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Food and Agriculture Organization of the United Nations

GCP/RAB/013/ITA – Working Paper

International workshop

"The use of treated wastewater in agroforestry systems: cooperation among Mediterranean countries, results of the first year of GCP/RAB/013/ITA project activities and future developments"

University of Basilicata

Potenza (Italy), 29-30 April 2013

Forest Assessment, Management and Conservation Division
FAO Forestry Department

GCP/RAB/013/ITA
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Comments and feedback are welcome.

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Project FAO GCP/RAB/013/ITA

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Abbreviations and Acronyms

AATO-SSI	Autorita'di Ambito Territoriale Ottimale per il Servizio Idrico Integrato (Optimal Territorial Area Authority for Integrated Water Service), Basilicata Region, Italy.
APQ	Accordo di Programma Quadro (Program Framework Agreement)
BOD	Biochemical Oxygen Demand
CNR	Consiglio Nazionale per la Ricerca (National Research Council), Italy.
DGF	Direction Générale des Forets (General Directorate of Forestry)
FAO	Food and Agriculture Organization of the United Nations.
HCEFLCD	Haut Commissariat aux Eaux et Forêts et à la Lutte Contre la Désertification, Morocco
ICID	International Commission on Irrigation and Drainage
INRGREF	Institut National de Recherche en Génie Rural Eaux et Forêts (National Research Institute of Rural Engineering, Water and Forests), Tunisia
IRSA	Istituto di Ricerca sulle Acque (Italian Research Institute on Water), Bari, Italy.
ISPRA	Istituto Superiore per la Protezione e la Ricerca Ambientale (Institute for Environmental Protection and Research), Italy
NAMAs	Nationally Appropriate Mitigation Actions
PRIN	Progetto di Ricerca di Rilevante Interesse Nazionale (Project of Relevant National Interest).
RADEEMA	Régie Autonome de Distribution d'Eau et d'Electricité de Marrakech, Morocco
SAFE	Scuola di Scienze Agrarie, Forestali, Alimentari e Ambientali (School of Agriculture, Forestry, Food and Environmental Science), University of Basilicata, Potenza, Italy.
SI	Scuola di Ingegneria (School of Engineering), University of Basilicata, Potenza, Italy.
UCA	Université Cadi Ayyad (University of Cadi Ayyad), Marrakech, Morocco

International Workshop on

"The use of treated wastewater in agroforestry systems: cooperation among Mediterranean countries, results of the first year of GCP/RAB/013/ITA project activities and future developments"

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INTRODUCTION

The workshop to report on the first year of the FAO project GCP/RAB/013/ITA "Forest restoration in Algeria, Egypt, Morocco and Tunisia using treated wastewater (TWW) to sustain smallholders' and farmers' livelihoods" was held in Potenza at the University of Basilicata[1] on the 29-30 of April 2013. The workshop provided a scientific forum for discussion on technical advancement and opportunities for reusing treated wastewater. It was also aimed at presenting to the scientific community the wastewater treatment methodologies implemented by the project and to have them validated. During this event, representatives of the four project countries and Italian experts on the use of treated waste water convened to share their experiences, present achievements of the first year of activities and receive formal technical endorsement from the scientific community. At the same time participants had the opportunity to observe the practical application of wastewater treatment methodologies to increase agroforestry production in the experimental site of Ferrandina near Potenza, Italy.

The workshop co-organized by FAO and the School of Engineering of the University of Basilicata, saw the participation of several Italian research groups and universities, local and regional administrations, a video message from H.E. Gianni Pittella, vice president of the EU Parliament, and a live intervention of H.E. Hassan Abouyoub, Moroccan Ambassador to Italy. Together with a delegation from FAO Headquarters, the representatives of the FAO project four recipient countries, namely Algeria, Egypt, Morocco and Tunisia and other project partner institutions, represented by Prof. Paolo De Angelis for the University of Tuscia, and Mr Giovanni Mughini on behalf of the Italian Council for the Research in Agriculture (CRA) also attended. All partner Institutions endorsed project activities.

The agenda for the formal two-day workshop (see *Annex 1*) included the following sessions; day one: (1) technical presentations on the state-of-the-art, problems and opportunities for wastewater reuse and opportunities for further collaboration between the government of the Basilicata region and its institutions and the FAO GCP/RAB/013/ITA project; two parallel sessions on (2.a) presentation of the results of the first year of a scientific research project of relevant national interest (PRIN) jointly developed by the University of Basilicata and other Italian universities and (2.b) a business meeting with the FAO project recipient countries and the FAO delegation to discuss progresses and to gather recommendations and expression of interest to move forward with the project beyond its first year of activity, to fully seize the project benefits. The workshop continued in the following day with a morning session (3) on the transfer of knowledge and the application of innovative technologies for wastewater

[1] University of Basilicata is one of the GCP/RAB/013/ITA project partners.

treatment in the Mediterranean region, with special reference to the four FAO project countries, and the final complete endorsement of the recommendations drafted by project partners in the previous day and (4) a field visit to the research site of Ferrandina, where an olive grove has been irrigated for the past 12 years using treated wastewater obtained through a secondary selective removal treatment devised by the University of Basilicata. Such methodology is one of the two applied, under the FAO project umbrella, in Morocco and Tunisia to treat wastewater and enrich degraded soil quality.

OPENING SESSION

Professor Mancini, Director of the School of Engineering (SI); Professor Mauro Fiorentino, President of the University of Basilicata; Mr Angelo Nardozza, Commissioner from the Territorial Authority for Integrated Water Services (AATO – SSI) in the Basilicata region; Ms Rosa Gentile, President of Acquedotto Lucano – the local water management company; Mr Marco Arcieri, Secretary General of the Italian committee of the International Commission on Irrigation and Drainage (ICID) and Secretary of the President of the Basilicata region; and Mr Douglas McGuire, Team Leader of the FAO Forest Resources Management, Assessment and Conservation Division opened the workshop and thanked participants.

All panellists stressed the importance of the topic of discussion and the central roles that knowledge transfer and innovations can play in addressing the issue of water scarcity, all around the Mediterranean region. They also congratulated the University of Basilicata and the FAO project for their effort to promote network building, transfer of innovative methodologies, sharing of technical and scientific expertise and good practices with developing countries in the southern rim of the Mediterranean to achieve sustainable development and a more efficient and cost-effective use of a scarce natural resource.

In this context, further opportunities for knowledge sharing and strengthening cooperation between the government of the Basilicata region and its institutions in the Mediterranean under the umbrella of the FAO GCP/RAB/013/ITA project were also highlighted.

Mr Marco Arcieri, on behalf of the Secretariat of the regional administration of Basilicata confirmed the importance of creating a network of people that work in this field. In this light the Regional government intends to collaborate with FAO to develop a partnership and is negotiating an economic contribution to support the scientific cooperation and further project developments in Morocco.

Likewise H.E. Gianni Pittella, vice president of the EU Parliament, conveyed, through a recorded video message, his political support and congratulations to the project initiatives in the Mediterranean area and wishes for project continuation. The theme addressed in this workshop and the specific focus on EU closer neighbours in the southern rim of the Mediterranean are nowadays all the more important for the European political and cooperation agenda.

Finally H.E. Hassan Abouyoub, Moroccan Ambassador to Italy, applauded, via phone call, the activities implemented in his country and assured his commitment to ensure extended support to the FAO project. Ambassador Abouyoub also invited representatives of the School

of Engineering of the University of Basilicata to gather in Rome, together with the FAO project team and him, to discuss an action plan to provide continuity to ongoing activities in Morocco and consider possible ways to ensure project continuation.

Mr Douglas McGuire reminded participants of the relevance of this project for FAO, as this is indeed a cutting edge project that uses innovative and affordable technologies and applies them in situation where water scarcity can hinder a country's socio-economic development.

Mr McGuire also underlined the important peculiarity of this project, which is the ability to interconnect different types of partners: from local government to regional authorities, Universities and scientific water institutions. This has enabled the crucial intertwining of the scientific community that has developed these technologies, with practitioners of development, which could apply these technologies in the field.

This project was originally conceived to cover a period of five years. This workshop has marked the conclusion of the first year of activities. Therefore in this occasion countries will also need to discuss how to move forward and scale up those activities that are now implemented at pilot level. In order to achieve this, recommendations will be formulated and endorsed at the end of the workshop by all involved stakeholders.

Mr McGuire reconfirmed the strong political commitment of FAO to move this process forward. FAO will do all possible to try to find the financial and technical means to be able to continue this project in a long term context, to be able to deliver the impacts sought each country involved. Mr McGuire also wished for a stronger collaboration with the Basilicata region, through a decentralized cooperation program that FAO has already used to establish cooperation with other Italian Regions, provinces and municipalities. In this regard Mr McGuire invited representatives from the Basilicata region to come to the FAO HQ in Rome to further discuss opportunities to collaborate in this field.

Professor Mancini reiterated that providing continuous support to this project, which FAO will continue to coordinate, is also the intent of the University of Basilicata, as the issue of technology and knowledge transfer in the field of water reuse is key for the University as well.

On the sidelines of the event Professor Masi from SI, together with Professor Romano from the School of Agriculture, Forestry, Food and Environmental Science (SAFE) of the University of Basilicata and Mr Douglas McGuire from FAO released interviews to local media and national television on the importance of the topic of the workshop.

Day 1. SESSION 1: PROBLEMS AND OPPORTUNITIES FOR WASTEWATER REUSE

This technical session, chaired by Professor Salvatore Masi of the University of Basilicata presented the scientific state-of-the-art of wastewater treatment methodologies. It also gave participants an understanding of the main benefits and challenges, in terms of minimizing health and safety risks, environmental degradation and reducing economic costs and environmental impacts of treating wastewater.

Mr Marco Arcieri of ICID with his intervention stressed the importance of developing a strategy to build networks to transfer knowledge, experience and contacts and to mobilize funds to cope with the problem of water scarcity and shortage of water resources. This is the mandate of its organization, which also enjoys the status of permanent observer at FAO and IFAD.

Mr Arcieri reminded participants that according to FAO data, only 50 countries worldwide are really active in the field of treated wastewater reuse, and only the 10 % of land is irrigated with treated wastewater. This means that there is great scope for improvement and especially if wastewater treatment plants are realized in compliance with norms and regulations, profits can really exceed costs.

According to Mr Arcieri, this type of initiative demonstrates that even small universities, like the University of Basilicata, can constitute point of excellence in the field of research and contribute to finding a solution to global problems. To this extent ICID would also like to be part of this process of network building, together with FAO and the University of Basilicata and other institutions present at the workshop.

Technical presentations:

a. **Wastewater treatment for reuse in agriculture: conventional schemes and IRSA's experience in Apulia**, Mr Alfieri Pollice, Italian Research Institute on Water (IRSA) of the National Research Council (CNR), Bari. IRSA-CNR Bari has been a long-term partner of the University of Basilicata. The two research institutions started collaborating 12 years ago to set up the experimental field of Ferrandina, where an olive grove was irrigated with treated wastewater to test for production growth and soil fertilization capacity of wastewater. The presentation included three case studies of IRSA projects on unconventional cutting edge technologies for wastewater treatment and reuse. Since the year 2000 IRSA has been working on developing treatment systems for water reutilization, also for agriculture, that use low-pressure surface filtration processes with membranes (surface bio-reactors with micro and ultra-filtration schemes). A particularly interesting study that was reported on, described the effects of contamination of Escherichia coli on soil, due to potential release of pollutants present in partially treated wastewater used for irrigation of a lawn. The controlled results showed that with irrigation nitrates were completely preserved, due to increase nitrogen levels in the water, resulting in twice as much production of grass and there was no growth of coliforms, no persistence, and no accumulation. Even simulating an accident, with a huge release of treated wastewater in the field, evidences showed that Escherichia coli levels can be absorbed and returned to normal in maximum 15 days.

b. **Planning wastewater reuse: technical and economic sustainability assessment,** Professor Giorgio Bertanza, University of Brescia. Few conditions must be satisfied to reuse treated wastewater: environmental safety, workers health safety and technical-economic feasibility of reusing treated wastewater. Evaluation tools are needed to assess the compliance with such conditions; indicators are used for this purpose. The Italian Institute for Environmental Protection (ISPRA) has asked the University of Brescia to develop a methodology to quantify the feasibility of the reuse of treated wastewater.

Technical-economic indicators were developed for this scope. Proposed markers were: 1) wastewater treatment plant performance (treatment efficiency and reliability), based on simplifies statistical analysis of operation data; 2) the hydraulic system required to supply the water from the plant to the final user (estimation of size and costs of pumping stations, pipeline extension and diameter, crossings and losses, etc.) and 3) advantages for the final user, in terms of water availability and water quality as compared to present alternatives and current situation. These indicators can be a valuable tool for policy-makers to make informed decisions on whether or not to reuse treated wastewater and where to allocate funds. However one needs to always rely on trustworthy input data and clearly understand how such indicators are built.

c. **Environmental aspects of treated wastewater reuse: impacts on quality of water in river systems**, Professor Donatella Caniani, University of Basilicata. Given the high costs of treating and discharging water back into rivers in Italy, a cheaper and more efficient way to optimize the use of water is to promote an integrated approach to water management and to reuse treated wastewater for irrigation. This can also indirectly benefit the quality of surface water in Europe as well as in all countries of the Mediterranean basin. To demonstrate the benefits of reusing treated wastewater, by subtracting the pollutant load in the river stream, the University of Basilicata developed a new methodology. Such methodology allows assessing the quality of water, at the river basin level, and can be applied it to the analysis of different rivers for hydro-morphological, chemical and physic-chemical conditions to evaluate the environmental status of the river, as well as their responses to different scenarios. Moreover the methodology considered three hydrological regimes for each river and assigned preliminary environmental water quality status, based on the following macro descriptors: dissolved oxygen, biochemical oxygen demand (BOD), nitrate-N, ammonia-N and total phosphorous. It is important to consider different hydrological conditions since the river qualitative framework changes in relation to them. This methodology, which also encompasses objective entropy, based on multi-criteria analysis, is proposed to support decision-makers in their assessment of various river basin management scenarios, using standard water quality parameters.

d. **Wastewater availability and the establishment of bio-energy value chains** , Professor Severino Romano, SAFE, University of Basilicata. The issue of conflicting uses of water is a very controversial one. Fresh water can sometimes be diverted from agriculture to more value-adding bio-agricultural energy chains. To avoid this, treated wastewater can be used instead, especially when fresh water is scarce and so crucial for the development of a country. This presentation focused on the use of treated wastewater to create energy value chains for production of biomass and to support a more sustainable economic and social development of a country, through the creation of green jobs. SAFE has developed a model to clearly identify and geo-refer areas most suitable to the establishment of small agro-energy districts that could use readily available treated wastewater for the production of short-rotation biomass. The developed method included a geographic multi-criteria analysis and a consequential reclassification of obtained maps

using linguistic quantifiers to identify areas most suitable for cultivation. In the second phase SAFE evaluated the availability of water supply, especially treated wastewater, screening all the treatment plants available in Basilicata. Finally an economic analysis was carried out to quantify the investment required to establish and maintain a biomass plant over a period of 12 years. Also return on investment and induced economic return, in terms of working days and job creation, were computed. The economic analysis produced the following results: 5,421 hectares can be used to establish short-rotation biomass plants. These are located close to 69 treatment plants and require a total net investment of 42.5 million Euros, in the worst case scenario, with the possibility of generating on average 4,700 work days, over the 12 years of the economic life of the investment. In addition to these, job creation related to the construction of the simplified treatment plants and the economic and occupational return of processing biomass should be added. This model can be used for clearly identifying the most profitable areas of intervention. It can also be applied to other geographic locations and it is a valuable tool for policy makers to assess and plan productive investments.

e. **FAO's vision on water reuse in agroforestry**, Mr Javier Mateo Sagasta, FAO – Natural Resources Department, Land and Water Division sets the framework on the main objectives and on the approach of FAO on the use of treated wastewater.

This presentation gave an overview of the different types of wastewater available for different uses, their pro and cons, and offered a summary of the main health hazards associated with the improper use of wastewater in agro-foresty. It also provided a description of FAO vision on how to reduce the risks associated with treated wastewater (lowering hazards and reduce the exposure of the population through multi-level barriers at production, farmer, trader, retailer and final consumer level). This approach is more affordable in developing countries that cannot invest in more complex and expensive water reclamation technologies.

The speaker then presented the different opportunities for water reuse, most of which are realized through the GCP/RAB/013/ITA FAO project activities. In agriculture wastewater can be used, provided that strict precautionary measures are taken, and only on specific crops. In cities wastewater can be used to create productive agroforestry green belts for peri-urban agriculture to increase food security and income opportunities for farmers. These can also act as green filters to combat desertification and offer adaptive strategies to cope with climate change. Furthermore wastewater can be used to increase soil fertility and indirectly contribute to the creation of carbon storage sinks, thus reversing carbon emission trends of local communities, and enabling the establishment of carbon credits market schemes.

The role of FAO is to raise awareness on the benefits and the risks associated with the use of treated wastewater and on sanitation practices, through publications and thematic guidelines, and to transfer this knowledge in the field, through projects. FAO also works

on collecting data on wastewater production, collection, treatment and reuse through databases.

The technical cooperation project CapitalMED. This session was concluded by the intervention of Professor Giovanni Quaranta who presented the institutional technical cooperation project implemented by the University of Basilicata and financed under the EU Framework Program Agreement (APQ) for the Mediterranean, targeting initiatives in Morocco, Tunisia, and Egypt.

The project is directed towards the safeguarding and management of water resources in the following three areas: 1) institutional governance and planning of management strategies, with an aim of developing the macro-regions of the Mediterranean and Adriatic-Ionian basins; 2) resource management to provide drinking water and water for agricultural purposes: technological innovations and exchange of good practices; 3) resource management to provide water for industry: technological innovations and exchange of good practices.

The macro objectives of CapitalMED are: 1) targeted and efficient use of institutions, funding and legislation 2) The capitalization of activities already carried out in line with point 2.3. of the APQ program and their integration into work tables of the Mediterranean and Adriatic-Ionian macro-regions; 3) consolidation and strengthening of partnerships and the development of project proposals for financing through the setting up of multi-national pilot initiatives; 4) participation of local productive systems and the identification of strategic commercial production chains to meet the specific needs of each nation.

Day 1. SESSION 2: THE FAO PROJECT GCP/RAB/013/ITA "FOREST RESTORATION IN ALGERIA, EGYPT, MOROCCO AND TUNISIA USING TREATED WASTEWATER TO SUSTAIN SMALLHOLDERS' AND FARMERS' LIVELIHOODS"

In the afternoon two parallel sessions took place. One session covered the results of the first year of activity of the PRIN scientific research project, jointly participated by the University of Basilicata and other Italian Universities, on the issue of " reuse of wastewater: operational issues and emerging pollutants".

The second parallel session focused on the FAO project GCP/RAB/013/ITA. This session, chaired by Mr Douglas McGuire from FAO, was conducted as a business meeting. Project countries and represented stakeholders and institutions were asked to summarize project progresses and achievements in their own countries and to identify main constrains to the timely completion of planned activities. Countries articulated the following points.

Algeria: the phyto-depuration plant is under construction, the basins have been set up, poplar cuttings have been received and canalization work has been completed.

The Direction Générale des Forets (DGF) is satisfied with the experience of Brezina and it is asking FAO support and the technical expertise of the University of Tuscia to develop new constructed wetlands and put in place an integrated water management system for the oasis of Taghit. This oasis, located in the Willaya of Bechar, sustains the population of five villages and is currently under serious threat of environmental degradation.

Moreover the region of Taghit has been classified national cultural heritage site, due to the material and immaterial value linked among others to the presence of the "ksour", traditional ancient dwellings, and this can turn the area in an important tourist destination. The rehabilitation of the oasis palm grove is also crucial for the preservation of its environmental and climate change adaptation functions. Indeed the design of the constructed wetland systems and better water management practices can preserve this important ecosystem and constitute a good foundation for a successful integrated rural development project.

Egypt: the project's local counterparts are already capitalizing on the results achieved in the first year to mobilize resources to scale up project activities throughout the country. Prof El Settawy of the University of Alexandria reported that in the week ahead of the workshop a study on the current and future state of forest plantation irrigation reusing sewage water was submitted to the Prime Minister of Egypt.

In this particular occasion the use of wastewater for afforestation and the importance to support this small scale FAO project, financed by the Italian government, were discussed. The Prime Minister was also informed about the results of the FAO first year of project activities and the proposed continuation of the forest management plan in Ismailia until 2022.

The Egyptian government is strongly committed to increase capacity building, through the establishment of future training programs and build new infrastructure for forester training. A new training centre for foresters is likely to be set up in Egypt, possibly in the Serapium forest, Ismailia or even Cairo. This will then be used as model to trigger other sites. The Egyptian government was very satisfied with the work done by the FAO project and it is keen to support this project strongly.

Morocco: Following the recommendations of November 2012 atelier, FAO elaborated a Memorandum of Understanding to be signed by all partners, which is currently with the University of Basilicata for approval. The species to be plant in the experimental parcel were identified.

The steering committee composed by the Haut Commissariat aux Eaux et Forêts et à la Lutte Contre la Désertification (HCEFLCD), the University of Cadi Ayyad (UCA) with the support of the University of Basilicata and FAO, contacted the Régie Autonome de Distribution d'Eau et d'Electricité de Marrakech (RADEEMA) to jointly strategize and plan the implementation of the project design for the secondary treatment plant and the wastewater reservoirs to be constructed in the pilot parcel.

RADEEMA asked a new study, conducted by a third-party to have more detailed information about the plant design. Moroccan counterparts stressed the need for additional funds to complete planned activities and finalize the ferti-irrigation system.

The completion of the experimental parcel is also crucial for mobilizing additional funds for the next phase of the project in Morocco. The government, together with the financial support of interested donors such as the World Bank and the European Union, is eager to upscale this project throughout the country but efforts must be put to first complete this pilot project and show the environmental, economic and social benefits of it.

Tunisia: A duty travel is still to be scheduled to Tunisia to collect the relevant documents information and cartographies to move forward with the two project designs of both the phyto-depuration and the ferti-irrigation systems. For the Kairouan site it was suggested to test the proposed methodology not only on olive trees but also on energy crops (jatropha) and other agroforestry species (arganiers, carrubiers, etc.).

Project partners recommendations

After a fully participated and interesting discussion all project partner institutions endorsed the activities carried so far in the different countries and requested FAO to support completion of planned activities and to move forward with the second phase of the project. They also agreed on the importance of involving their respective governments and other potential funding agencies in their own countries to mobilize resources to ensure project continuation and full appreciation of the environmental, economic and social benefits engendered by the project. More in particular project partner institutions discussed and adopted a number of recommendations to be presented in the following day to the scientific community to receive its technical endorsement. These recommendations are:

Common to all project Countries:

- To finalize the implementation of the first phase of project activities in each country as prerequisite for resources mobilization for the second phase
- All project partner countries request their respective governments to support project continuation, both at regional and national level, through a formal letter of endorsement to be submitted to FAO
- FAO, together with project partners, to continue investigating opportunities for resource mobilization (grants preferably than loans) with national development cooperation agencies (USAID, AUSAID etc.) and multilateral cooperation including GEF6, EU, World Bank and regional development banks
- FAO, to create a mailing-list or a platform on the website to communicate and share information among project countries more effectively
- FAO project and partner countries and institutions, to explore the possibility of linking project activities with other regional and global initiatives, networks of practitioners and national strategies that promote broader landscape management or restoration practices, combating desertification, food security and natural resources management in urban and peri-urban environment (e.g. FAO's Food for the Cities network)
- FAO to strengthen the regional component of the project and integrate different in-country activities in a more coherent regional framework to successfully mobilize support both at global, regional and national level.

Country-specific:

- Algeria:

    1. The DGF, jointly with FAO, will prepare a concept note to create synergies among the different programs that target the development of tourism, arts and crafts, culture, environment and agriculture, and rural development sectors of the oasis of Taghit.

    2. The DGF, jointly with FAO, will work to find additional sources of funding, with the sectors concerned, to complete the first phase of the project and ensure the continuation of the project for the second phase.

- Egypt:

    1. All involved Egyptian partner Institutions (Ministry of Agriculture, Ministry of Housing, Ministry of Local development, Drainage Company, University of Alexandria, the Horticultural Research Institute, and Desert Research Center) request the involvement of the National Government of Egypt to prepare a letter of endorsement of project activities to urge FAO and the Italian Cooperation to continue mobilizing support for the implementation of the project's second phase.

    2. Egypt, to ensure that the recommendations included in the Forest Management Plan for the Forest Plantation of Serapium, Ismailia are put into practice for the period up to 2022.

- Morocco:

    1. Finalize the Memorandum of Understanding in order to formally start the cooperation in the country (integration of comments and circulation of the final document for signature) in June 2013.

        In this context, consult with RADEEMA to ascertain the necessity of conducting a geotechnical that also includes details on investment costs related to the realization of the water supply system to the pilot plant, operating expenditure and other billing expenses

- Tunisia:

    1. To strengthen cooperation and exchange of information among the University of Tuscia, the University of Basilicata and the Tunisian local counterparts to start implementing project design activities.

    2. Complete activities planned for the first phase, and request FAO to act with potential donors in order to ensure project extension and additional funding for the realization of the two systems designed in the first phase of the project.

Day 2. SESSION 3: REUSE OF WASTEWATER IN THE MEDITERRANEAN; OPERATIONAL ISSUES AND EXPERIENCES WITH TRANSFER OF KNOWLEDGE.

The second day of the workshop was aimed at presenting and discussing the achievements of FAO project countries in the field of technology transfer for wastewater treatment and their views on how to strengthen regional and international collaboration on this specific issue.

- Algeria. The first presentation was given by Ms Sabrina Rachedi. After giving a brief update on the progresses in the construction of the phyto-depuration plant in Brezina, Ms Rachedi moved on to the discussion of current constraints for project implementation. These are primarily related to sand encroachment in the basins, due to degraded slopes nearby. Consequently the urgency of ensuring that wind breakers are put in place all around the treatment plant.
  The speaker once again stressed the significance of reusing wastewater in arid and semi-arid regions. For the Algerian delegation this FAO project represents an invaluable opportunity to use treated wastewater to increase water availability in arid zones, but also to increase production of biomass.
  Algeria wishes to replicate the experience of Brezina also in the oasis of Taghit. Taghit was chosen for its location, on the verge of the grand erg in the valley of the Saoura, its landscape value and variety, and the important functions performed by the palm groves located in the wadi Zouzfana, which is also home to many varieties of palm trees.
  The problem in Taghit is to restore the protective and productive functions of the "palmeraie" which is under serious environmental threat of degradation because of the direct discharge of low quality wastewater from the villages directly into the grove (the same water is also used for irrigation during drought and dry seasons). This has led to increasing eutrophication of stagnant water in the carved depressions of the wadi, presence of bad weeds and the decline of the wadi arable land due to water erosion, posing risks for both the palm grove and the population itself.
  Therefore, with the expertise of the University of Tuscia, Algeria has proposed to build a system of constructed wetlands to solve the environmental problems of the oasis of Taghit. The intention is to have an integrated rural development project with a specific component on water management and wastewater treatment and reuse to protect the palm grove but also to produce other species that well adapt to local

conditions and can be used for the provision of goods and services, fight against desertification and stock carbon in the soil.
If the project in Taghit proves successful then the Algerian authorities will have the technical capability to treat wastewater and to use it in many different sites across the Saoura valley, to restore other "palmeraie", such as the one in Béni Abbès etc..

- University of Tuscia. Subsequently Professor Paolo De Angelis from the University of Tuscia explained the importance of the oasis ecosystem as well as its extreme frailty. In this context, the benefits of creating agroforestry plantations with wastewater in arid and semi-arid areas are manifold. From an environmental point of view these range from the protection of soil from wind erosion, to reduced need of fresh water for irrigation, fight sand encroachment and subsequently greening and reclamation of marginal degraded land. Moreover wastewater can be used to support the creation of sustainable economies.
  The University favours an integrated approach to wastewater management and reuse. This entails from one side the reduction of wastewater pollution through phyto-remediation and constructed wetlands and other side the creation of forestry and agroforesty systems to sustainably support agricultural production and promote land rehabilitation, planting different tree species according to a multipurpose scheme and local needs. Pilot applications of this system are currently underway in Algeria in the oases of Brezina and soon Taghit, and Ouetchtata and Haffouz in Tunisia.
  Each system is customized for the needs and the climate, ecological and physical conditions of the site in which the phyto-depuration plant will be constructed. Furthermore particular attention is given to reducing the impact of these systems on the environment (to avoid possible accidental contamination of the soil due to spill-over and heavy rain and for browsing animal) and on the population that lives in close proximity (reducing odours and mosquitoes with the help of aromatic plants).
  A more detailed description of the design and functioning of the constructed wetland systems of Brezina and Taghit can be found in the presentation by professor De Angelis in annex to this document.
  The final objective of creating agroforestry testing plots irrigated with treated wastewater is to produce closed value chains of short-rotation biomass for producing and processing high-energy content materials, such as bio-char, bio-ethanol and forage and timber species, like eucalyptus, or other suitable for construction.
  In Brezina, Algeria, the project received the support of the Italian ministries of Environment and Economic Development and FAO but also the scientific backing of the University of Mascara and the local DGF. In Tunisia there is a need to reinforce exchanges with the Tunisian counterparts.

- Egypt. The following intervention by Professor El Settawy focused on the situation of forest plantations irrigated with treated wastewater in Egypt. The presentation also discussed the work carried out by the FAO project to ensure the effective and sustainable management and operation of the forest plantation of Ismailia, Serapium for the next decade. This was achieved through the provision of training to young

foresters, exchange of technical knowledge on forest inventory data collection and measurement, and improved silvicultural practices.

A forest management plan for the above mentioned plantation was also drafted by FAO experts. In this plan water management constraints and other issues of concern were identified. In addition silvicultural treatments to promote the growth of most suitable and promising tree species were proposed.

As far as the Serapium forest is concerned, the Egyptian government, following the recommendations laid out in the forest management plan, intends to establish a forest training centre in Ismailia; expand the forest area; improve wastewater treatment technology and clearly define production targets for the plantation also by improving silvicultural practices.

In the near future potential areas of collaboration between the University of Basilicata and the University of Alexandria, Egypt, can be foreseen in the use of sludge for soil fertilization and in the establishment of a carbon credit market to capitalize on carbon credits produced by the increase in CO2 stocked in the forest plantations of Egypt.

- Morocco. Afterwards Professor Naaila Ouazzani, from the University of Cadi Ayyad, Morocco, reported on the constraints and future developments of the construction of the ferti-irrigation plant for the green belt of Marrakech.

  After giving an extended overview of activities already completed by the University i.e. collection of climate data for the studied site; agronomic study and assessment of crop needs and the design of the irrigation system and wastewater treatment plant for ferti-irrigation in collaboration with the University of Basilicata, Ms Ouazzani identified the major technical needs to be fulfilled in order to ensure timely completion of project activities in Morocco.

  These technical needs were: a detailed technical study, to be commissioned to a third-party consulting company, which was requested by the RADEEMA; a geotechnical study about which explains how to link the RADEEMA Marrakech wastewater treatment plant to the ferti-irrigation site; construction work of the system.

  Institutional constraints were also acknowledged. These were related to the time lapse before the final approval by all implementing institutions of the memorandum of understanding drafted after the last workshop held in November 2012 in Marrakech. This memorandum will clearly define responsibilities for each partner. In the meantime UCA will carry out experimentation in their laboratories on activated sludge and once the parcel is ready in Marrakech they would like to reproduce their results in a small pilot plot to be built on site.

- Tunisia. Mr Khouja from the National Research Institute of Rural Engineering, Water and Forests (INRGREF), Tunisia reminded participant of the importance of the FAO project for the Institute and other involved partners, particularly for the research and innovation components that this begets. The use of treated wastewater for irrigation and groundwater recharge is also one of the main priorities of the national water strategy.

INRGREF already boasts a solid expertise on irrigation of forest plantations with treated wastewater and it is very eager to test the ferti-irrigation system and constructed wetlands not only on olive trees but also on energy crops (jatropha) and other agroforestry species (arganiers, carrubiers, etc.). These methodologies can be extremely useful as cost-effective means to provide water for agriculture in Tunisia.
Indeed the use of treated wastewater in Tunisia dates back to the mid 1960s. At present more than 8000 ha are irrigated with treated wastewater (i.e. 2-3% of all irrigated land). However wastewater treatment is currently limited to the secondary level. In order to have water suitable for irrigation in agriculture wastewater treatment must be taken to the tertiary level. And this is obviously very costly.

- University of Basilicata, Tunisia. The following speaker, Mr Rafet Ataoui, engineer and student from the University of Basilicata provided more details on the study for the realization of the ferti-irrigation pilot projects in Tunisia. The innovative idea of the system proposed is to operate a controlled and selective removal of organic carbon, nitrogen and phosphorus already available in wastewater to feed them directly into the soil through dripping irrigation.
  The study conducted by Mr Ataoui assess the opportunity to establish two ferti-irrigation systems connected to the wastewater treatment plants of Kairouan city and Haffouz, Tunisia.
  Most of the volume of treated wastewater produced in Kairouan is then discharged into nearby effluents.Indeed the land surrounding the wastewater treatment plant of Kairouan is characterized by high soil salinity that make it inadequate for any agricultural practice.
  On the contrary, to the west side of the station, there are large agricultural lands, most of them cultivated by olive trees which are not irrigated. Therefore assuming that the wastewater treatment plant in Kairouan produces 5Mm3/year of treated wastewater, and considering annual average rainfall in the region, the FAO project intends to use this wastewater to irrigate about 1600 hectares of these olive groves.
  Similarly in Hafouz part of the treated wastewater will be used to irrigate olive trees located downstream from the plant.

- University of Basilicata, Morocco. In the second to last intervention of the morning Mr Targetti Ferri from the FAO office in Rabat, Morocco introduced the audience to potential innovative uses of treated wastewater, aside from soil rehabilitation or irrigation. Indeed treated wastewater applied to a degraded soil can increase its carbon content. The carbon stocked in the land can then be measured and exchanged into voluntary carbon markets, as a useful tool to improve the economic value of investments in the agroforestry sector.
  The creation of a voluntary carbon market is a complex process that involves many different stakeholders and requires a great deal of accurate data and proper financing.
  First of all there is the need to establish a clear governance structure. This implies obtaining the certification from internationally recognized standard (such as VCS; CCBS; CFS; VSS panda standard) and the application of these standards in field

projects which will also provide for the creation of a platform to exchange credits and the establishment of a national registry for generated credits. In addition third-party verification and measuring, reporting, and verification (MRV) will be required.

At any rate to establish a voluntary carbon credit scheme two-level interventions are envisioned. On the one hand, at the local/micro level, one must intervene through the establishment of pilot projects for climate change mitigation and adaptation, aimed at increasing carbon storage in the soil, or preventing carbon emission, while improving living conditions of rural community at the local level.

For instance the FAO GCP/RAB/013/ITA project is a good example of creating a win-win situation in which restoration of agricultural land and productivity increase, through the use of non-conventional water, coincides with reducing vulnerability to climate change, by boosting adaptation strategies and creating new income opportunities for farmers.

A precise evaluation, through dynamic models, of CO2 balance and the amount of CO2 fixed in the soil and in the biomass irrigated with treated wastewater, together with information on the agroforestry sector (potential storage) are also required in the short-run.

On the other hand in the long-run these data can be used by national institutions for the elaboration of low carbon strategies or Nationally Appropriate Mitigation Actions (NAMAs) and the creation of a national market.

As for other similar Kyoto-type mechanisms, certain criteria must be taken into consideration when preparing carbon project. These are: 1) Additionality of the project; 2) measurability of credits generated; 3) permanence of its effects through time; 4) exclusivity of the project; and 5) avoid double credit counting.

Likewise certain weakness must be acknowledge and dealt with when preparing this type of project. These include: 1) Access to finance, often the main hindrance. Need for start up financing, transaction and monitoring costs and even opportunity costs should be included in the financial assessment; 2) building stakeholders' trust; 3) a required strong political will and finally 4) the exact size of the carbon projects, as often big donors would rather invest in higher impact-higher return projects than small-scale innovative pilot ones.

Establishing a voluntary carbon credit scheme can also provide a profitable way for the public and private sector to offset their emissions while financing development through an improved use of funds for sustainable land management projects. This will also directly improve the livelihoods of small holders and farmer communities through the sale of emission reduction credits generated and consequential increase in revenues for farmers.

- FAO. The last intervention of the second day, by Mr Alberto Del Lungo from the FAO forestry Department and technical leader of the FAO project, provided a comprehensive summary of the GCP/RAB/013/ITA activities, the innovative wastewater treatment methodologies applied, progresses in each countries and the efforts to support country capacity development, through direct training, study tours, the establishment of networks and partnerships, information sharing, and sustainably

transferring knowledge and technologies to recipient countries. Despite the great success achieved by the project in the four countries, Mr Del Lungo reminds the audience that some constraints still remain to ensure project continuation over the original 4-year period, as agreed in the inception workshop of the project in Hammamet, 2010. These pertains to the need to find additional financing, strengthening relationships with donor countries and funding institutions, and raising awareness on the benefits related to the use of treated wastewater in agroforestry systems in order to further stimulate the interest of international donors, particularly the European Union.

The following discussion was devoted to the wrap-up of the discussions held in the previous day and the finalization of the workshop recommendations drafted by the FAO project participant countries.

In the afternoon workshop participants had the opportunity to visit the experimental site of Ferrandina, near Potenza where the University of Basilicata has been implementing the ferti-irrigation system on an olive grove for the past 12 years.

Conclusion

The workshop on the first year of activities of project GCP/RAB/013/ITA represented an important opportunity to convene project stakeholders and participants to take stock of progresses and achievements but also to discuss a road map to ensure the project long-term sustainability and completion of current activities in each partner countries.

The workshop also offered a good overview of innovative technologies and the state-of-the-art of cutting edge research on the treatment and reuse of wastewater for the preservation of the environment and to raise the productive of agriculture and forestry systems. Workshop participants greatly valued the opportunity to establish and extend their professional and scientific networks and knowledge through this event.

Moreover the field visit to the pilot site of Ferrandina provided a concrete example of the application of the innovative "ferti-irrigation" system, developed by the University of Basilicata whom the FAO project is implementing in all four project countries.

This system operates with wastewater treated at the second level, selectively removing pathogens and harmful substances from it. The result is a partially treated wastewater, still rich in agronomically useful organic matter that will be used for irrigation of olive groves.

Among the different productive uses of wastewater, that the FAO project strongly supports, the workshop particularly emphasized the importance of using this resource to increase soil fertility and carbon storage capacity of arid zones. The carbon content, captured in poor quality soil, via the application of wastewater, can be measured and the resulting increase of CO2 stocked can be sold in ad hoc voluntary markets for carbon credits.

Such an additional source of income can then be employed as a direct revenue stream for farmers who adopt virtuous treated wastewater practices, but also to finance new projects for

sustainable land management and to fight desertification and land degradation in particularly arid zones.

Based on the above, workshop participants strongly endorsed the important achievements of FAO intervention and support and indeed express their eagerness to move forward with a "phase two" of the current GCP/RAB/013/ITA project, as originally planned in the extended logical framework, drafted during the Hamammet workshop in 2010.

To this extent, countries' representatives and the scientific floor approved the need to mobilize additional financing to scale up project activities in the near future and they drafted and agreed upon a list of recommendations to address these issues and challenges.

The agreed and endorsed recommendations are presented on page 9 of this report.

ANNEX 1 Workshop agenda

Monday 29 April

8.30 – 9.00 hrs
Registration of Participants

9.00 – 10.00 hrs
Opening Session, moderator: Prof. Ignazio Mancini
Welcome speeches:

- Prof. Mauro Fiorentino, President, University of Basilicata
- Prof. Ignazio Mancini, Director, School of Engineering of the University of Basilicata
- Mr. Doug McGuire, Team Leader, Forest Management Team, FAO Forestry Department
- Ms. Rosa Gentile, President, Acquedotto Lucano s.p.a.
- Mr. Angelo Nardozza, Commissioner, Optimal Territorial Area Authority for Integrated Water Services (A.A.T.O. - S.S.I.) for the Basilicata region
- Mr. Marco Arcieri, Secretary General of the Italian Committee, International Commission on Irrigation & Drainage (ICID)

10.00 12-00 hrs
Session 1, *PROBLEMS AND OPPORTUNITIES FOR WASTEWATER REUSE*
Moderator: Prof. Salvatore Masi, School of Engineering of the University of Basilicata

Alfieri Pollice, Research Institute on Water - National Research Council, IRSA-CNR, Bari
Wastewater treatment for reuse in agriculture: conventional schemes and IRSA's experience in Apulia

Giorgio Bertanza, University of Brescia
Planning wastewater reuse: technical and economic sustainability assessment

Donatella Caniani, School of Engineering, University of Basilicata
Environmental aspects of treated wastewater reuse: impacts on quality of water in river systems

Severino Romano, School of Agriculture, Forestry, Food and Environmental Science (SAFE); University of Basilicata
Wastewater availability for the establishment of bio-energy value chains

Javier Mateo Sagasta, FAO Natural Resources Department, Land and Water Division
FAO's vision on water reuse in agroforestry

Giovanni Quaranta, University of Basilicata
The cooperation project CapitalMED

12.00 – 13.30 hrs
The cooperation between the Basilicata region, Morocco and FAO in the framework of the FAO-Italy project

- Video message from H.E. Gianni Pittella, Vice chair of the EU Parliament
- Phone call from H.E. Ambassador of the Kingdom of Morocco to Italy
- Mr. Doug McGuire, Team Leader, Forest Management Team, FAO Forestry Department

13.30 – 15.00 hrs, Lunch Break

15.00 – 17.00 hrs
Session 2, ***PRESENTATION OF THE RESULTS OF THE FIRST YEAR OF ACTIVITY OF THE MIUR's PRIN – PROJECT OF RELEVANT NATIONAL INTEREST. "REUSE OF WASTEWATER: OPERATIONAL ISSUES AND EMERGING POLLUTANTS".***
Moderator: Prof. Salvatore Masi, School of Engineering of the University of Basilicata

Giorgio Bertanza, University of Brescia
Micropollutant removal from wastewater using conventional and advanced treatments

Daniele Goi, University of Udine
Sonozone and photo-oxidative technologies applied to wastewater treatment

Salvatore Masi, University of Basilicata
Selective removal of pollutants from urban wastewater for agricultural and forestry applications

Ezio Ranieri, Polytechnic of Bari
Constructed wetlands for wastewater treatment in Southern Italy

Bartolomeo DiChio, University of Basilicata, DICEM
Agro-environmental sustainability of the use of treated wastewater for olive groves irrigation: long-term applicative effects

Paolo Roccaro, University of Catania
Development of a decision support system to assess the sustainability of wastewater reuse projects and evaluation of occurrence and control of emerging contaminants in wastewater reuse systems

17.00 hrs Discussion
Moderator: Prof. Daniele Goi, University of Udine
Speakers from previous session, regional authorities and professional from water utilities, workshop participants

15.00 – 17.00 hrs
Parallel Session 2,

THE FAO PROJECT GCP/RAB/013/ITA "FOREST RESTORATION IN ALGERIA, EGYPT, MOROCCO AND TUNISIA USING TREATED WASTEWATER TO SUSTAIN SMALLHOLDERS' AND FARMERS' LIVELIHOODS". PRELIMINARY RESULTS AND FUTURE DEVELOPMENTS.
Moderator: Mr Doug McGuire, FAO Forestry Department

Tuesday 30 April

9.00 – 13.00 hrs,
Session 3, ***WASTE WATER REUSE IN THE MEDITERRANEAN REGION: DEVELOPMENTS AND TRANSFER OF KNOWLEDGE AND TECHNOLOGIES***
Moderator: Prof**.** Naaila Ouazzani, University Cadi Ayyad, Morocco

Sabrina Rachedi, Direction Générale des Forêts, Ministère de l'Agriculture et du Développement Rural, Algeria
Progress report of the project in Brézina, El Bayadh State, Algeria and outlook

Paolo De Angelis, University of Tuscia, DIBAF
Phyto-technology to reduce water pollution and sustain forestry and agroforestry activities in the southern Mediterranean region

Ahmed A. El-Settawy, University of Alexandria, Forestry and wood technology Department, Egypt
Results of the first year of the FAO project in Egypt: recommendations and potential impacts

Naaila Ouazzani, University Cadi Ayyad, Morocco
The ferti-irrigation plant for the Green Belt of Marrakech: constraints and future developments

Coffee break

Mohamed Larbi Khouja, INRGREF, Tunisia
Experiences and opportunities for wastewater reuse in Tunisia

Rafet Ataoui, School of Engineering, University of Basilicata
Study for the realization of ferti-rrigation pilot projects in Tunisia

Simone Targetti Ferri, PhD School of Agriculture, University of Basilicata
Voluntary carbon mechanisms: a useful tool to improve the economic value of investments in the agroforestry sector

Alberto Del Lungo, FAO Forestry Department
The FAO project: achievements and follow up

Discussion

13.30 hrs, Lunch Break

15.00 – 17.00 hrs, Improving cooperation and country capacity building between Italy and the Mediterranean countries on the use of treated waste water in forestry and agroforestry systems of arid zones

Moderator Douglas McGuire, FAO

Delegations of Algeria, Egypt, Morocco and Tunisia
University of Basilicata
University of Tuscia
National Council for Research
Research Council for Agriculture
Workshop participants

17.00 hrs, Session 4, ***FIELD VISIT TO THE EXPERIMENTATION SITE OF FERRANDINA, TO ASSESS THE EFFECTS OF THE USE OF TREATED WASTEWATER FOR IRRIGATION OF OLIVE GROVES***

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