On date visit organized on request*
Contact	*luciano.mateos@ias.csic.es*

Demonstration Site description

A linear move sprinkler irrigation machine equipped with a Site-Specific Variable Rate Irrigation (SS-VRI) system is installed at the experimental station of the Institute for Sustainable Agriculture. The facility has the double purpose of research and demonstration. On one hand, it is used to test and demonstrate the benefits of integrated soil and irrigation water conservation practices, by comparing conventional and minimum tillage crossed with full and deficit irrigation treatments in a long-term experiment. On the other hand, it deploys all hardware and software components of SS-VRI. This is the equipment vitrine supporting collaborative research with farmers considering the investment on SS-VRI for water and energy saving as well as disease control.

Results obtained so far

One year of results comparing irrigation treatments crossed with soil management treatments and showing performance of SS-VRI equipment.

Success factors

New conservation practices in the field. Demonstration and opportunity to show advanced irrigation equipment while operating. Direct contact with irrigation equipment manufacturer. Involvement of farmers and manufacturers in cooperative innovation

Performance indicators

3 farmers in one year have shown interest on SS-VRI (viability study + negotiation with dealers)

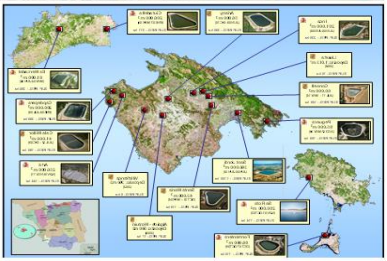
Repeatability & Applicability

Integration of soil and irrigation water conservation should spread over all field crops in Andalucía. SS-VRI has a niche although its extent is still to be determined.

Further references

New demo-site in Majorca Island (Consell pilot)

Promoter	*Tragsa*
Period	*Since 2016*
Location	*Consell, Majorca Island, Spain*
Objective	*To test reclaimed water post-treatment methods so as to improve its effect in different crops and to bring down the impacts on soils and groundwater. Methods are based on water management strategies, studies on additional soft measures, chemical techniques and in-real time monitoring*
Target Audience	*Farmers, irrigation communities, public administration*
Level	*National, Regional*
Accessibility	*It is expected the site will have new installations during 2018*
Contact	efernan6@tragsa.es



Demonstration Site description

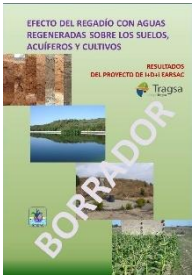
In order to test the willingness of the reclaimed water to supply the required volume and to keep testing its effect in different conditions, a new demonstration site is already operative and will be adapted and improved in Consell, Majorca, Balearic Islands (Spain). It is integrated by a big irrigation dam connected to a tertiary treatment WWTP. Water is conducted to a protected plot of land with different crops in 145 irrigation hectares, and there are three wells and boreholes, what allows many different combinations of reclaimed water, groundwater and surface water, with possibilities to include different doses of fertilizers. Some instruments have already been installed to monitor the irrigation, in special flow meters.

Results obtained so far

The demo-site in Consell (Palma) is a three-compound area with a dam of advanced secondary treatment reclaimed water, an irrigation network and three groundwater extraction wells of different depths. There are also different crops to test a large amount of combinations of mixtures of water and environmental conditions. Studies of the effect of irrigation on the crops, the soil and the aquifer underneath will be conducted. Apart from collecting samples and analyses, a new model to test the effect on the long term is foreseen. COMSOL Multiphysics and a specific app might be a good software to get this target done.

Success factors

Irrigation with reclaimed water is currently a hot spot, especially from the points of view of its psycho-social perception and the presence of emergent pollutants. The pilot adopts Spanish regulation on irrigation, regarding quality standards. No affection on soils, aquifers and plants have been detected so far. A bigger effort must be made to study post-treatment measures to improve this resource´s effectiveness.



Performance indicators

Repeatability & Applicability

Similar experiences can be easily set up in other Mediterranean areas.

Further references:

A new book is about to be released (in Spanish)

ACQUA CAMPUS – Area ricerche irrigue

Promoter	*Consorzio di Bonifica di secondo grado per il Canale Emiliano Romagnolo-CER*
Period	*Since 1959*
Location	*Italy - Emilia-Romagna - Bologna*
Objective	*Improve irrigation efficiency and productivity. Dissemination and training on High Efficiency Irrigation Technologies and Strategy*
Target Audience	*Farmers, Technicians, Students, Policy/Decision Makers, Scientist/Researchers*
Level	*International, National, Regional*
Accessibility	*Open days are organised from March until October.; On date visit organized on request*
Contact	*genovesi@consorziocer.it*

Demonstration Site description

Since 1959 CER is promoting and carrying out research and studies on water saving in agriculture, assessing crop response to irrigation, plant growth parameters, feasibility and sustainability of water reuse in agriculture, water use efficiency and productivity. The results obtained over a 50 years spell were utilised developing deficit irrigation strategies as regulated deficit and partial root zone drying, as well as models and Decision Support Systems utilised at regional and national level. Researches and field test continue through participation in national and international projects, improving irrigation management and developing knowledge for future irrigation scenarios adapting to climate change. Visitors will meet irrigation experts showing sensors, irrigation technologies and strategies deployed in the experimental fields and water treatments in constructed wetland at the farm scale.

Results obtained so far

A rough analysis of the research programs impact over the last 35 years revealed substantial changes in the farmer's irrigation patterns which led to a reduction of the annual irrigation volume ranging from 30 to 50%.

Success factors

A continuous improvement of the knowledge base, producing and implementing innovation through a diffuse system of communication and support for farmers.

Performance indicators

Yearly control of irrigation water supply to cumulated crop evapotranspiration ratio, water use efficiency in agriculture and related benefit.

Repeatability & Applicability

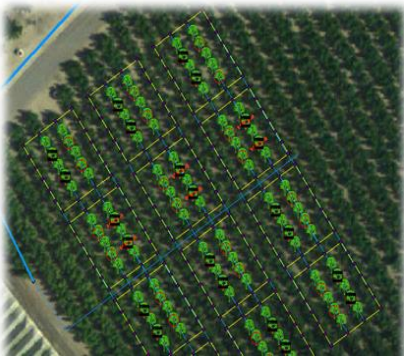
Experimental farms managed by Universities and Research Institutes can be opened to visitors.

Further references

www.consorziocer.it

IRIDA – Fruit trees DEMO

Promoter	*CEBAS-CSIC. Irrigation Departament*
Period	*Since 2016*
Location	*Spain/Murcia/Mid-Segura river basin*
Objective	*Validation of an irrigation scheduling algorithm based on a tree transpiration model and the assessment of tree vegetative vigour by satellite remote sensing*
Target Audience	*Farmers and Irrigation Districts managers*
Level	*Regional demo site belonging to an international projects*
Accessibility	*On date visit organized on request*
Contact	*dintri@cebas.csic.es*



Demonstration Site description

It is a commercial early maturing peach orchard belonging to a large private fruit producer collaborating with our research team. It is located within the Segura river basin in the south-eastern Spain. An area of extreme water scarcity where rainfall if often below 300 mm/year and water quality for irrigation is also a main constraint.

Results obtained so far

We have developed an irrigation scheduling algorithm based on computing separately tree transpiration and soil evaporation. The algorithm uses NDVI indices obtained by analysing Landsat 2 images in order to derive tree ground cover and light interception. The model is currently under final field validation by comparing the crop performance according to different irrigation scheduling procedures including the one normally employed by the grower co-operator. In collaboration with the IAS-CSIC team from Córdoba, we are developing procedures for mapping the variability and sensitivity to water stress within the orchards. This information will be used for assisting growers in the decision on how to install the on-the-ground plant sensor

Success factors

The success factor is the possibility to continuously contacting with the grower co-operator who is actively involved in the experiments and demonstrations carried out. Farmers are particularly interested in the demo activities because they face severe water restrictions. The contact with the growers is also helping them in carrying out addition field practices to increase water use efficiency under our research team guidance.

Performance indicators

At technical level: Water savings (%), Water Use Efficiency (Kg/m3), Yield (Kg/ha), Fruit composition (SST, Acidity, Taste) Pruning weights (Kg/tree)
At the dissemination level. Publications in Trade Journals and number of growers assisting to the field days and grower talks still to be organized

Repeatability & Applicability

The experience can be replicated in other stone fruit tree producing areas because the tree transpiration and soil evaporation models are semi-mechanistic and based on previously published research

Further references

http://irida.grupoinnovati.com/
http://www.cebas.csic.es/dep_english/irrigation/irrigation_lineas_en.html
http://quantalab.ias.csic.es/

RIEGO-ASESOR – Vegetable Crops DEMO

Promoter	*CEBAS-CSIC*
Period	*Since 2016*
Location	*Spain/Murcia/Low-Segura river basin*
Objective	*Validation of an irrigation scheduling algorithm based on a plant transpiration model and the assessment of soil evaporation separately.*
Target Audience	*Farmers and Irrigation Districts managers*
Level	*Regional demo site belonging to an international projects*
Accessibility	*On date visit organized on request*
Contact	*dintri@cebas.csic.es*

Demonstration Site description

It is a commercial open field vegetable field belonging to a medium size private vegetable producer collaborating with our research team. It is located within the low Segura river basin in the south-eastern Spain. An area of water scarcity where rainfall if often below 300 mm/year and where currently the water quality for irrigation is the main constraint.

Results obtained so far

We have developed an irrigation scheduling algorithm based on computing separately plant transpiration and soil evaporation. The algorithm incorporates weather forecast prediction developed in collaboration with a non-profit research organization (Fundación de Investigación para el Clima). The model has been tested in several vegetable crops and performs well in comparisons with other irrigation scheduling protocols based on the use of sensors and large empirical experience. Currently the model is under incorporation in the ERP platform of an SME company Hispatec which expects to commercialize it jointly with the CEBAS-CSIC team.

Success factors

The success factor is the possibility to demonstrate that it is possible to carry out an irrigation scheduling without the need to have installed on the ground sensors.

Performance indicators

At technical level: Water savings, Water Use Efficiency, Yield. At the dissemination level: Number of end-users that will purchase the new Decision Support System developed.

Repeatability & Applicability

The algorithm is currently under registration and will be incorporated into a Decision Support System. It will be commercialized by the Spanish SME company HISPATEC.

Further references

http://www.cebas.csic.es/dep_english/irrigation/irrigation_proyecInnpacto_en.html
https://www.ficlima.org/asesor-virtual-en-la-toma-de-decisiones-en-estrategias-de-riego-sostenibles/
http://www.hispatec.es/proyectos/riego-asesor-proyecto/

ClimaTree – Fruit ecosystem services DEMO

Promoter	*CEBAS-CSIC*
Period	*Since 2016*
Location	*Spain/Murcia/Mid-Segura river basin*
Objective	*Validation of a tree CO_2 sink capacity calculator taking into account irrigation regime effects on CO_2 balances*
Target Audience	*Farmers and Environmental agencies*
Level	*Regional demo site belonging to an international projects*
Accessibility	*On date visit organized on request*
Contact	*dintri@cebas.csic.es*

Demonstration Site description
Within the Segura river basin, there are several peach, citrus and persimmon orchards were carbon balance are currently on-going to feed the development of a simplified spreadsheet for orchard CO2 balances assessment.

Results obtained so far
Development of a new methodology for the enumeration of carbon storage from permanent tree-crops

Success factors
The project is very policy oriented since should contribute to improve the development, implementation and enforcement of Union environmental and climate policy and legislation. The project results should act as a catalyst for, and promote, the integration and mainstreaming of carbon sink objective into Common Agricultural Policy, the relevant national public authorities and farmer communities;

Performance indicators
At technical level: Tree capacity to store fix and store carbon (Tons/ha). Capacity to fix and store carbon according to the irrigation supplied (Tons/ha x m3)

Repeatability & Applicability
The project's proposed implementation area is S. Europe (i.e., Greece, Italy and Spain) where permanent crop areas are about 27% compared with forest cover areas.
The generated methodology will be incorporated in an end-user friendly interface that will be built upon open-source software enabling this way its expansion and transferability to all member states' stakeholders.

Further references
http://www.cebas.csic.es/dep_english/irrigation/irrigation_proyecUE_en.html
https://www.lifeclimatree.eu/

MONITORING AND CONTROL OF WATER, NUTRIENTS AND PESTICIDES

Promoter	*Institute for Systems and Computer Engineering, Technology and Science (INESC TEC)*
Period	*Since 2017 (until 2020)*
Location	*Europe (Portugal, Spain, Turkey, Sweden, The Netherlands)*
Objective	*Development of an effective integrated and sustainable monitoring and control system with innovative ion selective sensors for nutrients and bio-based sensing of pesticides for optimal water and nutrient supply and reuse, minimizing the effects on the environment.*
Target Audience	*Farmers, Technicians, Policy/Decision Makers, Scientist/Researchers.*
Level	*International (Europe), National, Regional*
Accessibility	*Open days organised during 2018-2019 at several demo-sites in Porto (P), Murcia (ES), Konya (TR), Bleiswijk (NL). Contribution to Network User Groups.*
Contact	*josenalde.b.oliveira@inesctec.pt; jos.balendonck@wur.nl*

Project description

For optimizing plants needs while minimizing the environmental impacts, sustainability and competitiveness of European agriculture are intrinsically related to the efficient use of water, fertilisers and plant protection products (PPP). Good Agricultural Practices - in the context of the circular economy- force growers to minimize their waste water and thus optimize the use of nitrogen and phosphorus based fertilizers and PPPs. Better management requires reliable decision-making systems (DSS) based on water quality feedback making use of cost-effective, robust, low-maintenance and accurate sensors for nutrients and pesticides. So far, available sensor technology does not meet the challenges for on-site monitoring. The project intends to develop such sensors and integrate them into fertigation equipment, with demonstration of their use for practical management purpose at several European demo-sites..

Results obtained so far

• R&D of an integrated and sustainable monitoring system with innovative ion selective sensors for nutrients (NPK) and bio-based sensing of pesticides (IMIDACLOPRID and PIRIMICARB); to be used for optimal water and nutrient supply and reuse, minimizing the effects on the environment (prototypes expected 2017-2018).
• An easy-to-use, robust and fault-tolerant fertigation controller, to meet both crop needs and grower yield/costs expectations (prototype expected 2017-2018).
• Validation and demonstration the applicability of developed technologies at four sites covering several types of crop production systems (recycled or cascaded water system) from greenhouses to open-field agriculture in various climatic regions (expected 2019-2020).
• Monitoring and Control Products available for the market (expected 2020 ...).

Success factors

The project builds on the extensive experience, competence and early work conducted on optical fibre-based sensors, biosensors, water policy models, plant nutrition, smart irrigation scheduling and robust control. It is implemented by a trans-disciplinary team of experts involving multi-actors. The demonstration sites will be open during 2018-2020 for

visiting. Farmers, suppliers, scientists, water boards and policy makers are welcome to visit these demo-sites at open days. Relevant stakeholders may join the regional Network User Groups set-up around the demo-sites in order to be informed during the research and development phase of the technologies. Their input is valuable for the project in order to tune the systems to the end-user needs..

Performance indicators

The new sensors will lead to worldwide new markets for European water technology sector, thus strengthening the competitiveness and growth of SMEs and related companies. As a result, significant increase of water and fertilizer use efficiency is obtained in the agricultural/horticultural sector (expected < 50%), longer and economic reuse cycle for the drainage water is achieved, and pollution of surface and ground waters by fertilizers and PPP is prevented or significantly reduced..

Repeatability & Applicability

With the sensors, growers will have information about the input and output water quality, and can evidence-based decide on how and when to irrigate and fertigate, and on whether the costly task of cleaning is advisable before disposal. Governmental organizations (water authorities) may use sensors for checking water quality (pesticides) in ground and surface waters. Technology suppliers (re-sellers of equipment for agricultural practices) can acquire a license to sell the sensors and decision support systems world-wide.

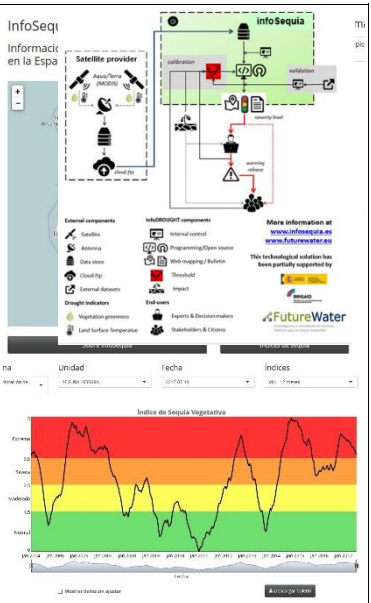
Further references

The project “Integrated monitoring and control of water, nutrients and plant protection products towards a sustainable agricultural sector” is funded by: ERA-NET / Co-fund WaterWorks2015

PROJECT COORDINATOR:
Dr. José Boaventura-Cunha
INESC TEC, R. Dr. Roberto Frias, 4200-465 Porto, Portugal
E-mail: jose.boaventura@inesctec.pt Web-site to be announced

infoSequía – Drought Monitoring Tool

Promoter	*FutureWater*
Period	*Since 2013*
Location	*Iberian Peninsula*
Objective	*Drought Monitoring and Assessment Tool*
Target Audience	*Water decision-makers; Agricultural Associations; Insurance Companies*
Level	*Regional, Basin-scale*
Accessibility	*Monitoring tool: web-based service (www.infosequia.es)* *Decision Support System: under contract*
Contact	*Sergio Contreras (s.contreras@futurewater.es)* *Johannes E. Hunink (j.hunink@futurewater.es)*



Project description

InfoSequía is a web-mapping climate service developed by FutureWater for the operational monitoring of droughts and their impacts. It provides straightforward and weekly information on the drought conditions of a region through simple and interactive functionalities. InfoSequía is a Drought Monitoring toolbox that can easily be integrated with existing Early Warning Decision Support Systems. The core of the system includes a set of algorithms which automatically collects satellite data from the cloud, processes and generates severity drought indices and portable bulletins, and feeds a web-mapping service from which all the information can be interactively queried and downloaded. InfoSequía is a site- and user-tailored system with a flexible and modular structure. The calibration (threshold definitions) and validation of the system are performed by combining expert knowledge and auxiliary impact assessments and datasets. Different technical solutions (basic or advanced versions) or deployment options (open-standard or restricted-authenticated) can be purchased by end-users and customers according to their needs. InfoSequía has a programming structure integrated by three main modules (pre-processing, processing and communication) with connected-cascade task-specific algorithms. Algorithms in the pre-processing and processing modules have been coded in a Phyton-QGIS-GDAL open source environment, while the algorithms in the communication module have been codified using R or R-shiny. According to their needs, customers define, with the support of FutureWater experts, the region of interest, the number and type of satellite-based indicators to be used, and the level/s of spatial aggregation (spatial units) adopted for showing severity warnings. The system requires to parameterize some thresholds to convert drought index values into severity classes. This task is addressed by FutureWater experts adopting a calibration-validation approach and using external-auxiliary data on drought severity and impacts. The general programming code has been optimally designed to manage potential runtime in a fast and secure way. This guarantees fast responses to customers in case of system failures.

Results obtained so far

InfoSequía provides on a weekly basis capabilities for: a) the operational satellite-based tracking of the severity and spatial extent of drought impacts on forestry and agriculture sectors: b) the dissemination and provision of drought information in a faster and easier way

Success factors

Water Management Authorities have shown interest of integrating infoSequía into their Decision Support Systems. For instance, the Water Management Authority of Valle del Cauca in Colombia is currently undertaking a project to integrate infoSequía into their management system. Insurance companies are, likewise, interested in the application of infoSequía on their assessment processes.

Performance indicators

The performance of infoSequía is currently being tested in the context of the BRIGAID project (www.brigaid.eu)

Repeatability & Applicability

The development of infoSequía provides the following main opportunities

- Political: There is an EU policy framework which pushes to a common infrastructure and management strategy on Water Scarcity and Droughts (WS&D). The framework still fails in covering national and regional requirements.
- Economic: Drought Monitoring (DM) systems like infoSequía are being promoted as insurance tools for quantifying and compensating crop losses.
- Social: There are differences in vulnerability, awareness & social perception of WS&D. Harmonized and friendly user interfaces between population and decision-makers are required to reinforce co-responsibility.
- Technological: The is a lack of an harmonized DM system at the European level. Because monitoring is scale-dependent, context-specific approaches able to integrate of multi-temporal indices, expert judgment and social perceptions are required.
- Environmental: DM systems as infoSequía contributes to improve WS&D management in a future scenario characterized by an increase of the frequency and severity of drought and water scarcity events.

Legal: European policy on WS&D is triggered and promoted by an EC Communication (EU-COM(2007) and follow-up reports on good practices and learned lessons). References to environmental commitments are linked to the Water Framework Directive.

Further references

www.infosequia.es
www.futurewater.eu

The INAPRO aquaponics demonstration-site in Waren

Promoter	*Leibniz-Institute of Freshwater Ecology and Inland Fisheries + Müritzfischer*
Period	*Financing period 2014-2017* *Demonstrations sites open from September 2016*
Location	*Waren (Germany)*
Objective	*Dissemination and demonstration of an improved aquaponics system.*
Target Audience	*Farmers, Horticulturists, Fish farmers, Entrepreneurs, Policy/Decision Makers.*
Level	*Regional, National, International*
Accessibility	*On date visit organized on request.*
Contact	*sofia.minero@alienoreu.com*

Demonstration Site description

The construction of the Waren demonstration site was finalised in 2016 and consists of an aquaponic facility exploiting the INAPRO aquaponic system and proving its viability.

The INAPRO demonstration facility has been built in order to demonstrate that the INAPRO system is able to produce sustainable food with a low environmental impact by optimising conventional aquaponics. Aquaponics is a resource-efficient food production system which couples the production of fish and plants while using the nutrient-rich fish tank water for nourishing the plants.

The total area of the INAPRO aquaponics facility is 573m2 and consists of the fish farm with the recirculating aquaculture system (RAS), a broad-ship greenhouse, a technical room with a combined heat and power plant (CHP) and the computer control system, a feed storage room and an outside secondary clarifier.

The production of fish and tomatoes in Waren started in May 2016, and June 2016, respectively. The facility is expected to produce around 24 tonnes of African catfish (Clarias gariepinus) and 11 tonnes of tomatoes per year.

At the INAPRO demonstration site, there are two independent water recirculation systems: one for the plants and one for the fish. These systems are unidirectionally coupled to transfer the correct amount of nutrient-rich fish water to the hydroponically grown crops. This so-called double water recirculation system provides optimised conditions for the production of fish and plants and increases the productivity of both. Moreover, in order to minimise the fresh water demand, the evapo-transpirated water from the plant area is regained through cooling traps and reinserted into the fish tanks. This feature ensures that the daily water input is less than 3% of the total amount of water circulating in the system.

The whole production process is monitored and controlled through a management execution system (MES). The MES records and evaluates all technical and economic parameters in a single standardized system in order to provide a precise daily overview to the user of the production of both fish and tomatoes. For this purpose, the system includes tools such as a feed and nutrient calculator, a simulator of water and energy consumption and a profitability calculator. The MES is designed to give precise recommendations to the user concerning the status of the whole system and to provide inputs for improving the system's efficiency. In order to make it practical for the end-user, the MES has an intuitive user interface that makes the whole system easily understandable.

Results obtained so far

Analysis have shown that the tomatoes produced by the INAPRO aquaponics have the same characteristics as the ones produced by conventional hydroponics, confirming that the INAPRO tomatoes are good, healthy and tasty. Until now, the fruits have been sold by Müritzfisher on the premises of the demonstration site and in a local supermarket.

Repeatability & Applicability

The INAPRO system can be adapted and applied to installations of different sizes, situated in different locations and thus to different climatic conditions. As the INAPRO system helps end-users of the aquaponics system (fish farmers, plant growers, newcomers and supporting groups) to save water and resources it is particularly suitable for regions dealing with water scarcity issues.

Further references

Website: http://www.inapro-project.eu/page/waren-germany_p134/

INAPRO – Innovative Aquaponics for Professional Application

Period	*Financing period 2014-2017* *Demonstrations sites open from September 2016*	
Location	*1. Waren (Germany) + 2. Abtshagen (Germany) + 3. Murcia (Spain) + 4. Shouguang (China)*	
Objective	*Dissemination and demonstration of an improved aquaponics system.*	
Target Audience	*Farmers, Horticulturists, Fish farmers, Entrepreneurs, Policy/Decision Makers.*	
Level	*Regional, National, International*	
Accessibility	*On date visit organized on request.*	
Contact	*sofia.minero@alienoreu.com*	

Project description

The collaborative project INAPRO implements innovative water, energy and nutrient management solutions to exploit all available opportunities of resource efficiency in rural and urban aquaponic facilities. It will provide optimised aquaponic demonstration sites based on mathematical models. The final goal of the project is the commercialisation of an innovative model-based aquaponic system.

INAPRO aims at improving aquaponics through an innovative double-recirculating system for water. This new coupling technology is made of two double recirculation systems, one recirculating aquaculture system (RAS) for the fish and a second recirculating hydroponic unit for plants. Both systems run independently and are one-way connected to transfer the nutrient rich fish water into the hydroponic unit. This allows to establish optimum conditions for both the fish and plants. To minimize the fresh water demand, the evaporated water from the plant area is regained via cooling traps and reintegrated into the fish tanks cutting, the daily need for freshwater to less than 3% of the total system's volume.

Besides a test & research facility in Abtshagen (Germany), 3 INAPRO demonstration systems were constructed: 2 in Europe and one in China. The European demonstration sites are located in Murcia (Spain), and in Waren (Germany).

Results obtained so far

The tests conducted in the INAPRO research facility in Abtshagen clearly demonstrated that similar tomato production yield and quality can be reached with the INAPRO system compared to conventional hydroponic production. Moreover, this yield is achieved along with a drastic reduction of water use (1-3% vol./day) by regaining evaporated water from the plants' section.

The INAPRO system also increases productivity in respect of conventional aquaponics thanks to the use of the double recirculation aquaponic system for water which allows to establish optimum conditions for both fish and plants.

Success factors

The consortium is well balanced and includes scientists, private companies and SMEs which are involved in the commercialisation phase of the project. Moreover, seminars and training are organised on the demonstration sites' premises for interested end-users, in particular fish farmers and horticulturists.

Performance indicators

The success of the INAPRO system can be monitored by looking at: 1.water consumption, 2.energy consumption, 3.nutrient consumption/exchange, 4.tomato yield and quality, 5.fish productivity.

Repeatability & Applicability

The INAPRO system can be adapted and applied to installations of different sizes, situated in different locations and thus to different climatic conditions. As the INAPRO system helps end-users of the aquaponics system (fish farmers, plant growers, newcomers and supporting groups) to save water and resources it is particularly suitable for regions dealing with water scarcity issues.

Further references

Website : http://www.inapro-project.eu/

EU LIFE REWAT

Promoter	*Scuola Superiore Sant'Anna*
Period	*October 2015 – September 2019*
Location	*Italy, Tuscany, Livorno*
Objective	*To design a resilient to water coastal area based on innovative demonstrators, training and participatory approach*
Target Audience	*Farmers, Technicians, Students, Policy/Decision Makers, Scientist/Researchers*
Level	*International, National, Regional*
Accessibility	*Open days are organised from 2018 until 2019. On date visit organized on request – please check the LIFE REWAT web site for details: http://www.liferewat.eu/*
Contact	*Rudy Rossetto r.rossetto@santannapisa.it*

Project description

LIFE REWAT project (sustainable WATer management in the lower Cornia valley through demand REduction, aquifer Recharge and river Restoration) aims at developing a participated strategy for integrated water resources management at sub-catchment level, as a model of governance for sustainable development and agro-ecosystem maintenance of the lower Val di Cornia (Italy). Within LIFE REWAT, this strategy - adaptive towards Climate Change - refers to the water budget (re)balancing of the complex system of the lower river Cornia. The LIFE REWAT project treasures of some state-of-the-art techniques and technologies currently available for the planning and management of water resources, with the aim to prove their effectiveness to solve water management issues in coastal areas. The proposed way is to implement in the Val di Cornia (Italy) different innovative actions: managed aquifer recharge, reuse of treated wastewater for irrigation, river restoration, sub-surface drip irrigation to reduce consumption in agriculture and reduction of losses from water networks; to reach a peerless unicum in the Mediterranean basin.

The main objective of the project will be achieved by completing four Specific Objectives (SO):

- (SO1) fostering the knowledge on the functioning of the hydrological system by integrating knowledge on the land, surface- and ground-water uses;
- (SO2) awakening and proactively involving water users about the importance of water saving and groundwater banking (both public and private actors);
- (SO3) demonstrating the technical feasibility, the economic advantage and the environmental sustainability of innovative technical solutions;
- (SO4) developing an integrated and participated governance tool for surface- and ground-water management at a sub-catchment scale, that will lead to the signature of a "Water Contract", a pioneer innovative experience in Italy of negotiated agreement for all the waterbodies in the coastal area.

Relevant for the WIRE AG is a sub-surface drip-irrigation for artichoke cultivation pilot - 4 ha area in a private active farm irrigated by using subsurface dripping pipelines.

Aforementioned LIFE REWAT actions are integrated in a framework, along with open source and public domain software tools for planning and management of water resources, with capacity building for technical staff of public institutions and private companies, and communication activities on the importance of sustainable use of water resources, aiming at creating a common and shared vision on the value of water.

Results obtained so far

At present, August 2017, the project is still in its implementation phase.

Success factors
As per the involvement of the agricultural sector factors affecting the success of the project lie in the capacity to involve farmers and technicians form the extension services. relevant is also the public private partnership (PPP), made up of Universities, land and irrigation management entities, governing authorities and farmers associations. The pilot for demonstrating subsurface drip irrigation of artichoke crops greatly improve the capacity to disseminate water-saving technologies while maintaining economically feasible production.

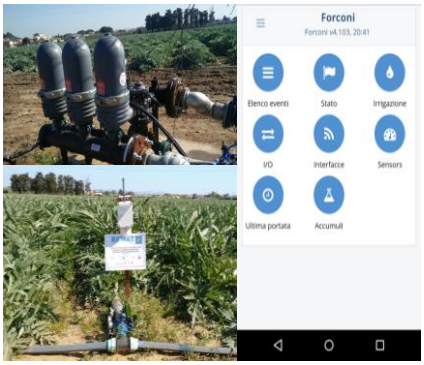
Performance indicators
Performance indicators are under definition.

Repeatability & Applicability
This demonstration project aims to be replicable in other similar contexts at Mediterranean and European scale.

Further references
Web-site: http://www.liferewat.eu/
Twitter: @rewatlife
Facebook: https://www.facebook.com/LIFEREWAT/

Sub-surface drip-irrigation for artichoke cultivation (LIFE REWAT – pilot)

Promoter	*Consorzio di Bonifica 5 Toscana Costa - Scuola Superiore Sant'Anna (Italy)*
Period	*Since September 2016*
Location	*Campiglia Marittima, Livorno, Italy*
Objective	*Demonstration and training on sub-surface drip-irrigation for artichoke cultivation*
Target Audience	*Farmers, Technicians, Policy/Decision Makers, Researchers, Students,*
Level	*International*
Accessibility	*Open days are organised from 2016 – during the EU LIFE REWAT project site visits for farmers, students and other stakeholders will be organised*
Contact	*rudy.rossetto@sanatannapisa.it, alberto.mantino@santannapisa.it*



Demonstration Site description

The demonstration is located in Venturina (Campiglia Marittima, Italy) within the EU LIFE REWAT project activities (www.liferewat.eu) and it covers a 4 ha area in a private active farm irrigated by using subsurface dripping pipelines. The soil is characterized by sandy-loam texture, 7.81 pH and 1.72% of organic matter. Irrigation water, mainly groundwater, is characterized by 7.2 pH and 1300/1400 µS/cm electrical conductivity. The field test provides the comparison of sub-surface drip-irrigation (SubSDI) system respect to surface drip-irrigation (SDI). Deficit irrigation strategy are under investigation, in order to test the possible increase in water saving. The system was implemented at the beginning of September 2016. The sub-surface buried pipelines were placed at 0.25 m depth, with emitters spaced 0.5 m. The distance between pipelines was 1.5 m, according to globe artichoke layout (1.5 m between rows, 1 m in-row spacing). Surface-buried tubes were placed in an area about 0.75 ha wide for the comparison with SDI. Artichoke var. Terom were transplanted after the system test.
In order to minimise water losses and to increase the crop water productivity, the SubSDI scheme is remotely managed making use of soil moisture sensors. Irrigation starts only when soil moisture is lower of a user selected threshold. This threshold was calibrated and set at 20% of water content in the soil.

Results obtained so far

Regarding the artichoke growth, no differences were recorded between the SubSDI and the SDI system during the first year. The crop yield was at about 12t/ha (fresh matter) of marketable buds, well-over the local average productivity. The amount of watering during the first year was about 620 m3 per hectare.

Success factors

The following factors are to be mentioned for the success of the demonstrative system: i) training by demonstration and opportunity to check devices while operating; ii) direct contact with experts and manufacturer; iii) involvement of private companies manufacturing irrigation equipment.
During the first year of artichoke cultivation, several open-days occurred: students, farmer, experts and extentionists visited the field during the growth period of the crop.

Performance indicators

The following performance indicators will be used to evaluate the pilot effectiveness:
- crop water productivity;

- irrigation water use index.

Repeatability & Applicability

The experience can be replicated in several situations and locations in the Mediterranean without limitation.

Further references

LIFE REWAT project website: www.liferewat.eu

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