Forestry Department

Food and Agriculture Organization of the United Nations

Planted Forests and Trees Working Papers

International Workshop

"Forest Restoration in Algeria, Egypt, Morocco and Tunisia using Treated Waste Water to Sustain Smallholders and Farmers Livelihoods"

FAO Project GCP/INT/059/ITA

Hammamet, Tunisia, 16-17 October 2010

Forest Management Team
Forest Assessment, Management and Conservation Division
Forestry Department

Working Paper FP/45E
FAO, Rome, Italy

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The purpose of these papers is to provide early information on on-going activities and programmes, and to stimulate discussion.

Comments and feedback are welcome.

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FAO Project GCP/INT/059/ITA

International Workshop

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Acronyms

CNR	National Council for Research (*Consiglio Nazionale per le Ricerche)*
CRA	Council for Research in Agriculture (*Consiglio per la Ricerca in Agricoltura)*
ETP	Potential evapotranspiration
FAO	Food and Agriculture Organization of the United Nations
GIS	Geographic Information System
LFA	Logical Framework Approach
OSS	Sahara and Sahel Observatory
PRW	Phyto-remediated water
STEP	Waste water treatment plant (*Station de traitement des eaux épurées*)
TWW	Treated waste water

International Workshop

"Forest Restoration in Algeria, Egypt, Morocco and Tunisia using Treated Waste Water to Sustain Smallholders and Farmers Livelihoods"

Hammamet, Tunisia
16-17 October 2010

Opening Session

The International Workshop "Forest Restoration in Algeria, Egypt, Morocco and Tunisia using Treated Waste Water to Sustain Smallholders and Farmers Livelihoods" was held from 16 to 17 October 2010, at the Diar Lemdina Hotel in Hammamet, Tunisia, in cooperation with the University of Alexandria, Egypt, and the University of Tuscia, Italy. The purpose was to facilitate knowledge transfer by bringing together specialists and decision makers from the four participating countries and Italian specialists to improve and transform the preliminary project concept note (*Appendix A*) into a project proposal to be submitted to donors and funding agencies. The workshop concept note is given in *Appendix B.*

The International Workshop was organized by FAO and funded by the FAO Project GCP/INT/059/ITA, with the kind support of the Government of Italy.

In total, twenty-eight participants attended the meeting. Algeria, Egypt, Morocco and Tunisia were represented by two delegates each, Italy was represented by experts from two Italian universities - Basilicata, Potenza, and Tuscia, Viterbo - as well as from the CRA (*Consiglio per la Ricerca in Agricoltura* – Council for Research in Agriculture) and the CNR (*Consiglio Nazionale per le Ricerche* – National Council for Research). Additionally, two observers from the Italian Ministry of Foreign Affairs (Italian Cooperation) took part in the event. Five observers from Tunisia, one representative of the Sahara and Sahel Observatory (OSS) and four officers from FAO Headquarters and the Regional Office for the Near East also attended the meeting. The list of participants is given in *Appendix D.*

Mr. Mohamed Saket, FAO Senior Forestry Officer in Cairo, welcomed all participants to the meeting and thanked the Italian scientists for sharing their experience in the area of afforestation using treated waste water, as well as the FAO officers. He said the initiative was very important for the concerned countries due to their particular characteristics, and could contribute to improve the local people's needs of forestry goods and services and to food security. There were, however, many institutional, financial, technological and political challenges that the planned project could help to overcome. Finally, he wished the participants to have a productive workshop that will lead to the envisaged project.

Mr. Salem El Fekih, Director-General of Forests of Tunisia, also welcomed all participants on behalf of the Minister of Agriculture and thanked the Italian representatives and FAO officers for their support in this important initiative which will contribute to the integrated rural development and the forestry sector in the region and improve the smallholders and farmers livelihoods.

Ms Maria Pia Rizzo, from the Italian Ministry of Foreign Affairs, emphasized the significance of the use of natural resources for sustainable development. The international community was more and more aware of the importance of the governments' responsibility and of the inter-relation among different countries in resource management. The Italian experience and expertise could be utilized in a sustainable way and this opportunity should be taken to address the political, social and economical aspects of sustainable development in arid zone countries.

Mr Walter Kollert, FAO Forestry Officer (Planted Forests), presented the objective of the workshop. He recalled that the countries in the region had since long recognized the need to work together on shared forestry problems and had created the *Silva Mediterranea* network to this effect. This Workshop was a follow-up event of the 18th session of the Near East Forestry Commission held in Tunisia earlier this year which had recommended "to encourage countries to use treated water waste in forest tree planting with required precautions". The workshop would provide an opportunity to facilitate knowledge transfer among the countries concerned, to better understand the particular forestry characteristics of these countries, to contribute to the transfer of scientific research into forest policies, and finally to prepare and develop in a joint effort a project proposal which may be eligible for funding by international donor agencies.

Approval of the Agenda

The Provisional Agenda was adopted without amendments and is available in *Appendix C*.

Workshop procedures and organizational arrangements

Mr. Houssem Bel Hadj, Facilitator of the meeting, presented the Workshop procedures and organizational arrangements which included *inter alia* the role of the facilitator and of the rapporteurs; thematic papers; use of resource persons and the working group sessions.

Country reports by Algeria, Egypt, Morocco and Tunisia on the use of treated waste water in forestry and agroforestry

Participants reported on the use of treated waste water in their respective countries and presented a brief summary which can be found below. The full presentations are attached as *Appendix E*.

Algeria

The report was presented by Mr Nasr Eddine Kazi Aoual and Ms Sabrina Rachedi, the two representatives from Algeria, and included a description of the country with geographic distribution of forests, the state of mobilized waters and availability of treated waste water in the country, the re-utilization of treated waste water in the agricultural sector and the current programme in this area.

Egypt

Prof. Ahmed El Baha presented the report related to the Egyptian experience. He mentioned the general geographic and ecological description of the country and indicated that due to the scarcity of rainfall, about 96 percent of the territory were constituted of desert. Twenty-six planted forests irrigated with treated waste water had already been established in different locations of the country. He also described the four main methods of irrigation and indicated the main constraints related to the use of treated waste water in urban and peri-urban areas, forestry and agroforestry.

Morocco

The two representatives from Morocco, Mr Mourad Taroq and Ms Kawtar Gazoulit, gave a general description of the forestry conditions in the country, and the potential and challenges of using treated waste water in forestry and agroforestry in Morocco. The regeneration of urban and peri-urban forests and the creation of a green belt was part of the objectives of the Moroccan new strategy. An estimation of used waste water production in Morocco was given, as well as some examples of re-utilization of this type of water.

Tunisia

The presentation was made by the two representatives of Tunisia, Mr Rafik Aini and Ms Raqia El Aitiri, and included the geographic description of the country, climate and ecology aspects, in particular the rainfall scarcity, and soil resources. The national water strategies included water mobilization, conservation, participatory management and treated waste water reuse for agricultural needs.

Case studies

Two case studies related to the use of two different technologies used for treating waste water in order to be re-used for reforestation or irrigation of olive trees were also presented:

- Afforestation Project to establish a forest plantation irrigated with phyto-remediated water (PRW) in the Oasis of Brézina, El-Bayadh (Algeria), by Prof. Paolo De Angelis, University of Tuscia, Italy

- Simplified treatment systems for reuse of waste water in agriculture and forestry: Ten years of irrigation results on an olive tree culture in Italy, by Prof. Salvatore Masi, University of Basilicata, Italy

These two presentations, which can be found in *Appendix E,* were met with great interest of the participants and the speakers had to answer a number of questions about the proposed technologies, as well as the results and limits experienced in Algeria and in Italy.

Introduction to project planning: problem analysis and Logical Framework (outcomes, outputs, activities, roles and responsibilities, indicators)

Mr. Houssem Bel Hadj presented an introduction to the project planning. The Logical Framework Approach (LFA) was an aid to systematic and logical thinking, the process of which was as important as the product itself. Tools should be applied as part of an iterative process and the product of the analysis had to be open to review and revision. The LFA tools presented in this training were not exclusive and there were many other complementary tools that could be used.

Working sessions

Working sessions were organized in four groups to allow participants to draft project proposals based on the country needs reported during the Plenary Session. Four working Groups were set up: Working Group 1: Algeria; Working Group 2: Egypt; Working Group 3: Morocco; and Working Group 4: Tunisia. A representative from Italy and an FAO staff supported each group in their discussion.

The different groups used the METAPLAN method (Boards and cards with different colours) in order to identify the activities to be implemented in their respective countries that would achieve the outputs.

Workshop results, conclusions, further steps – Endorsement by participants

Mr Walter Kollert, FAO, presented the results and conclusions of the Workshop to the plenary (see details in *Appendix G).* The Logical Framework as drafted during the workshop was endorsed by all participants (*Appendix F*) and FAO obtained the mandate by the countries to continue work based upon this logical framework.

Closing of the Workshop

Ms Maria Pia Rizzo, on behalf of the Italian Ministry of Foreign Affairs, said that the Workshop was not the end of the process but the starting point to stimulate thinking and working together. She acknowledged that the workshop participants had made use of the possibility to exchange technical information and ideas and had managed to develop goals for a joint cooperation project.

Mr Aleksander Zaremba, from the FAO Technical Cooperation Department, thanked the participants for the challenging dialogue in building up a project proposal that would transfer knowledge and technology from more advanced countries into the Mediterranean region.

Mr Mohamed Saket, Senior Forestry Officer in the Near East Regional Office, thanked the participants for their hard work and acknowledged the results achieved through the workshop. He also thanked the Sub-Regional Office for North Africa in Tunis for their kind support and cooperation. He then declared the Workshop closed.

Appendix A – Preliminary Project Concept Note

Planted forests for waste water management and improvement of smallholder and farmer livelihoods

Beneficiary countries	Morocco, Algeria, Tunisia and Egypt

Title	Planted forests for waste water management and improvement of smallholder and farmer livelihoods

Duration	Three years (36 months)

Responsible Technical Unit	FAO – Forestry Department, Forest Management Team, FOMR

Total budget	Total: 4,000,000 USD

Target Group and Benefits	Smallholders, farmers, farmers associations, forestry, agricultural and environmental protection departments

Background and rationale for the proposal

Planted forests provide a wide range of wood, non-wood and fibre products. Their use in afforestation and reforestation programmes reduces the pressure on natural forests, and increases the production of quality wood. The integrated use of planted forests and agroforestry systems are effective tools to combat hunger and reduce poverty through the direct or indirect provision of services that help to increase farmers' income. The integrated use of certain species of planted trees is relevant for the production of biomass and fodder and for the production of handicraft (baskets, chairs, little tables), which can provide a sustainable source of income particularly for women in rural areas. Further, planted forests support a wide range of social and ecosystem services contributing to sustainable livelihoods and rural communities development, including employment, ecosystem services, urban and rural amenity, combating desertification and salinization, shelterbelts and windbreaks for agricultural lands, riparian bank and slope stabilization, soil rehabilitation/restoration, protection of watersheds, phytoremediation and waste water management, livestock fodder, and sequestering and storing carbon.

Irrigated agriculture in Northern African countries, particularly Morocco, Algeria, Tunisia and Egypt, accounts for most of the water withdrawals and increasing demand and development of irrigated agriculture involve the progressive reduction of easily accessible water resources river flows and shallow good quality ground-water. Countries are seeking safe, environmentally sound and cost-efficient ways to treat and dispose of wastewater produced by urban communities and industries. At the same time, increased attention is being focused on the role that forestry, traditionally a rural-based sector, can play in improving the urban and peri-urban environments in arid and semi-arid regions. One opportunity to address both concerns is the use of municipal wastewater (both sewage and industrial effluent) to irrigate planted forests, greenbelts and amenity trees. Wastewater re-use for planted forests irrigation has several benefits: safe and low cost of treatment and disposal of wastewater; rehabilitation of fragile ecological zones; reduced discharge of wastewater into the sea; and use of nutrients in wastewater for productive purposes.

Desertification control and planted forests development are crucial in Northern Africa, since the natural woodland resources are inadequate to meet the increasing demand for forest products and services. The majority of natural forests in the region are open woodlands and scattered trees of relatively low productivity. The increased population demand for wood, particularly for fuel in the region has led to the depletion of the scarce natural wood resources resulting in a negative impact upon the livelihoods of rural communities. The scarce natural and planted forest lands are particularly significant for their economic, social, cultural and environmental values, including provision of livelihoods for rural communities, protection of fragile soils and conservation of scarce biological diversity. In response to this situation, irrigated planted forests and tree planting in various settings have been established in many countries of the region, particularly using multi-purpose and fast-growing species to provide wood, fodder and protection as well as increasing soil fertility.

Morocco, Algeria, Tunisia and Egypt are strongly influenced by the Sahara desert and their forest cover is among the lowest in the world (Morocco 9.8%, Algeria 1.0%, Tunisia 6.8% and Egypt 0.1%,). However a lot of effort is put on planted forests (see following table).

Country	Forest area ('000 ha)	Planted Forest area ('000 ha)	Planted Forest % of forest area
Morocco	4,364	563	13
Algeria	2,277	754	33
Tunisia	1056	498	47
Egypt	67	67	100

Source: FAO, Forest Resources Assessment 2005

The project proposal will contribute towards the UN Millennium Development Goals 1: "*to eradicate poverty and hunger*"; 7: "*to ensure environmental sustainability*" and 8: "*develop global partnerships for development*".

Project outputs and activities will strengthen smallholder and farmer capacities in the use of recycled waste water on planted forests and agroforestry irrigation in urban and peri-urban lands

The main recipient organizations involved have been identified as follows:

- **Morocco:** Haut Commissariat aux Eaux et Forêts et à la Lutte contre la Désertification
- **Algeria:** Ministère de l'Aménagement du Territoire et de l'Environnement
- **Tunisia**: Ministère de l'agriculture et des forêts and Institut National de Recherches en Génie Rural, Eaux et Forêts
- **Egypt**: Ministry of Irrigation and Water Resources; Ministry of Agriculture and Land Reclamation; University of Alexandria

These institutions will act as implementing agencies and collaborate with key stakeholders including farmer associations, communities, NGOs, research institutions, and to support the project.

Target Groups

The direct target groups are smallholders and farmers living in urban and peri-urban areas. They will benefit from the transfer of knowledge and technology on the use of recycled waste water for irrigation of planted trees including nursery and planting techniques, silvicultural management, and the harvesting and marketing of wooden end products. The quality of the environment will be improved through the recycling of waste water that will reduce the pollution in the soil and will also have positive impacts on the reduction of water consumption. The sale of locally produced wood will contribute in the long term to generate new job opportunities and sources of income, and by that, contribute to alleviate poverty and improve the livelihoods of the rural communities. The project will further have an impact on government officials, local research organizations and NGOs as indirect target groups, which will be strengthened by support from scientific research organizations to enhance their technical knowledge on the use of recycled waste water for irrigation of planted trees, particularly through the involvement of research groups. Additionally, support will be given to rural extension structures through government, non-government and private organizations and the transfer of knowledge and technology to farmers.

Expected outcomes

Expected outcomes are:

- Reduced imports through the increasing of good quality wood production;
- Improved living and socio-economic conditions of farmers from the production of roundwood, fuelwood, biomass and other wood products;
- Job opportunities in the forestry and agroforestry sectors;
- Improved adaptation of planted trees to biotic and abiotic stresses, climate change, waste water and saline soils through targeted scientific cooperation;
- Improved quality of the environment with special care to soil and water.

Expected outputs

The expected project outputs are:

- Improved country capacity building both at research and field level through the introduction of field-tested, proven, genetic planting material resistant to highly salty soils, poor water quality, and biotic and abiotic stresses, drought and climate change;
- Reduced pressure on fresh water reservoirs and better control on quality of water;
- Progressive reduction on land soil contamination;
- Increased afforestation areas;
- Increased availability of local fuelwood, biomass and wood products from early thinning and harvesting of new plantings;
- Increased wood quality and better growth rates through availability new genetic resources;
- New job opportunities for the generation of income in rural communities;

- Educational material on forestry, agriculture and the environment to support public awareness campaigns on role of planted forests for environmental purposes.

The monitoring of the same outputs will serve to assess the project development.

Actions to be implemented

The key programme activities comprise educational programmes for professionals and researchers. Training measures and study tours for extensionists and farmers will be supported by the project to facilitate capacity building and the transfer of knowledge and technology. Farmers' groups, extension workers and employees of the Government will be trained and educated in the application of planting and forestry techniques in saline soils of arid lands. Specialists will also be trained on treatment practices of recycling waste water for forest/agroforestry irrigation practices in arid zones. Soil and biomass analysis will be conducted to assess the degree of contamination. Plans for preliminary treatments of waste water will also be developed. Tested planting material, resistant to saline soils will be imported from more experienced countries. Experimental trials will be established to adapt the imported material to the local climatic conditions and polluted soils. Woodlots of fast growing, locally tested afforestation species will be established.

Media, environmental NGOs and education bodies will be involved to raise awareness on reducing water consumption.

Human Resources

The regional project will be executed in the four countries and will require an international CTA (P4) and a General Service staff and four national recruited officers (P3-P4) in the countries. The hiring of international and national consultants will be crucial to implement the key project activities. Another major expenditure will be travel costs for the coordination of the project in the four participating countries.

Implementing period and budget

The duration of 3 years for development project focussing on the establishment of planted forests for environmental and production purposes.

Abudget of US$4,000,000 for the triennium, plus operating costs, is proposed, as detailed below.

Personnel:	30%
International consultants	10%
National consultants	5%
Travels:	15%
Capacity building and training material:	10%
Establishment of demonstration sites:	12%
Hardware and equipment:	5%
Project support costs:	13%

Organisation and implementation of an International Workshop on:

"Forest restoration in Algeria, Egypt, Morocco and Tunisia using treated waste water to sustain smallholders and farmers livelihood"

Hammamet, Tunisia
16 – 17 October 2010

Introduction

Planted forests provide a wide range of wood, non-wood and fibre products, reduce the pressure on natural forests, and increase the production of quality wood. Integrated use of planted forests and agroforestry systems are effective tools to combat hunger and reduce poverty through the direct or indirect provision of services that help improve farmers' livelihood and increase income. Desertification control and planted forests development are crucial in the participating countries, since the natural woodland resources are inadequate to meet the increasing demand for forest products and services. Irrigated agriculture, particularly in Morocco, Algeria, Tunisia and Egypt accounts for most of the water withdrawals and increasing demand and development of irrigated agriculture involves the progressive reduction of easily accessible water resources river flows and shallow good quality ground-water.

One opportunity to address both concerns is the use of municipal wastewater (both sewage and industrial effluent) to irrigate planted forests, greenbelts and amenity trees where ecological conditions allow at low risk to the water table and environment in general. Wastewater re-use for planted forests irrigation has several benefits: safe and low cost of treatment and disposal of wastewater; rehabilitation of fragile ecological zones; reduced discharge of wastewater into the sea; and use of nutrients in wastewater for productive purposes.

In collaboration with the Government of Italy, FAO has been implementing since June 2008 the project GCP/INT/059/ITA "Poplars and Willows for Sustainable Livelihoods and Land-use" in selected Mediterranean and Central Asian Countries that aims to improve the contribution of planted forests in meeting sustainable livelihoods and land-use. The FAO-Italy project is in line with the Millennium Development Goals 1, 7 and 8 (*...eradicate extreme poverty and hunger*; *ensure environmental sustainability*; and *develop a global partnership for development*).

Purpose of the workshop

The FAO–Italy Project GCP/INT/059/ ITA, in collaboration with the University of Alexandria, Egypt and the University of Tuscia, Italy, has prepared a preliminary project concept note titled "Planted forests for waste water management and improvement of smallholder and farmer livelihoods". The formulation of this concept note builds upon the recommendations of the 23rd session of the International Poplar Commission (IPC), in Beijing, China, October 2008; the International Poplar and Willow Workshop in Izmit, Turkey, July 2009 and of the 18th Session of the Near East Forestry Commission, Hammamet, Tunisia, April 2010, "*to encourage countries to use treated water waste in forest tree planting with required precautions*".

The workshop will be an opportunity to facilitate knowledge transfer by bringing together specialists and decision makers from the four participating countries and Italian specialists to improve and transform the preliminary concept note into a full-fledged project proposal to be submitted to donors and funding agencies.

Participants

The workshop should be attended by two specialists from each of the four participating countries and by subject matter specialists from Italy. FAO will also attend to facilitate the workshop.

The representatives of the participating countries are requested to report on the status of planted forests in their countries including agroforestry systems. They are also expected to report on the use of treated waste water for irrigation in agriculture and other land uses.

A reporting template will be provided by FAO prior to the workshop and will outline the structure and contents of the expected country reports.

Place and time

A Hotel (tbd) in Tunis, Tunisia, from 16 to 17 October, 2010.

Agenda

16 October

Plenary

08.30 –09.30	Registration Opening (Organiser) and introduction of participants Nomination of the chair
09.30 – 12.00	Country reports (Algeria, Egypt, Morocco and Tunisia): historical developments, status, challenges and opportunities
12.30 – 13.30	Lunch
13.30 – 14.00	Introduction to project planning: Problem Analysis and Logical Framework Approach
14.00 – 14.30	Summary of the country priorities

Working Session

14.30 – 18.00	Identification of problems, priority needs and pilot project proposal drafted into Logical Framework: Impacts, Outcome, Outputs, Activities Implementation arrangements and inputs

17 October

Working Sessions

08.30 – 10.30	Session (cont.d): Identification of problems, priority needs and pilot project proposal drafted into Logical Framework: Impacts, Outcome, Outputs, Activities

Plenary

10.30 – 12.30	Implementation arrangements and inputs Summary of Working Sessions, preliminary results
12.30 – 13.30	Lunch
13.30 – 15.30	Endorsement and recommended follow up actions
15.30	Closing of the Workshop

Expected Outputs

- Project proposal for submission to potential donors
- Establishing professional contacts in arid zone countries
- Identification of country priorities, partners and partner institutions

Developing Country Support

Funding of travel and DSA is available for developing country participants, on request.

Language

The workshop will be held in English and French. Two interpreters will assist in the two languages.

Background Resources

- Report of the 23rd Session of the International Poplar Commission, and 44th Session of Executive Committee, Beijing, China
- Report of the International Workshop: Improve the contribution of Poplars and Willows in meeting sustainable livelihoods and land-use in selected Mediterranean and Central Asian Countries, Izmit, Turkey
- The use of treated waste water in Forest Plantations in the Near East Region, Secretariat Note (FO:NEFC/02/4), Secretariat Note (2002)
- Project Concept Note: Planted Forests for waste water management and improvement of smallholder and farmer livelihoods
- Sand dune stabilization, shelterbelts and afforestation in dry zones (Conservation Guide 10, 1985)
- Role of forestry in combating desertification. (Conservation Guide 21, 1985)
- Arid zone forestry: A guide for field technicians (Conservation Guide 20, 1989)
- Management of sand dune plantations (arid zone forests and Forestry Working Paper, in process of finalization).
- Guide to implementation of phytosanitary standards in forestry (2010)

Appendix C – Workshop Agenda

Saturday, 16 October	
08.00 – 08.30 Registration of participants	
Session 1: Introduction	
08.30 – 08.40	Opening by Mr. Mohamed Saket, RNE Cairo
08.40 – 08.50	Welcome address by Ms. Maria Pia Rizzo, Ministry of Foreign Affairs, Italy
08.50 – 09.00	Objective of the workshop by Mr. Walter Kollert, FAO, Rome
09.00 – 09.15	Workshop procedures and organisational arrangements by Mr. Houssem Bel Hadj, Facilitator
09.15 – 09.30	Self-introduction of participants
Session 2: Country reports and case studies	
09.30 – 11.00	***Country reports by Algeria, Egypt, Morocco, Tunisia on the use of treated waste water in forestry and agroforestry (20 min for each country).***
11.00 – 11.30	*Coffee break*
11.30 – 12.30	Case Study 1: ***Afforestation project to establish a forest plantation irrigated with phyto-remediated water in the oasis of Brézina, El-Bayadh, Algeria.*** Prof Paolo De Angelis, University of Tuscia, Italy Case Study 2: ***Simplified treatment systems for reuse of wastewater in agriculture and forestry: Ten years of irrigation results on a olive trees culture in Italy.*** Prof. Salvatore Masi, University of Basilicata, Italy
12.30-13.00	Questions and Answers, discussion of further proceedings
13.00 – 14.00	*Lunch*
Session 3: Project Planning	
14.00 – 14.45	Introduction to project planning: problem analysis and Logical Framework (outcomes, outputs, activities, roles and responsibilities, indicators), Mr. Houssem Bel Hadj, Facilitator
Session 4: Working Session	
14.45 – 15.00	Introduction to the project impact and outcomes by Mr. Alberto Del Lungo, FAO, Rome
15.00 – 16.00	Identification of major problems and priority needs

16.00 – 16.30	*Coffee break*
16.30 – 18.00	Outcome and Outputs
Sunday, 17 October	
08.30-08.45	Brief summary of previous day work, Mr. Alberto Del Lungo, FAO, Rome
Session 5: Working Session (continued)	
08.45 – 10.30	Activities, roles and responsibilities
10.30 – 11.00	*Coffee break*
11.00 – 13.00	Indicators and implementation arrangements
13.00 – 14.00	*Lunch*
14.00 – 15.00	Indicators and implementation arrangements (continued)
15.00 - 16.00	Completion of draft Logical Framework
16.00 – 16.30	*Coffee break*
16.00 – 17.00	Workshop results, conclusions, further steps by Walter Kollert, FAO, Rome Endorsement by participants
17.00 - 17.30	Evaluation of workshop by Mr. Houssem Bel Hadj, Facilitator
17.30	Closing of the workshop by Mr. Aleksander Zaremba, FAO, Rome

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REPUBLIQUE ALGERIENNE DEMOCRATIQUE ET POPULAIRE
Ministère de l'Agriculture et du Développement Rural
Direction Générale des Forêts
Atelier sur
« La Régénération des Forêts par l'utilisation des eaux usées traitées »
Expérience Algérienne
Tunisie, 16-17 octobre 2010
M. KAZI AOUAL Nasr Eddine
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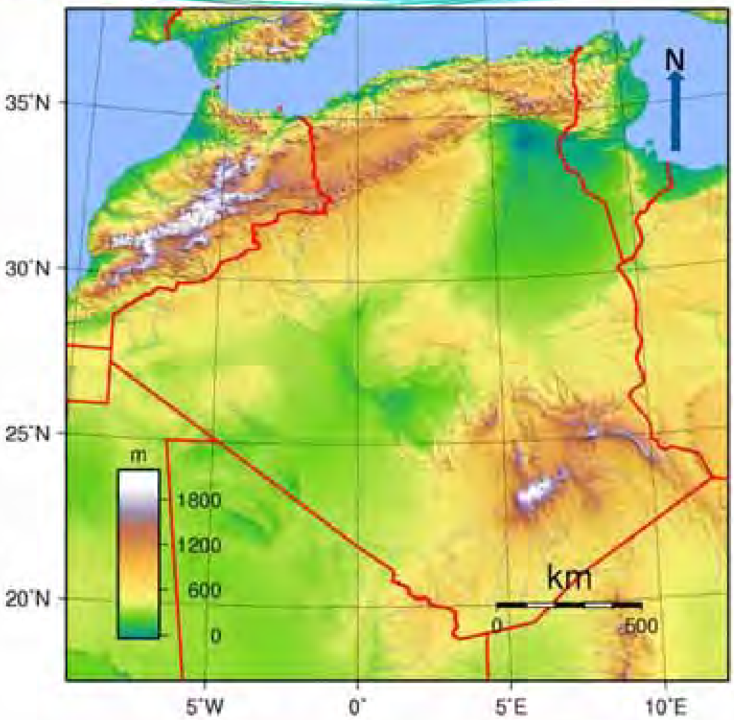
Sommaire
1- Description de l'Algérie
2- Répartition géographique des forêts
3- État des ressources en eau mobilisées
4- Disponibilité en eaux usées traitées dans le pays
5- Réutilisation des eaux usées épurées à des fins agricoles
6- Programme en cours en matière de réutilisation des eaux usées

1- Description de l'Algérie

1.1- <u>Géographie:</u>

- Latitude : 18°et 38° N
- Longitude 9° et 12°,
- superficie de **2 381 741 km2**.
- 3 ensembles géographiques:
  - Le littoral et la zone Tellienne prolongée à la mer Méditerranéenne.
  - Les Hauts Plateaux et la Steppe compris entre l'Atlas Tellien au nord et l'Atlas saharien au sud.
  - Sud



Source : www.wikipedia.fr

1.2- Le Climat :

A/ <u>Températures:</u>

- En hiver, les Hauts plateaux et Steppe sont plus froids que l'Atlas Tellien, le Littoral et le Sahara.

- T° moyenne est entre 5,0 à Djelfa et 14,5 à Ain Salah, en janvier. (grande amplitude de variation de la température , **8,7°C** en allant du Nord au Sud).

- En été, la température avoisine 25°C, au mois de juillet, le climat de l'Atlas Tellien ne se différencie pas fortement de celui des Hauts Plateaux. Le mois de juillet est le plus chaud dans le Sahara central (**36,9°C à Ain Salah**).

- En été et en hiver, le littoral jouit de l'effet adoucissant de la mer, mais cet effet s'estompe dès que l'on pénètre de quelques kilomètres à l'intérieur des terres.

B/ Précipitations:

- l'Atlas Tellien est plus arrosé que le Littoral et les Hauts plateaux.

- Au mois de janvier, la quantité des pluies mensuelles varie entre de 3,7 mm à Ain Salah, et 120,5 mm à Miliana. En été, les pluies sont rares et se produisent plus sur le littoral que partout ailleurs.

- En Automne, le régime des pluies est quasiment le même sur l'Atlas Tellien et les Hauts Plateaux. La quantité annuelle des pluies est de 15,8 mm à Ain Salah, et 827,3 mm à Miliana (Nord- Est du pays).

2- Répartition géographique des forêts

2.1- Superficie:

Associant les forêts et maquis ensemble, dans la catégorie des formations forestières, nous trouvons qu'elles couvrent une superficie de 4,7 millions d'hectares. Cette dernière est répartie comme suit :

- **1 500 000** ha de forêts proprement dites ;
- **1 876 000** ha de maquis ;
- **1 324 000** ha constituent les reboisements réalisés depuis l'indépendance en 1962.

En comparant ces chiffres aux données existantes avant la colonisation française en 1830, où les forêts couvraient 5 000 000 ha, nous constatons la réduction de du patrimoine forestier existant. Cette situation est conséquente, principalement, à une surexploitation durant la 1ere guerre mondiale pour la production de charbon ainsi qu'aux évènements durant la colonisation.

2.2- Répartition géographique:

- La forêt algérienne de type méditerranéen est localisée entièrement sur la partie septentrionale du pays et limitée au sud par les monts de l'Atlas saharien.

- Elle est répartie suivant les différentes régions écologiques => taux de boisements très variables; Ils décroissent d'Est en Ouest et du Nord au sud plus particulièrement.

- Elle est constituée par une variété d'essences appartenant à la flore méditerranéenne, leur développement est lié essentiellement au climat. Au fur et à mesure que l'on s'éloigne du littoral, le faciès forestier change du nord au sud du pays. On peut distinguer deux principales zones bien différentes :

✓ **Le littoral et surtout les chaînes côtières de l'est du pays,** ces régions sont **bien arrosées**, elles comportent **les forêts les plus denses**, constituant l'air de répartition de deux essences principales, à savoir : **le chêne liège et le chêne zeen**. (*Ouelmouhoub S. 2005)*

✓ **Les hautes plaines continentales**, **plus sèches,** représentées par les régions steppiques situées entre les chaînes côtières et l'Atlas saharien. Ces zones contiennent dans leurs parties accidentées de grands massifs de **Pin d'Alep et de chêne vert**.

2.3 - Répartition par essence:

Concentrée surtout dans l'Algérie du nord, la forêt est très inégalement répartie sur l'ensemble de cette partie du territoire.

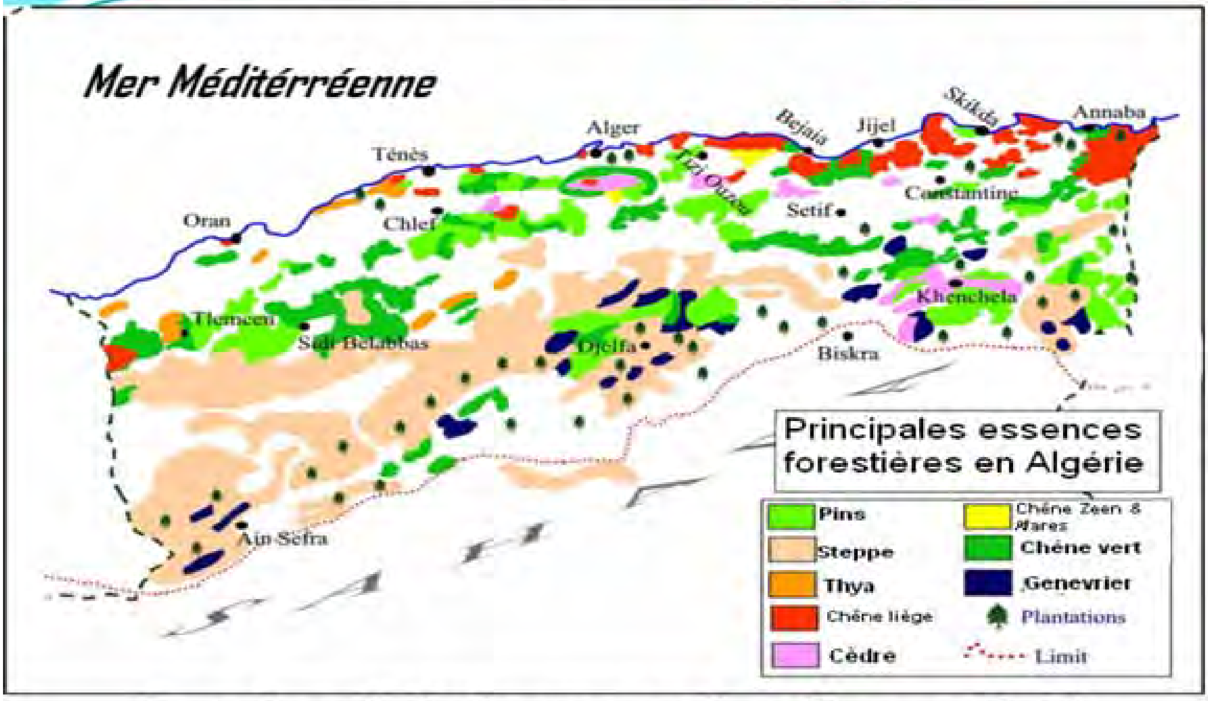
De façon générale, les principales essences couvrent **1 491 000 ha**, elles se répartissent en deux principaux groupes, à savoir :

- **Forêts d'intérêt économique** constituées par : les résineux (pin d'Alep, pin maritime et cèdre) et les feuillus (**chêne liège, chêne zeen et afarès, eucalyptus**) , occupant une superficie de **1 249 000 ha**;

- **Forêts de protection** composées de Chêne Vert, Thuya et Genévriers, couvrant une superficie de **219 000 ha.**

Le reste des surfaces forestières qui s'étendent sur **2 603 940 ha,** se répartissent entre les maquis et broussailles qui occupent une superficie de **1 876 000 ha** et les reboisements de protection qui ne couvrent que **1 489 830 ha**.

Principales essences plantées en Algérie:



Carte des principales essences forestières en Algérie. (INRF)

3- État des ressources en eau mobilisées

- **Eaux souterraines :**
  - Volume exploit exploité au nord : 1,8 milliards de m m3/an /an.
  - Volume exploit exploité au Sahara : 2 milliards de m m3/an /an.
- **Eaux superficielles :**
  - Nombre de grands barrages : 59.
  - Capacité totale actualisée : 6 milliards de m3.
  - Volume régularisé : 2 milliards de m3/an
  - Volume mobilisé (juillet 2007) : 3 milliards de m3 .
  - Taux de remplissage : 50 %.

3.1 Contraintes :

- Déficit pluviométrique de plus de 30%.
- Faible taux de remplissage des barrages.
- Taux de satisfaction de l'irrigation de 25 %.
- Demande en eau en augmentation.
- Croissance démographique.
- Développement économique.

3.2 Solutions:

- Actions sur la demande à travers des programmes d'économie d'eau.
- Accroissement de la mobilisation des ressources en eau:
  - **Eaux conventionnelles** : Barrages - Retenues collinaires et Forages.
  - **Eaux non conventionnelles** : Réutilisation des eaux usées épurées.

4- Disponibilité en eaux usées traitées dans le pays

Eaux usées produites:

– Volume annuel :**730 hm3/an**.

– Volume annuel à l'horizon 2020 horizon : 01 milliard de m3/an.

Eaux usées épurées:

– Capacité installée actuelle: 270 hm 3.

– Volume actuel épuré : 150 hm 3.

– Capacité installée à l'horizon 2020 : 990 hm hm3.

– Capacité installée à l'horizon 2030 horizon :1.100 hm hm3.

5. Réutilisation des eaux usées épurées à des fins agricoles

- Superficie irriguée en (2006) : **410 ha**
- Superficie en projet : **12.000 ha**
- Superficie irriguer à terme: **60.000 ha**

6. Programme en cours en matière de réutilisation des eaux usées

6.1- Travaux : Quatre projets totalisant une superficie de : **3.000 ha**

- Périmètre de Hennaya à partir de la STEP de Tlemcen sur **912 ha.**
- Périmètre de Dahmouni (wilaya de Tiaret) sur une superficie de **1.214 ha**.
- Périmètre de d'irrigation à partir de la STEP de la ville de Bordj Bou Arreridj sur une superficie de **350 ha.**
- Périmètre de d'irrigation à partir de la STEP de Hamma Bouziane à Constantine sur une superficie de **327 ha**

6.2- Étude: Quatre projets totalisant une superficie de **10 185 ha** :

- Périmètre d irrigation de M'leta à partir de la STEP Oran sur **8.100 ha**.
- Aire d'irrigation à l'aval de la STEP de la ville de Médéa sur **255ha.**
- périmètre d'irrigation à partir de la STEP de la vallée d'oued Saida **330 ha**
- Périmètre d'irrigation à partir de la STEP DE Sedrata (Souk Ahras) sur une superficie de **1 500 ha.**

6.3 - Une étude de réutilisation des eaux usées à l'échelle nationale est en cours:

- Etude d'un schéma directeur de réutilisation des eaux usées
  épurées.

- Projet d'irrigation de l'oasis de Brezina à El Bayadh.

- Elaboration d'un projet de normes de réutilisation des eaux
  utilisation usées épurées.

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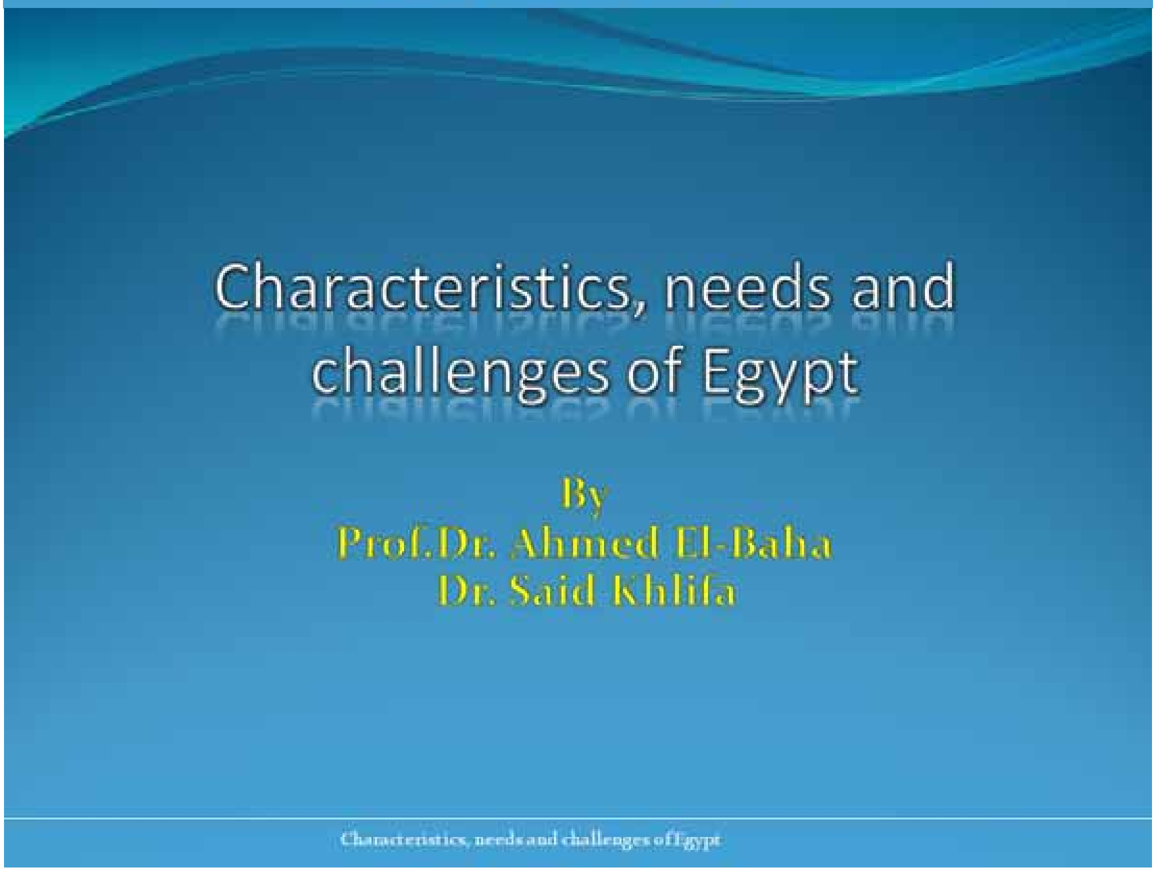
MERCI DE VOTRE
ATTENTION


Forest Restoration in Algeria, Egypt, Morocco and Tunisia using treated waste water to sustain smallholders and farmers livelihoods
Characteristics, needs and challenges of Egypt


Characteristics, needs and challenges of Egypt
By
Prof.Dr. Ahmed El-Baha
Dr. Said Khlifa
Characteristics, needs and challenges of Egypt

1- General geographic and ecological description of the country

- Egypt occupies the north eastern part of Africa between latitudes 22° N to 32° N and longitudes 25°E to 37°E.

- It covers an area of 1.002.000 square Km, nearly 3% of the total area of Africa.

Characteristics, needs and challenges of Egypt

- It is bounded in the north by the Mediterranean Sea. South by Sudan, west by Libya and east by El-Akba Bay, the Red Sea and Palestine.

- It can be divided into four main physiographic units: the Western Desert (about 680.000 Km^2), Nile and Delta valley (about 33.000 Km^2), Eastern Desert (about 221.000 Km^2), and Sinai Peninsula (about 61.000 Km^2).

Characteristics, needs and challenges of Egypt

- Due to scarcity of rainfall, about 96% of the territory of Egypt are desert.

Characteristics, needs and challenges of Egypt

- The remaining land (4%)is mostly made up of alluvial plains of the Nile valley and Delta.

- Generally the coldest month in Egypt is January, while July and August are the hottest.

Characteristics, needs and challenges of Egypt

- Temperature increases from north to south, from the Mediterranean Sea to the border with Sudan- from about 28° C up to 44° C in summer, and from 18° C up to 28° C in winter.

- Rainfall is very little, from 90 to 180 mm/year concentrated only in winter on the north.

Characteristics, needs and challenges of Egypt

2- Area and distribution of natural forests

- Total natural forests in Egypt are about 20.000 ha.

- Natural tree formation are found as follows:

(a)

- In form of mangrove stands -about 390 ha- , they are scattered over more than 20 sites along the Red Sea coasts and islands.
- *Avicenna marina* is the most abundant species of mangrove, while *Rhizophora mucronata* is restricted to the south part of Egypt's Red Sea coast.

- Natural tree formation are found as follows:

(b)

- The other natural woody vegetation -about 19600 ha- is found at Gabal Elba (Elba mountain) in the southern eastren part of the eastern desert.

- The area is characterized by the presence of *Dracaena ombet* shrubs which grow only on the high elevations of the coastal mountains and hills in the region.

- The common growing woody species are acacias, mostly in the form of scattered trees with low crown density.

3- Total area and geographic distribution of planted forests

- The number of standing trees in 2004 was 61 million trees with an area 65000 ha.

- According the FAR 2005 country report, the estimated area in 2005 was 67000ha (nearly 160.000 feddans), about 0.07% of the country area.

- The Undersecretariat for afforestation and environment (Ministry of Agriculture) has already established 26 planted forests irrigated with treated waste water in different locations within the country as follows:

Governorate	Forest	Area, feddan	Available water, m3/day	Planted area, feddan	Irrigation system	Planted species
1- Aswan	Edfu	900	7000	300	Modified surface irrigation (M)	Khaya
	Nasr Alnoba	100	1000	60	Modified surface irrigation (M)	Khaya
	Blana	1235	32000	280	Drip irrigation (D)	Khaya
	Wady Alalaky	350	50000	60	Drip irrigation (D)	Khaya
2- Luxor	Luxor"1"	260	5200	260	Modified surface irrigation (M)+ Drip irrigation (D)	Khaya- Eucalypt
	Luxor"2"	1741	50000	162	Drip irrigation (D)	Acacia – Mulberry-Jatrova

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Governorate	Forest	Area, feddan	Available water, m3/day	Planted area, feddan	Irrigation system	Planted species
3- Qena	Qena	300	26000	300	Modified surface irrigation (M)	Khaya
4- Suhag	Awlad Azzaz	267	56000	267	Modified surface irrigation (M)	Khaya
	Alkola	250	65000	180	Drip irrigation (D)	Jatrova
5- Asuot	Arab Almadabagh	45	?	45	Drip irrigation (D)	Khaya
6- Giza	Abo-Rawash	80	?	80	Drip irrigation (D)	Khaya - Cypress
7- New valley	Alkharya	300	13000	3000	Modified surface irrigation (M)	Khaya- Neem- Terminalia- Casuarina
	Paris	60	1000	60	Modified surface irrigation (M)	Khaya
	Alrashda	25	700	25	Modified surface irrigation (M)	Eucalypt, Terminalia
	Moot	700	2000	200	Drip irrigation (D)	Jatrova- Jojoba

Characteristics, needs and challenges of Egypt

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Governorate	Forest	Area, feddan	Available water, m3/day	Planted area, feddan	Irrigation system	Planted species
8- Menoufia	Alsadat	500	18000	450	Drip irrigation (D)	Cypress, Eucalypt, Casuarina, Pine
9- Dakahlia	Gamassa	200	-	100	Drip irrigation (D)	Cypress, Terminalia, Eucalypt
10- Ismailia	Serabium	500	9000	500	Drip irrigation (D)	Cypress, Pine, Eucalypt, Mulberry, Khaya
11- North Sinai	Grada	250	-	80	Drip irrigation (D)	Cypress, Pine
12- South Sinai	Tour Sinai	200	2000	140	Modified surface irrigation (M)	Cypress, Eucalypt, Casuarina
13- Red sea	Ghardaka	200	27000	150	Drip irrigation (D)	Khaya, Casuarina

Characteristics, needs and challenges of Egypt

- Near Alexandria, at 60 km, Ministry of housing who is the responsible of the waste water stations in Egypt established a planted forest near New Burg El-Arab city – 20 Km from the city – irrigated with treated waste water – primary treatment - as a mixture of municipal and industrial waste water.
- The forest is irrigated with surface irrigation system.
- The main species are: eucalypt, casuarinas, khaya and taxodium.

Tunisia- Egyptian Forest Friendship

El- Saf - Giza

Gamassa Forest- Dakahlia

Characteristics, needs and challenges of Egypt

Gamassa Forest- Dakahlia

Alkola Forest- East Suhag

Alkola Forest- East Suhag

Grada Forest- North Sinai

Grada Forest- North Sinai

Tour Sinai Forest- South Sinai

New valley

Jatrova in Luxor

Jatrova in Luxor

Jatrova and Khaya in Luxor

4- Total area and geographic distribution of agroforestry systems in Egypt

- The agroforestry systems in Egypt means trees and shrubs planted as windbreaks around fields, farms, roads, irrigation and drainage canals and for stabilizing sand dunes and affect positively on production.

- According to the data available, trees planted in 2004 as Agroforestry system were as fallows: windbreaks were estimated at 31 millions with an area 40000 ha, while about 13 millions were planted on the banks of irrigation and drainage canals and about 14 millions were planted for the protection of high ways.

- The main tree species are: *Eucalyptus* and *Casuarina* (*glauca*, *cunnighamiana*, *equistifolia*), *Salix* and *Poplus*.

- In addition to the planted trees to stabilize the sand dunes mainly in three regions:

(a) • North Sinai.

(b) • North coastal zone (near Rosetta).

(c) • New valley (Western desert).

- The common trees and shrubs in this consider are: *Acacia spp*. and *Tamarix spp*.

Geographic distribution of agroforestry systems

- They are distributed geographically as follows: about 33.5 millions in the north western coast up to the middle of the delta, 21 millions in the area of Sharkia Province to Beni Swief and 7 million trees in the southern part from El- Menia to Aswan.

5- Main species and use of planted trees

Species	Uses						
	fuelwood	biomass	wood	cash crops	dates	fodder	LS
Eucalyptus spp.	√	√	√	√	-	-	√
Casuarina spp.	√	√	√	√	-	-	√
Acacia spp.	√	√	-	-	-	√	√
Dalbergia spp.	-	√	√	√	-	-	√
Khaya spp.	-	√	√	√	-	-	-
Populus spp.	-	√	√	√	-	√	-
Salix spp.	√	√	√	√	-	-	√
Cupressus spp.	-	√	√	√	-	-	√
Taxodium spp.	-	√	√	√	-	-	-

LS: Land Stabilization

6- Water system

- There are four main methods of irrigation in Egypt:

1- Surface irrigation methods (traditional irrigation methods).

a- Flooding (or basin) irrigation.
b- Furrow and border strip irrigation.

2- Subsurface irrigation.

3- Sprinkler irrigation.

4- Drip (or trickle) irrigation.

Most of the planted forests in Egypt are irrigated with Modified surface irrigation (furrow and border strip irrigation) and drip irrigation.

7- Availability of fresh water

- The main source of fresh water in Egypt is the River Nile.
- Irrigated land represents more than 99% of cropped land.
- The net available Nile water is allocated as 55.5×10^9 m^3.

- Effective rainfall is negligible.
- Only a narrow strip along the Mediterranean coast receives some rainfall (on average 90-180mm/year) concentrated only in winter.
- Rainfall should not be taken into account when discussing potential land reclamation projects in Egypt.

8- Availability of fossil water in Egypt and the main constraints related to the use of water

- Areas that may be developed on groundwater cover only 8.9% of the potential land resources as identified in the land Master Plan.
- They are located in:

a- The New valley;
b- Sinai;
c- Eastern Desert;
d- North western coast;
e- Siwa,
f- East of Oweinat.

- Unfortunately, the land Master Plan made only rough estimates for groundwater potential development, due to lake of data on the groundwater resources for most of these areas.

- The Nubian Sandstone aquifer underlies a large area of Egypt, Sudan, Libya and Chad.

- This aquifer is estimated to contain 50×10^3 BCM.

- Only 20 BCM are estimated to underlie the New Valley area in Egypt.

- Water quality does not represent a problem from the agriculture point of view.

- The traditional method of obtaining water is the artesian pressure free flow.

- Studies indicated that groundwater levels were gradually declining.

- With the increase of the number of wells and the large extraction rates, the groundwater pressure has dropped.

- Water extracted from wells in the New Valley (MCM/year)

Type	Kharge	Dakhla	Farafra	Baharriya	Total
Shallow aquifer	15	51	0.2	18	84
Deep aquifer	75	148	1.1	16	240
Total	90	19	1.3	34	324

The main constraints related to the use of fossil water are:

1- The very high expensive costs due to the very deep underground water.

2- Dryness of wells.

3- Salinity of water.

4- Lake of information and technical methods.

9- Treated waste water in Egypt

- The annual volumes of treated waste water estimated in Egypt at 5 BCM.

- Mostly the first level of treatment is used (Isolation of solid materials).

The main constraints are related to the use:

1- The high and expensive costs of the treatments.

2- Contamination of the soil with heavy metals and other pollutants.

3- The hyper irrigation and using surface irrigation which lead to underground water contamination.

4- Lake of medical services and awareness of the staff and workers.

10- Use and constraints of phytoremediation systems

- Application of phytoremediation systems in Egypt are absent.

- Some researchers have used and tested some of these systems in their studies.

- For example El-Baha, Badran, Hassan and Ghorab, 2005 reported that:

- For accumulation of the heavy metals and biomass production the tree seedlings species can be arranged in the following descending order: *Albizzia lebbek*, *Tipuana speciosa*, *Pongamia glabra*, *Melia azedarach and Taxodium distichum*.So, the importance of selecting species and their VAM symbioses on the basis of not only growth but also nutrient accumulation to optimize renovation of wastewater and phytoremediation by tree plantations.

- It is also clear that Pb, Ni and Cd contents, in the five tree seedlings species irrigated with the primary or secondary treated wastewater were lower than the excessive or toxic levels, therefore they did not affect seedlings growth.

- So, we can reuse treated wastewater not only as a source of water but also as a source of nutrients and organic matter. Also, polluted and virgin soils can be used to cultivate hyper accumulation trees species.

- (Growth, biomass yield and heavy metals accumulation by seedlings of five tree species irrigated with wastewater and the role of VAM in heavy metals bioremediation).

11- Availability, type of water and main constraints in agroforestry systems and farms

Agroforestry system	Type of water
• Windbreaks around and inside fields and farms.	• Fresh water (Nile water, fossil water).
• Trees and shrubs on sand dunes.	• Rainfall and fossil water.
• Trees planted on high ways outside cities.	• Treated waste water.
• Trees planted inside cities.	• Fresh water.
• Trees planted on the banks of irrigation and drainage canals.	• No irrigation.

- The main constraints are:

1- Sometimes farmers do not plant the windbreaks because of :

- The allelopathic effects of the trees, problem of birds, competation with the crop, trees occubay part of the area.
- On sand dunes, people are facing the problem of scarcity of rainfall, therefore the low survival and growth of trees and shrubs.

- Trees planted on the banks of irrigation and drainage canals sometimes prevent the operations of irrigation and the operations of cleaning canals.

12- Use and constraints of treated waste water in urban and peri-urban areas

- Primary treatment only is usually carried on waste water in Egypt (separation and isolation of solid material), because the other treatments are expensive, therefore treated waste water do not use in urban and peri-urban areas in Egypt.

13- Main needs of the treated waste waters in forestry and agroforestry

- Estimation of average irrigation requirements or water requirements for woody trees in Egypt were not carried.

- As average of three crops in Egypt as: Deciduous fruits, Olives and Dates, the crop water requirements for woody trees at the main three geographical areas in Egypt are given in this table:

Area	Water requirements for woody trees M^3/yr/fed
Lower Egypt (from the Mediterranian sea to Cairo)	5000 (12500 /ha)
Middle Egypt (from south of Cairo to Menia governorate)	6000 (15000/ha)
Upper Egypt (from south of Menia to South of Aswan)	7000 (17500/ha)

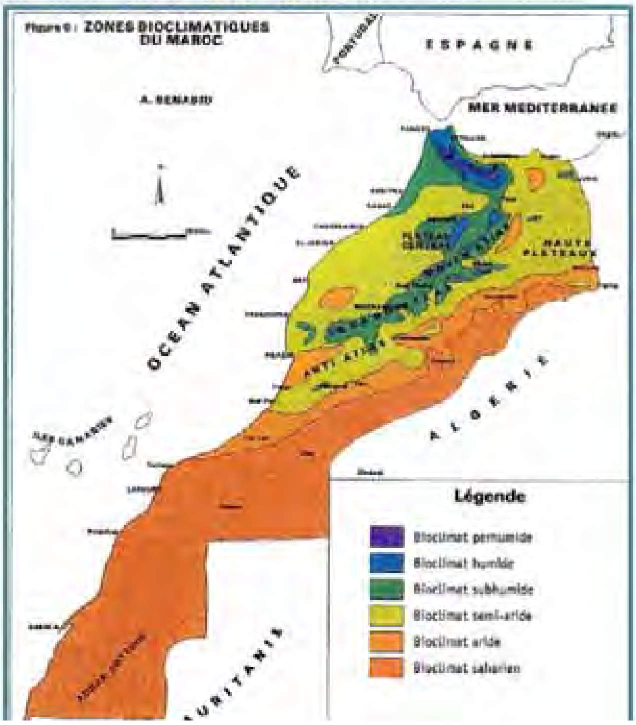
Thank you


Haut Commissariat aux Eaux et Forêts et à la Lutte Contre la Désertification
www.eauxetforets.gov.ma
Atelier International sur la régénération des forêts
Potentiel et opportunité de valorisation des eaux usées traitées en foresterie dans le contexte marocain
M.Taroq Mourad
Mme. Gazoulit Kawtar


Sommaire
1. Description générale du pays : écorégions et forêts
2. L'eau au Maroc : potentiel et défis
3. Les eaux usées : l' éxpérience Marocaine
4. Utilisations des eaux usées en foresterie : propositions d'issues stratégiques

Description générale du pays sur le plan géographique et écologique

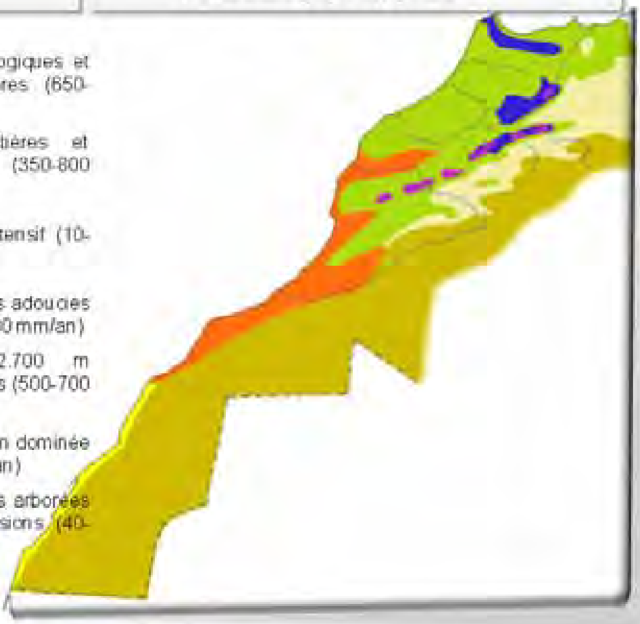
- Superficie totale du Maroc :
  712 550 km2
- Population :
  34 Millions en 2009
  39 Millions en 2025



Ecorégions du Maroc

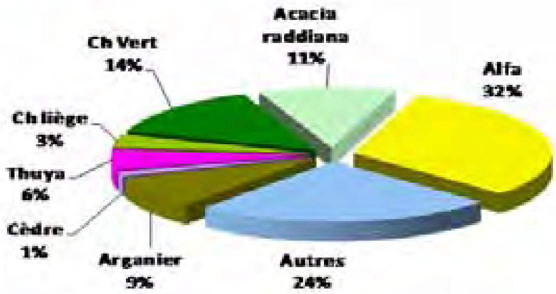
Diversité éco-systémique	
Forêt Humide	Valeurs écologiques et biologiques et grandes richesses forestières (650-2000 mm/an)
Forêt Sclérophylle	Grandes richesses forestières et biodiversité remarquable (350-800 mm/an)
Formation arborée pré- steppique et steppes	Vaste zone de parcours extensif (10-300 mm/an)
Formation arborée macaronnésienne	Particularités climatiques très adoucies par l'Océan Atlantique (40-400 mm/an)
Steppe atlasique de haute altitude	Montagnes dépassant 2.700 m d'altitude et absence d'arbres (500-700 mm/an)
Formation arborée et steppes	Vaste étendue sans élévation dominée par des steppes (40-60 mm/an)
Steppes du littoral océanique	Vaste étendue de formations arborées localisées dans les dépressions (40-150 mm/an)

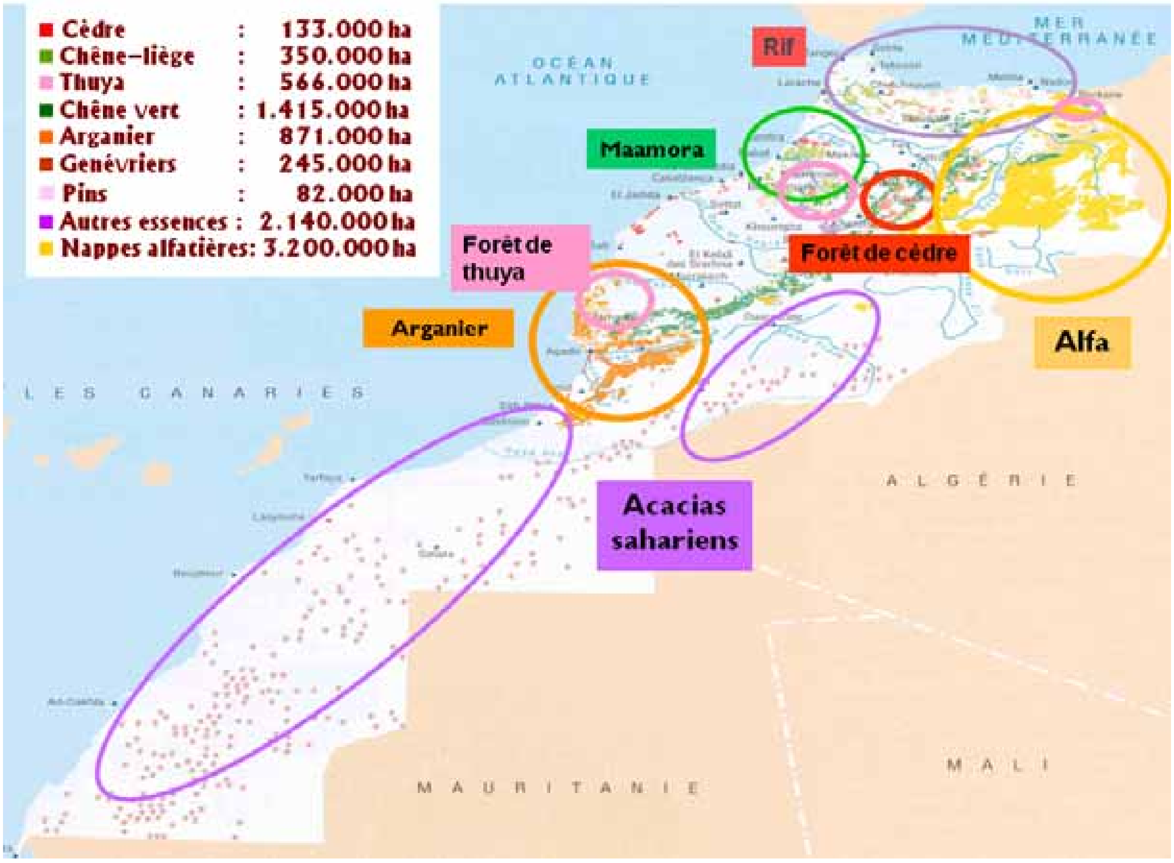
7 Ensembles d'écorégions



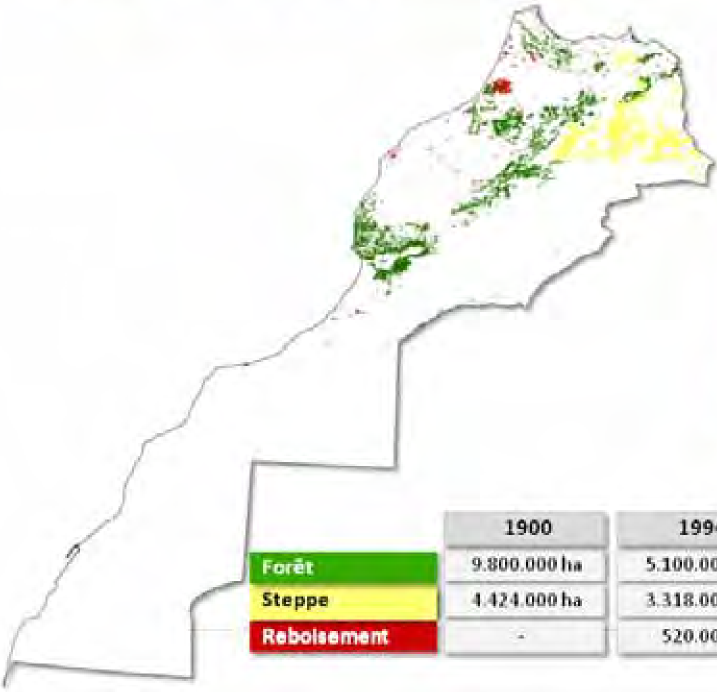
Superficies et distribution des forêts naturelles dans le pays

- **Un domaine forestier de :**
  - **9 millions ha dont 5,8 boisés**
  - **12 % du territoire national**
  - **80 % de feuillus & 20 % de conifères**





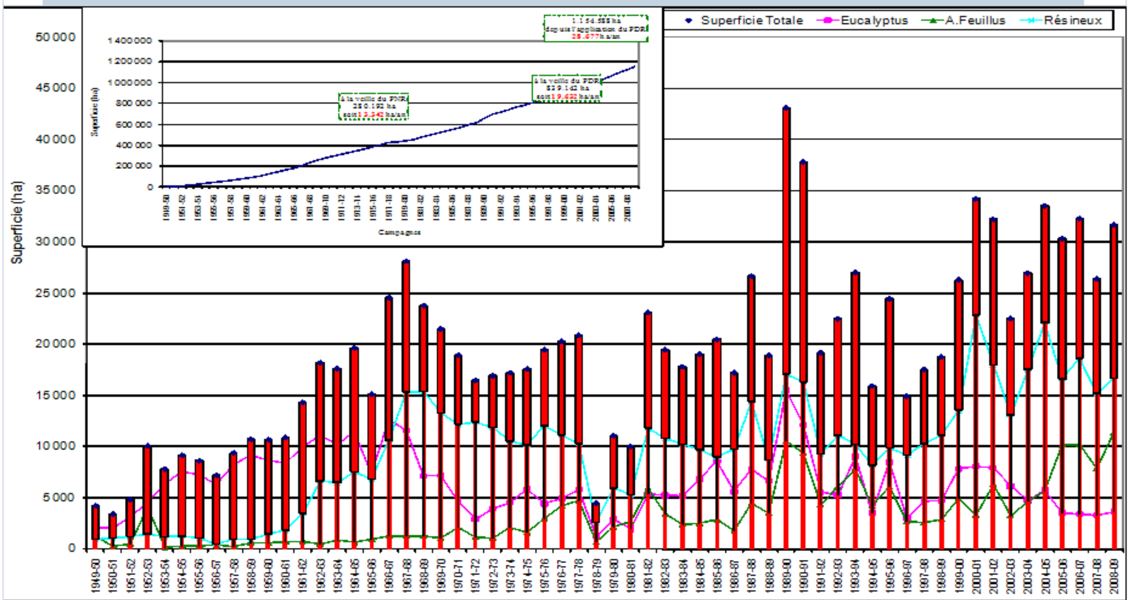
Le reboisement, nécessaire, ne corrige pas le déséquilibre des écosystèmes



	1900	1994	2050	Différence
Forêt	9.800.000 ha	5.100.000 ha	1.550.000 ha	-3.550.000 ha
Steppe	4.424.000 ha	3.318.000 ha	1.106.000 ha	-2.212.000 ha
Reboisement	-	520.000 ha	1.500.000 ha	+980.000 ha

Les reboisements/régénération en chiffres

Un effort soutenu de plus d'un Million d'ha reboisés depuis les années 50

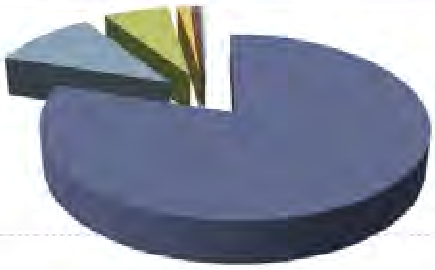


1950-59	1960-69	1970-79	1980-89	1990-1999	2000-2009
7 840 ha /an	19 390 ha /an	16 350 ha /an	21 600 ha /an	22.500 ha /an	30.000 ha /an

Le Patrimoine Forestier: Contribution dans l'économie nationale

Valeurs d'utilisation directs du domaine forestier

Création d'emplois	10 millions de JT	600 MDH
Bois d'œuvre et d'industrie	600.000 m^3	500 MDH
Bois de feu	6 Million Tonnes	
Liège	130.000 stères	
Chasse et pêche – OTDF – Autres produits	-	
Parcours	1,5 Milliard UF	4,4 milliards DH



Nouvelle stratégie du HCEFLCD pour le forêts urbaines et périurbaines

- 154 forêts urbaines et périurbaines participent au bien être de plus de 15 millions d'habitants dans plus de 50 villes du Royaume
- Utilisation croissante des forêts urbaines et périurbaines par des citadins en quête de nature
- Pression urbaine progressive
- la ligne stratégique : *Anticiper les besoins de la population et y répondre en préservant l'intégrité des forêts dans leurs limites foncières, dans leur fonctionnement biologique et dans leurs vocation forestière*

Objectifs de la nouvelle stratégie

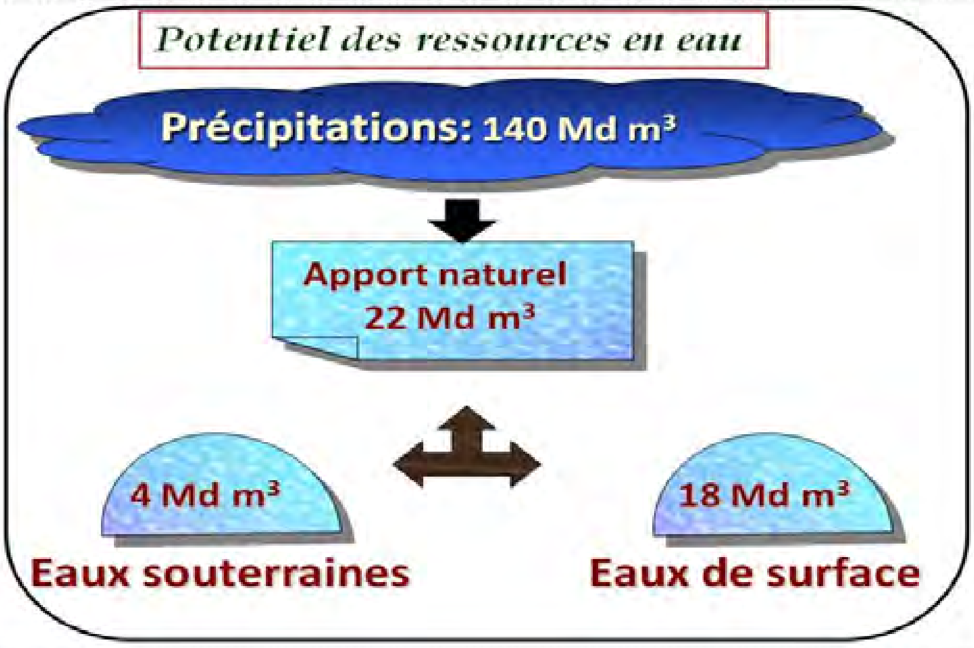
- Répondre aux attentes du public tout en assurant la pérennité et l'identité des milieux forestiers urbains et périurbains
- Réhabiliter et étendre les forêts urbaines et périurbaines notamment sur des terrains n'appartenant pas au domaine forestier de l'Etat
- Sauvegarder ces forêts uniques de toute mutation ou suréquipement qui pourrait avoir un impact sur leurs fonctions, leurs équilibres et leurs paysages naturels.
- Sensibiliser le public, les générations futures et les acteurs locaux à la conservation des forêts urbaines et périurbaines
- Etendre les forêts sur des terrains en dehors du domaine forestier

Régénération des forêts urbaines et périurbaines & création de ceinture verte

FUP : 2009	2010	
Plantaion nouvelles (ha)	Consolidation des plantations anciennes (ha)	Plantaion nouvelles (ha)
188	84	460
CV : 2007 - 2009	2010	
750	572	

Espèces : Chêne Vert, Frêne, If, Erable, Eglantier, Caroubier, Pins, Arganier, Eucalyptus, Schinus, Chêne Liège, Acacias

Potentiel des ressources en eau



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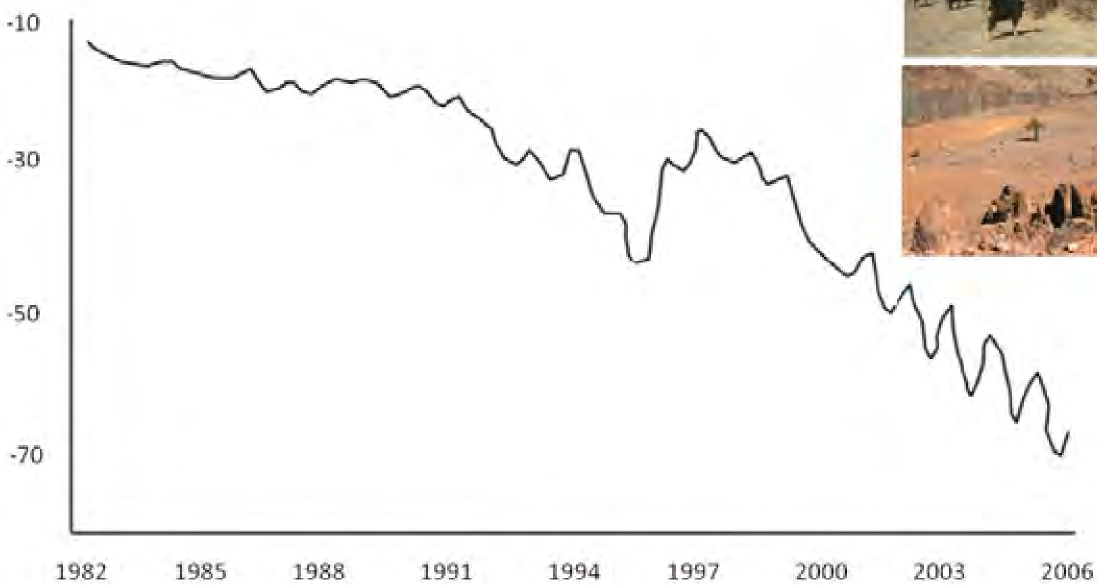
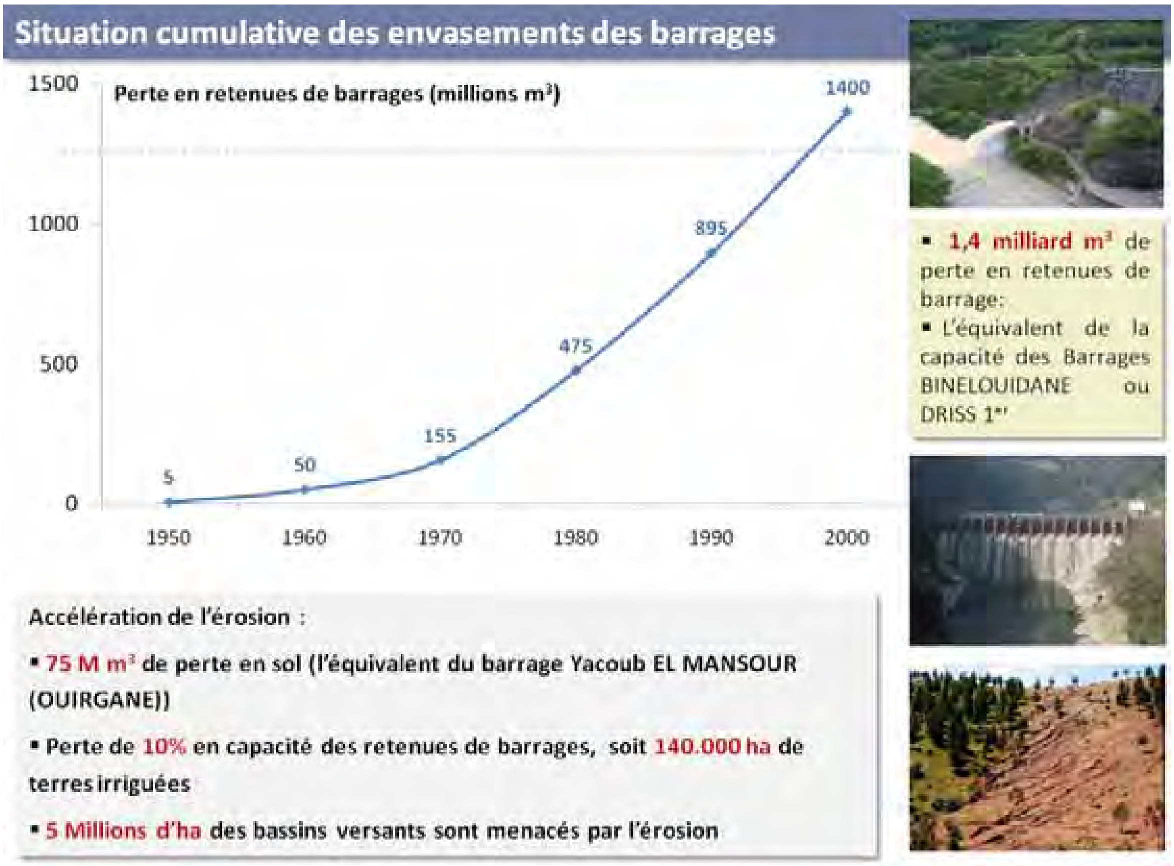
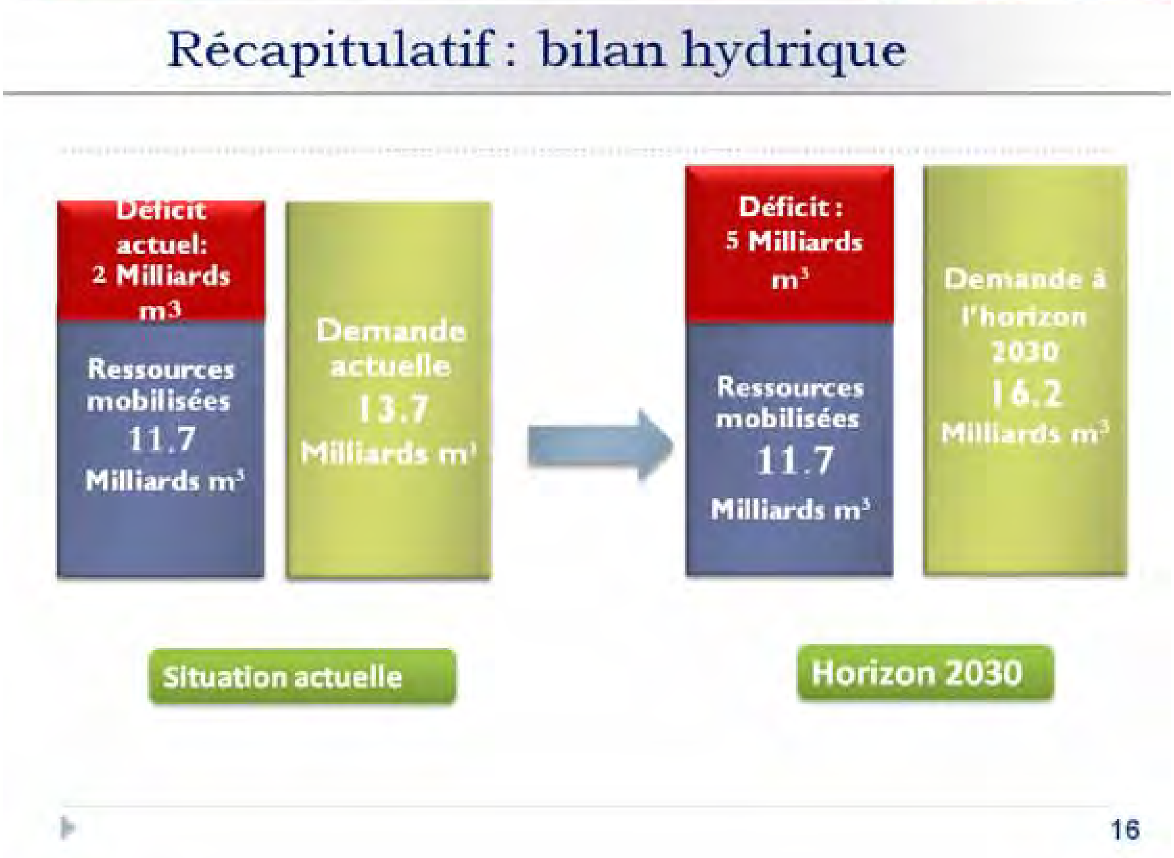
Baisse du niveau des eaux souterraines

Exemple : Cas de la nappe du Souss



Réduction du niveau piézométrique de **60 m en 24 ans**

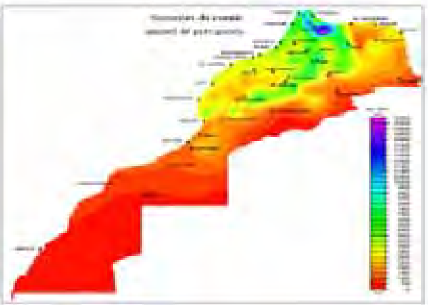

Situation cumulative des envasements des barrages
Perte en retenues de barrages (millions m³)
1500
1000
500
0
5
50
155
475
895
1400
1950
1960
1970
1980
1990
2000
▪ 1,4 milliard m³ de perte en retenues de barrage:
▪ L'équivalent de la capacité des Barrages BINELOUIDANE ou DRISS 1er
Accélération de l'érosion :
▪ 75 M m³ de perte en sol (l'équivalent du barrage Yacoub EL MANSOUR (OUIRGANE))
▪ Perte de 10% en capacité des retenues de barrages, soit 140.000 ha de terres irriguées
▪ 5 Millions d'ha des bassins versants sont menacés par l'érosion


Récapitulatif : bilan hydrique
Déficit actuel: 2 Milliards m3
Ressources mobilisées 11.7 Milliards m³
Demande actuelle 13.7 Milliards m³
Déficit : 5 Milliards m³
Ressources mobilisées 11.7 Milliards m³
Demande à l'horizon 2030 16.2 Milliards m³
Situation actuelle
Horizon 2030
16

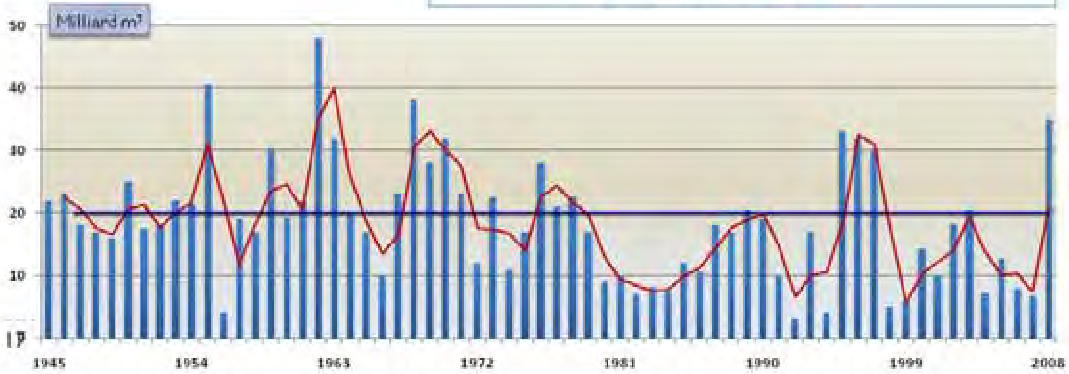
Contraintes et défis majeurs

+ Forte irrégularité des précipitations

Dans l'espace

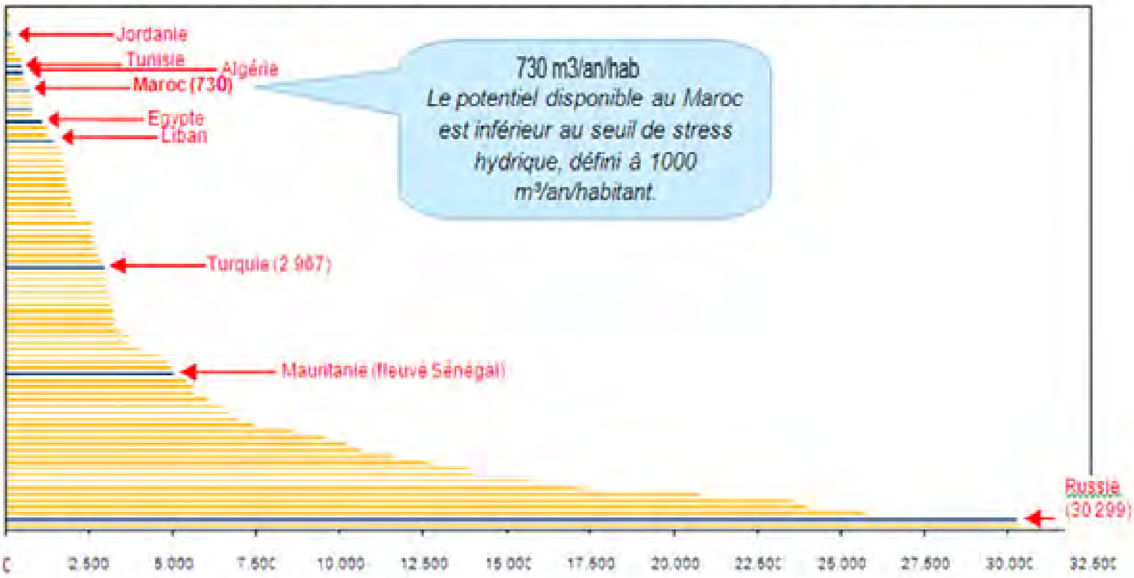


Dans le temps



Contraintes et défis majeurs

+ **Potentiel limité avec une demande en eau croissante**

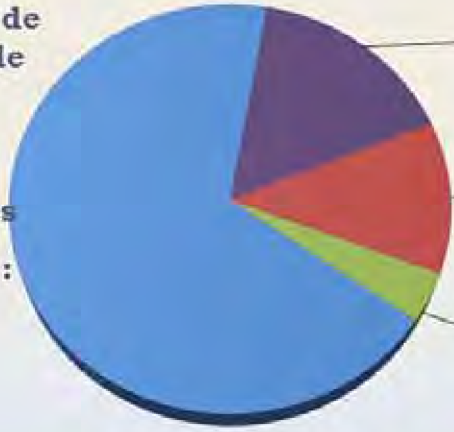


Stratégie Nationale de l'Eau

Mobilisation de 2.5 Milliards de M³/an

Les ressources en eau de surface: Mobilisation de 1.7 Milliards de m3

- **60 grands barrages**
- **1000 petits barrages**
- **Transfert Nord-Sud : 800 Mm3**



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Les eaux usées au Maroc : Estimation de production

Potentiel important de production des eaux usées traitées dans les grandes villes (une étude de promotion de la réutilisation d'une grande part des volumes importants générés est en lancement) :

- Marrakech + Meknès + Fès = 316 000 m³/j
- Centres urbains côtiers = 1 000 000 m³/j

Millions de m³/an	2010	2015	2020	2030
Production des Eaux usées brutes	640	750	870	1039

Quelques chiffres clés sur l'état de l'assainissement au Maroc

- **STEP existantes** : 51

PNA : Plan National d'Assainissement de 2007 :

- **Projets de STEP** : 76 projets
- **Parc des STEP à horizons 2015** : 142
- **Parc des STEP à horizons 2030** : 367
- **Taux d'épuration actuel** : 13 % des eaux usées
- **Capacité actuelle de traitement** : 399 000 m3/j soit 20 % des eaux usées brutes
- **Taux de dépollution projeté** : 80% en 2030

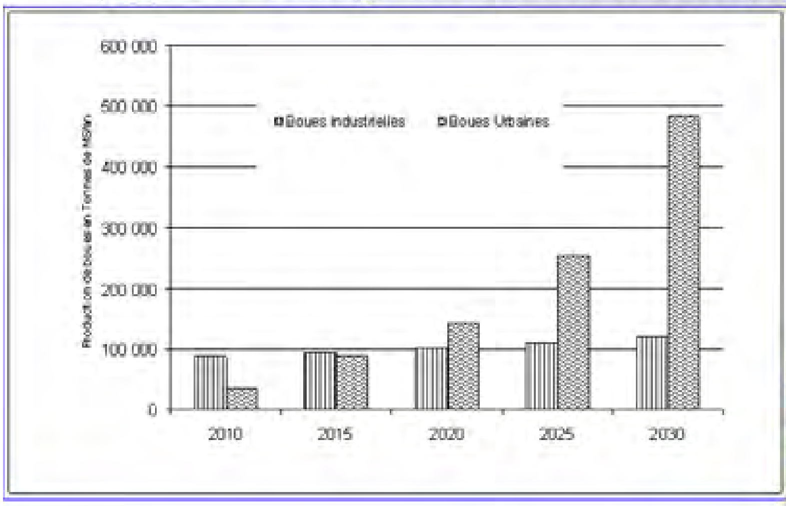
Expériences de réutilisation des eaux usées épurées

- **12 projets connus :**
  - en agriculture : 33000 m3/jour
  - En Golf : 15000 m3/jour
- **10 projets importants en cours :**
  - en agriculture : 143000 m3/jour
  - En Golf et espaces verts : 91000 m3/jour
- Villes intérieures surtout (Marrakech, Fès, Meknès, Ouarzazate, Essaouira, …)
- **Coût réel : difficile à approcher car peu de projets**
  - Entre 0,9 et 1,8 Dh/m3 :
    - **>Irrigation classique : 0,17 à 0, 63 Dh/m3**
    - **< Irrigation par pompage : 0,6 à 3 Dh/m3**

Cadre réglementaire

- **Actuellement :**
  - la REU est régie par quelques dispositions générales de la loi n° 10-95 sur l'eau et le décret n° 2-97-875 du 4 février 1998 relatif à l'utilisation des EU (autorisation, etc.)
  - Normes de qualité des eaux destinées à l'irrigation (y compris les EUE)
- **En cours :**
  - Texte réglementaire fixant les conditions d'utilisation des EUE :
  - (i) dossier de demande d'autorisation; (ii) conditions de traitement complémentaire ; (iii) Institution d'une commission locale des utilisations des eaux usées ; (iv) modalités du concours financier de l'Etat ; (v) Réglementation des rejets en mer, etc.
  - Réflexions sur la réglementation de gestion des boues

Evolution de la production des boues d'épuration des eaux usées (Etude de Stratégie de Gestion des boues, DEPP/SEEE. 2010)



Un grand gisement en matière organique et en éléments nutritifs à valoriser

- La production actuelle des boues de curage des réseaux d'assainissement des zones urbaines : 9900 Tonnes

Les eaux usées traitées au Maroc : Contraintes

- **Rejet** des eaux usées dans le littoral : plus de 50 %
- **Faible taux d'épuration** des eaux usées : 13% seulement
- **Utilisation des eaux usées brutes** pour l'irrigation : plus de 7000 ha
- **Infrastructures d'assainissement** : Peu de STEP existantes , bien qu'en grand développement actuellement, avec traitement insuffisant pour la REUT
- **la maîtrise des rejets industriels** à l'amont : Pollution avec eaux usées industrielles (salinité, éléments dangereux)
- **l'achèvement du Cadre institutionnel/cadre réglementaire :** La loi 10-95 Le décret n° 2-97-787 du 4 février 1998 et n° 2-97-875 du 4 février 1998 et l'arrêté conjoint n° 1276-01 du 17 octobre 2002
- **la problématique institutionnelle** de gestion des EUE : multitude d'institutions impliquées dans la gestion des eaux usées, sans coordination ni orientation commune

Utilisations possibles et intéressantes pour le Maroc

- **Irrigation agricole :** potentiel important avec réseau de distribution intéressant
- **Secteur touristique :** Peu intéressant par rapport aux potentiels calculés. Mais important sur site. Obligatoire sur Golfs
- **Secteur industriel :** Pas assez de retour au Maroc. Peu d'exemple au niveau international. A réfléchir au cas par cas mais obligation réglementaire possible (avec seuil). Normes à élaborer
- **Espace verts :** Véritable potentiel et en parallèle avec les recommandations du ministère de l'urbanisme. A créer au moment des aménagements. Potentiel de 200 000 000 m3/an. Normes à élaborer
- **Autres : Recharge, lutte contre la salinisation des eaux :** Répond à des problématiques particulières – Intéressant mais potentiel limité
- **Régénération et création d'espaces forestiers : Ceintures vertes, forêts urbaines et périurbaines :** usage à évaluer, promouvoir et planifier

Utilisations potentielles des eaux usées épurées en foresterie

- Catégories d'utilisation :
  - Reboisement
  - Forêt urbaine et périurbaine
  - Régénération
  - Fixation des dunes
  - Pépinière forestière
  - Réhabilitation des sols dégradés
  - Amélioration des nutritions des arbres
  - Séquestration du carbone

Projet de valorisation des eaux usées en foresterie -1-

- **Elaborer une étude sur les potentialités de valorisation des EUE en milieu forestier :**
  - Localisation géographique des projets d'utilisation en foresterie
  - Superposition avec la répartition des STEPs *(base: étude effectuée par la DRPE)*
  - Espèces forestières potentielles et leurs besoins
  - Le contexte climatique
  - Qualités des sols
  - Conditions d'application
  - Identification des besoins (quantités et qualités)
- **Elaborer des normes de REUE en fonction de la situation de la forêt, de la vulnérabilité du milieu, du degré d'accès/exposition du public, etc.)**
- **Réaliser des projets de démonstration (REUE et valorisation des boues) dans les périmètres de reboisement, production de plants, réhabilitation, etc.)**

Projet de valorisation des eaux usées en foresterie -2-

- **Renforcement des capacités:** formation des cadres et techniciens sur des modules en relation avec ce domaine
- **Evaluer le potentiel de valorisation des boues** dans les différents contextes et pour divers usages
- **Elaborer un guide de bonnes pratiques de valorisation des sous – produits de l'assainissement** (eaux épurées et boues) **dans le secteur forestier**
- **Mettre en place un réseau régional d'échange** sur la valorisation des sous-produits de l'assainissement en milieu forestier

Compléments pour la promotion de la réutilisation des eaux usées épurées -3-

- **Institutionnalisation** d'un schéma organisationnel, institutionnel et de gestion définissant clairement les rôles et responsabilités des intervenants (implication du HCEFLCD)
- Mise en place d'une **entité nationale d'orientation et de coordination** de la REUE (implication du HCEFLCD)
- Achèvement du **cadre réglementaire et normatif**
- Plan **d'information et de communication**
- Gestion intégrée des deux **sous-produits** de l'assainissement (Boues et eaux épurées) / Le secteur forestier peut résorber un grand volume de boues

Des ébauches sur ces aspects sont disponibles et les départements concerné sont penchés sur ces questions à travers deux études récentes clés:

- L'étude des potentialités de REUE
- La stratégie de gestion des boues des STEP

Atelier International:
Régénération des forêts en Algérie, en Egypte, au Maroc et en Tunisie

Utilisation des eaux usées traitées pour la régénération des forêts: Ecologie, forêts et parcours en Tunisie

Hammamet – Tunisie: 16 et 17 octobre 2010

RAFIK AINI
Ingénieur en chef, Génie Rural, Eaux et Forêts
Directeur de développement sylvo-pastoral

Géographie de la Tunisie

- La Tunisie est délimitée par des frontières communes au Sud Est avec la Libye et à l'Ouest avec l'Algérie, tandis qu'au Nord et à l'Est la Méditerranée dessine sa façade maritime. Sa superficie est de 164 000 km².
- Les côtes tunisiennes s'étendent sur 1300 km, son altitude moyenne est de 700 m et son point culminant est Jebel Châambi (1540 m).

Climat & Ecologie

- Le climat est méditerranéen allant de l'humide à l'extrême Nord au désertique à l'extrême Sud.
- Compte tenu des conditions climatiques et géomorphologiques, trois grandes zones agro-climatiques se distinguent :

✓ Le Nord, avec une pluviométrie moyenne entre 400-600 mm et un relief marqué par des massifs montagneux au Nord Ouest et des plaines fertiles au Nord-est, constitue la région sylvo-agricole (forêts et cultures annuelles essentiellement).

Climat & Ecologie (suite)

✓ Le Centre, avec une pluviométrie entre 200-400 mm, se distingue par une morphologie constituée par une basse steppe à l'Est avec des plaines fertiles interrompues par des dépressions et une haute steppe avec des massifs montagneux et des plaines. L'ensemble est à vocation agro-pastorale (parcours et plantation).

✓ Le Sud, avec une pluviométrie aléatoire de 100 à 200 mm, est caractérisé par son aridité et la vulnérabilité de ses sols à la désertification. C'est un espace à vocation pastorale avec des oasis autour des points d'eau.

Climat & Ecologie (suite)

- La Tunisie, en raison de sa situation géographique entre la Méditerranée et le Sahara, est un pays aride sur la majeure partie de son territoire. Cette aridité, conjuguée à la variabilité du climat méditerranéen, fait de l'eau une ressource à la fois rare et inégalement répartie dans le temps et dans l'espace.
- Le pays reçoit en moyenne 230 mm/an de pluie, soit 36 milliards de m^3 /an.
- Ce volume se limite à 11 milliards de m^3 /an en année de sécheresse et peut atteindre 90 milliards de m^3 /an en année pluvieuse.

Ressources en sols en Tunisie

- **Le Nord** :
  - ✓ les principales familles de sols rencontrés sont : Sols forestiers; Vertisols ; Sols rouges méditerranéens ; Sols carbonatés (Calcimagnésiques); Sols isohumiques et autres types de sols (salsodique, etc).
  - ✓ Les Sols sont acides : problème de pauvreté du sol du à la pauvreté de l'humus (percolation de l'azote).
- **Le Sud:**
  - ✓ Le Sud Ouest est caractérisé par de grands espaces à sols peu fertiles à savoir les sols sableux d'apport éolien (erg), les sols halomorphes ou salsodiques (Sebkhas, chotts), les sols caillouteux (regs, hamadas du Dahar), les sols loessiques (sierozems encroûtés, sols peu évolués développés sur d'anciens sols isohumiques encroûtés mais tronqués et évolués en surface, 0-50cm.) et les sols peu évolués sur roche mère alluviale ou éolienne dans les B.V.
  - ✓ Le Sud Est montre une unité assez homogène : la plaine de la Jeffara s'étend de l'Oued el Akarit, au Nord, jusqu'à la frontière libyenne au Sud Est.

CARTE PEDOLOGIQUE DE LA TUNISIE

(Source : Carte Agricole)

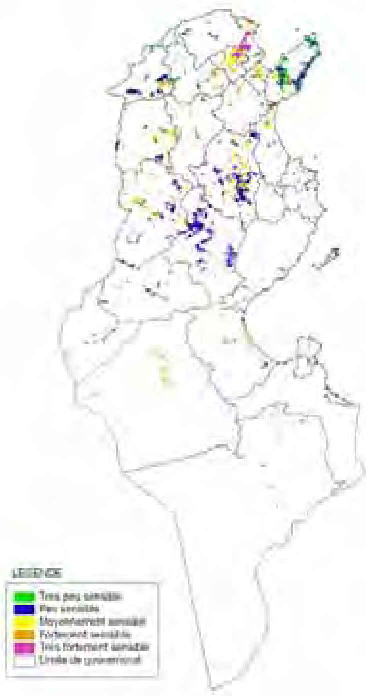
Vocation agronomique des sols

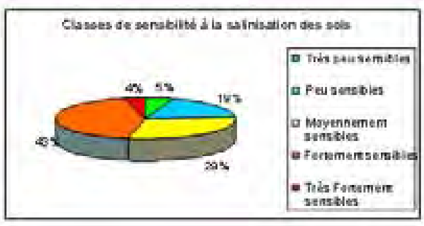
- **Le Nord Ouest** : Il est caractérisé par ses régions naturelles de Kroumirie et Mogods (humide et subhumide) est voué à la sylviculture et à l'élevage. Les plateaux de Haut Tell et les plaines (vertisols et sols rouges) forment la zone céréalière par excellence de la Tunisie (Jendouba, Béja, Le Kef, Siliana).
- **Le Nord Est** : subhumide à semi -aride (régions de Bizerte, Ariana, Zaghouan et Nabeul) possède des terres variées, vouées la polyculture : Grandes cultures, Maraîchage, oliviers, arboriculture fruitière et vignoble.
- **Le Centre Ouest et Tunisie centrale**: Les hauteurs de l'Ouest sont couvertes de forêts (pin d'Alep), de parcoures et de steppe d'alfa. En contrebas oliviers et arbres fruitiers associés aux céréales (orge) occupent les piémonts. Les plateaux du centre Ouest, à Steppe d'Alfa, servent de parcours jusqu'à la plaine de Kairouan ;

Suite

- **Le Centre Est** : dans le secteur littoral du Sahel de Sousse et de Sfax, oliviers et amandiers constituent les principales spéculations agricoles.
- **Le Sud Ouest**: Comprend les grandes étendues désertiques des Chotts et de l'Erg;
- **Le Sud Est** : l'arboriculture (oliviers, figuiers, amandiers) domine dans la plaine de la Jeffara qui bénéficie des apports d'eau de ruissellement. Les oasis littorales de Gabès, Mednine, Jerba sont établies sur des terrains alluviaux et sont irriguées à partir de forages profonds aux eaux chargées en sels (plus de 3 g/l).

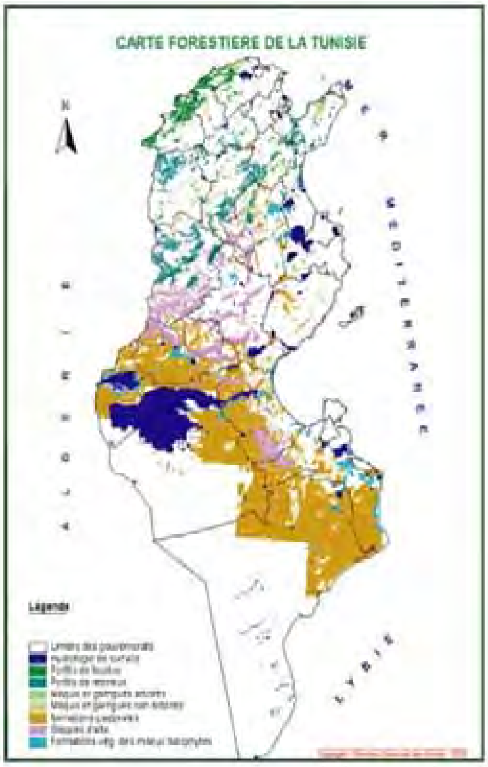
Carte de risque de salinisation





Forêts et Parcours: Principaux indicateurs

- Forêts et Parcours: 5,7 millions Ha;
- 1,3 millions Ha forêts dont 360.000 Ha forêts nat.
- Taux de boisement: 13,04% (2009)/ 4% (1956)
- Nbre de pépinières: 102 (35 Millions plts/an)
- Reboisement de 885000 Ha depuis 1956
- 8 parcs natio. ;16 réserves naturelles (218000 Ha)
- 160 Postes vigies et 10 centres protec. Contre feu



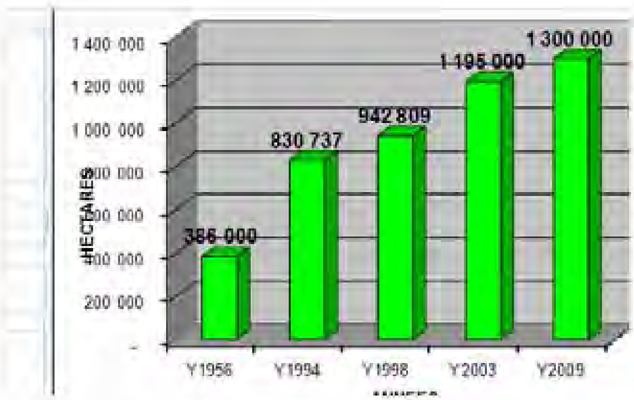
3

Objectif Global:
16% taux de boisement en 2020

- Reboisement de 250 000 Ha (2009-2020)
- Réalisation 27000 Ha à partir de 2012
- Budget: 250 Millions DT
- Augmentation de la proportion des aires protégées (par rapport à la superficie totale des forêts) de 17% à 20% d'ici l'an 2024
- grâce à la mise en œuvre du programme présidentiel indiquant la création de 20 aires protégées
- Coût estimé à 40 millions de dinars.
- Conservation des forêts, de la biodiversité et la lutte contre les incendies de forêts; coût: 30 millions DT.

ESPACE FORESTIER TUNISIEN

- Regression continue
  - 3 Millions ha à l'epoque romaine
  - 1.25 Millions ha en 1881
  - 400,000 ha en 1956
- Reforestation
  - 830,000 ha en 1994
  - 942,000 ha en 1998
  - 1,195 Millions ha en 2003
  - 1,3 Millions Ha en 2009



FACTEURS DE PRESSION SUR LES ESPACES FORESTIERS

- Pression humaine : 10% de la population totale et 200 000 familles ;
- Une densité de 70 à 200 ha/km2, soit 2 à 6 fois la moyenne nationale ;
- 30% de la population rurale du pays.

PRINCIPALES FONCTIONS DE LA FORÊT TUNISIENNE

- la production ;
- La protection du milieu et de l'environnement ;
- La récréation et le tourisme ; et
- Le développement socio-économique

Apports (output) directs des RF

1. Le bois

- Faible production à l'ha : 1 à 5 m3 /ha ;
- Seulement 2% des besoins en bois d'œuvre sont couverts par la production nationale ;
- Le bois de chauffe participe à hauteur de 14% de la consommation nationale d'énergie.

2. Le pâturage

- Production fourragère annuelle du domaine forestier de 300 à 400 Millions d'UF;
- Avec les parcours steppiques collectif, on arrive à une production de plus de 900 Millions d'UF;

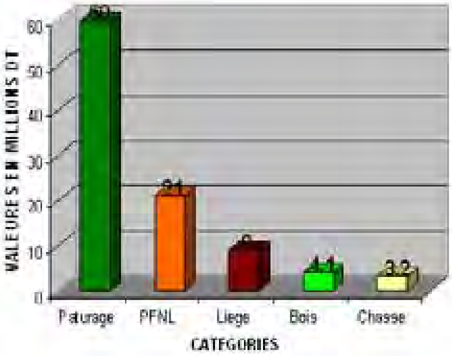
Apports (output) directs des RF

3. Produits forestiers non ligneux (PFNL)

- 7 à 9 000 tonnes de liège, avec une régression de près de 15% de la production depuis 1975 ;
- 46 000 tonnes d'alfa, soit 50% de la production des années 60 ;
- Autres produits variés tels que le romarin, le myrte, les graines de pin d'Alep et de pin pignon, les câpres, les champignons, la caroube etc..

Estimations des valeurs directes

- Pâturage 60 Mi.DT
- PFNL 21 Mi.DT
- Liege 9 Mi.DT
- Bois 4.1 Mi.DT
- Chasse 3.2 Mi.DT



Reflexions pour l'utulisation des eaux usées traitées

- Forêts urbaines et périurbaines
- Production de la biomasse (compost, bioénergie,..)
- Espaces verts
- Production ligneuse (Peuplier, saules,..)

Ministry of Agriculture, Water Resources
and Fishing
General Direction of Rural Engineering and Water Management

Using Treated Waste Water
to sustain small holders and farmers livelihood

Tunisia Experience

by
ALATIRI RAQYA
Director of Water Conservation

Tunis, October the 16th-17th , 2010

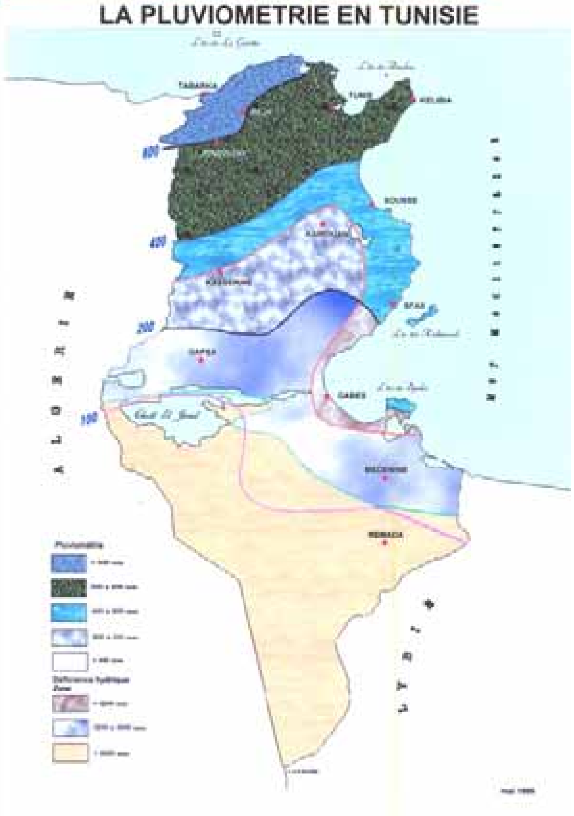
1- Climate variability and water scarcity

Tunisian climate is characterised by:

- rainfall scarcity
- a wide variability of rainfall within the year and through the country:
  - 1000 to 500mm/year in the north,
  - an average of 350 mm/year in the center,
  - less than 100mm/year in the south.

So irrigation is necessary to regulate crop production and to enhance productivity.

LA PLUVIOMETRIE EN TUNISIE



2- Water availability

Average annual rainfall stands at 35 Billion cubic meters (bm3).

About 15 bm3 are useful for rain-fed crops.

The potential water resources come to 4.8 bm3 that represent less than 500 m3/inhab/year .

The mobilized water resources, of about 4.3 bm3 per year are made up of:

- 2.400 bm3 of surface water (within 2.7 bm3), and
- 1.900 bm3 of groundwater (within 2.1 bm3).

The mobilization rate is of 93% now and will trend to 95% by the year 2014 due to implementation of new dams and boreholes within the complementary water mobilization strategy.

3-Water balance

-The agriculture requirements on conventional water will stand at 2.100 bm3/year beginning from the year 2011.

= > the rate of agricultural demand within the whole demand is about 80% but will be reduced to less than 70% because of increasing of competitive drinking and industrial use.

4- Irrigated areas

4-1-Within the potential area of about 460,000 ha that may be irrigated, 410,000 ha are equipped for intensive irrigation. They are divided into two types of areas:

- Public irrigated areas (225,000 ha), equipped thanks to public investments (55%).
- Private areas (185,000 ha), implemented by farmers themselves, mainly around shallow wells (45%).

Although the irrigated area occupies 8% of the arable area:

⇒it participates with 38% of the whole agricultural production value of the country.

4-2- Irrigated area distribution

Intensive irrigated area that cover 410 000 ha is composed of:

Public areas: (Rwu: about 60%)

- 147 000 ha : Dams
- 70 000 ha : Deep wells
- 8 000 ha : TWW

Private areas: (Rwu: > 100%)

- 152 000 ha : Shallow wells
- 29 000 ha : Deep wells
- 4 000 ha : around Small Dams

4-3- Hard natural and socio-economic conditions

In general, irrigation sector is facing hard conditions according to water availability:

- Increase of water requirements due to demographic growth.
- Competition of social and development sectors on water resources .
- High water salinity.
- Periods of drought that occur more frequently .

4-4 Water Management Shortcomings in irrigation sector

In addition to water scarcity, number of shortcomings are recorded in water management within irrigated areas, in particular:

- An important waste of water (before the implementation of National Water Conservation Program in 1995) :
  - at farm level (irrigation efficiency was estimated as 50 to 60%),
  - at public water distribution schemes (old-fashioned and not suitable to modern and pressurized irrigation).
- Groundwater over-use both for renewable aquifers or not witch leads consequently to:
  - decrease of water availability.
  - Increase of water table salinity and sea intrusion risk.
- A low economic water valorization in public areas specially in the northern regions (more rainy).

5- Adaptation measures

Tunisien natural conditions and current mobilization rate assert for global water scarcity situation and lead governmental institutions to implement specific water strategies (mobilization and management):

- to satisfy water requirements of all social and economic sectors, and
- to meet water balance between regions.

Many tools and measures are implemented within these strategies : financial (as providing subsidies), institutional, appropriate regulatory framework, carrying out awareness and training programs, ...

5- National water strategies

The major actions related to water management and implemented by the government are based on the main following strategies: issues that may be considered as adaptation measures to climate change:

- **Water mobilization strategy, involving :** *dam construction, linkage between big dams, and water conveyance to regions that suffer from lack of water, taking further more integrated water resources management through groundwater recharge* (C&NCW)...
- **Water conservation strategy** *(improvement of collective irrigation network efficiency, implementation of modern irrigation techniques at farm level, ...).*
- **Participatory management strategy** *(with appropriate institutional and regulatory framework for sustainable management for projects and water resources.*
- **Treated Wastewater Strategy** *(for irrigation and water table recharge)*

6- Water Saving Strategy

i- Improvement of collective water conveyance efficiency.

ii- Introduction of modern water saving techniques at farm level.

Results of WSS from 1995 to 2010:

- **Equipment of 350 000 ha with modern water saving techniques (85%).**

=> drip irrigation: 140 000 ha (40%).

- **Improvement of irrigation efficiency from 50 to 75%.**

7- Reclaimed water strategy for agriculture purposes

7-1- Objectives:

Within the natural hard conditions, treated wastewater reuse for agricultural purposes, took big importance and was developed as a National Strategy.

So, valorisation of TWW in agriculture sector becomes an interesting alternative since it contributes :

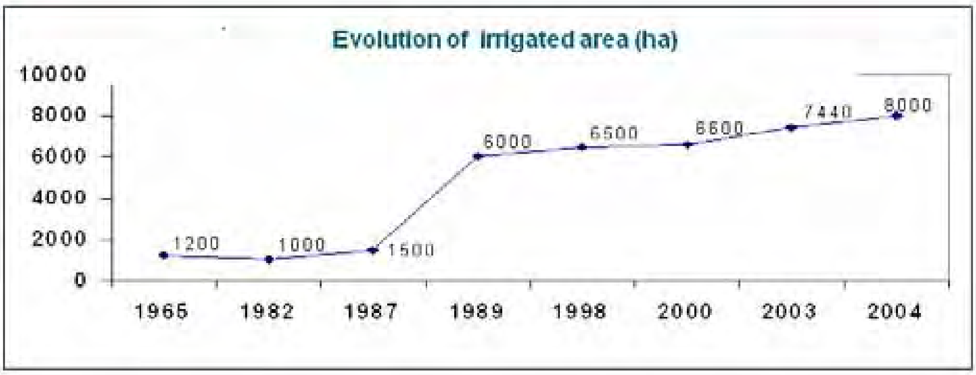
- to provide additional water resources:
  - to provide complementary irrigation in areas that suffer from big shortage of water (water tables over-used),
  - to develop new irrigated areas,
- to save fresh water, and
- to preserve environment from increasing pollution, of fresh water in particular (dams, water tables).

7-2- Treated waste water production

- Actually, 106 treatment plants produce about 238 Mm3 per year TWW.
- Wastewater is mainly processed up to a secondary treatment stage according to national standards *(these standards are under review in order to adapt quality to use).*
- Wastewater treatment will evolve to a tertiary stage to allow better acceptance by farmers.
- An other improvement that will be achieved in the short term is the implementation of 10 industrial treatment plants).

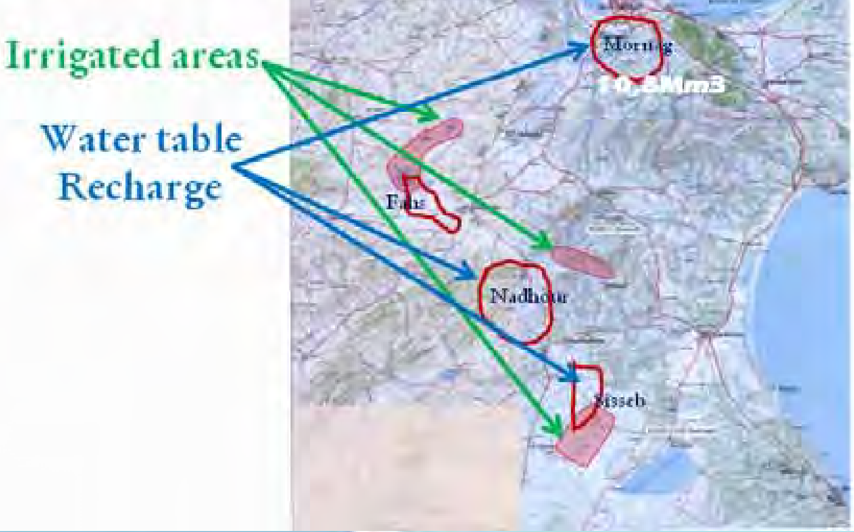
7-3- Treated waste water reuse for agricultural needs

- Reclaimed water reuse begun since 1965.
- Now, areas irrigated with treated wastewater (TWW) cover more than 8,000 ha and represent actually 2% of the whole irrigated areas (410,000 ha).



Potential reclaimed water:

- According to TWW availability at the medium (2014) and long term (2021), the quantity of water that may be transferred to south of Tunis is estimated as 132 Mm3. So, it will be possible to implement about 30,000 ha of additional irrigated areas (6% of the current irrigated areas) and to recharge some over-used water tables



7-4 Political interest

Since 1997, TWW reuse was the subject of an increasing political interest expressed within big subsidies provided within the water pricing policy (20% of the full price) in order to promote reclaimed water reuse.

- The agricultural sector remaining the most important field of reuse.
- An ambitious program was prepared within the forward development plans to improve TWW quality (by ONAS).
- Large sensitization programs will be carried out to increase farmers interest.

8- Legal and organisational aspects

- Water's Code was the first legislative measure published on march 1975.

  It stipulates that wastewater reuse is allowed only after appropriate treatment and that irrigation is forbidden for crops that may be eaten raw.
- Reclaimed water quality standards for agricultural reuse were established in 1989 (NT106-03).
- The restricted list of crops that may be irrigated with TWW was set on July 1994. Crops allowed are such as cereals, industrial crops, fodder crops, fodder bushes, forest trees, fruit trees ...
- The decree (1995), stated the particular modalities and conditions of treated wastewater reuse for agricultural purposes.

8- Legal and organisational aspects (2)

- Since the publishing of the decree (dated on march 1991) about environmental impact studies, mitigation components are taken into account in all projects to alleviate any related hazards.
- An interdepartmental national comity was set to coordinate actions between the different institutions involved.
- An interdepartmental regional comity was established to follow up effluent disposals and TWW reuse as to enforce regulatory texts.

Current constraints for TWW reuse

- Among the various constraints at farmer level, cropping restriction is the most important one that often leads to farmer's reticence.
- Indeed, farmers are in search of safety and favourable conditions to insure better valorisation and higher incomes.
- A big sensitization campaign will be carried out to promote wastewater reuse once treated effluent quality is improved.
- Major efforts are to be made in this way (with improvement of water quality) since the future of irrigation and development of intensive areas for food crops will come mainly from TWW.

Irrigation of forests with TWW

Treated wastewater reuse for irrigation of forests is a recent experience in Tunisia. An area of 1000 ha composed by several forest species was implemented for the reforestation of the mountain of tataouin in south Tunisia.

Big management problems were encountered by the CRDA, in particular at the level of O&M cost recovery (power, labor, ...)

This problem affects vegetation that suffer from shortage of water.

The solution would be to find a promoter to use the forest and to manage it in the framework of a concession (so to take in charge all operating costs).

Conclusion

- Since water reuse has noble goals of the environment preservation,
- that huge quantities of TWW will be available in the medium and long term, and
- that current irrigated areas have low intensification of their cropping systems,

= > there should be a forest belt around each irrigated area that may provide additional food to livestock (fodder trees).

So integration of subsistence agriculture and forestry must exist in order to meet sustainable development and within a participatory management.

Università Tuscia

"High Relevance" Research Project promoted by the Ministry of Foreign Affair and by the Ministry of University and Research of the Republic of Italy

The use of waste water for agro-forestry multipurpose systems in desert Oases

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1

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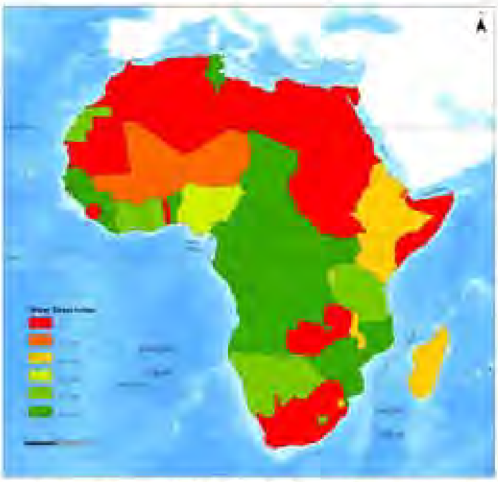
Algeria

- More than 80% of Algeria is comprised of either arid or semi-arid land, that is about 1.9 million square km.
- 91% of population lives on the coast.
- But about 3.1 million people are scattered on desert lands and survive from the rare but essential oases.



Water stress in Africa - AFRICA Atlas of Our Changing Environment, UNEP

2

Algerian oasis

THE SIMULATANEUS NATURE OF BIOTIC AND ABIOTIC FACTORS CAUSES OASIS DEGRADATION

Human pressure:

- Demographic growth
- Over-exploitation of natural resources
- New techniques of agricultural production - pivot - and water/soil management - water retention basin and dam - gradually destroying traditional organization

Climate changes:

- Persistence of high temperatures
- Low precipitation
- The rise in frequency of extreme events like dust storms

•Groundwater depletion
•Vegetation reduction
•Risk of pollution
•Salinity
•Soil degradation

Ouargla, Algeria - AFRICA: Atlas of Our Changing Environment - UN

3

location

Oasis of Brézina

33°6'N, 1°15'E, 800m s.l.

- 12,000 habitants, 75 ha of urban area
- 174 ha of palm grove, only 30% is cultivated.
- Arid climate with an annual mean temperature of 20°C. Diurnal variation of 11°C. Rain rarely exceeds 100 mm, low humidity 40%. High solar radiation of 4.6 kWh/m2 and high wind speed. April dust storm average wind speed grows until 5.9 m s^{-1}
- The Seggueur ephemeral river is the main source of water for the oasis

4

Brézina

challenges

Brezina is facing:

- Groundwater depletion resulting from two combined effects: the increasing urban population and the excessive retention of Seggueur dam upstream of the oasis
- Palm grove death
- Risk of groundwater contamination due to the outflow of untreated wastewater

6

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proposed solution

How can we avoid the risk of ground water and soil pollution?

How can we develop the oasis without damaging the palm grove?

Development of non-conventional water resources:

- ✓wastewater harvesting
- ✓natural treatment system
- ✓treated wastewater reuse

Improving of agroforestry plantation:

- ✓reclamation of marginal degraded land
- ✓establishment of a green belt that protects the palm grove
- ✓protection of soil from wind erosion
- ✓bringing of economic benefits
- ✓carbon sequestration

MODULAR APPROACH

7

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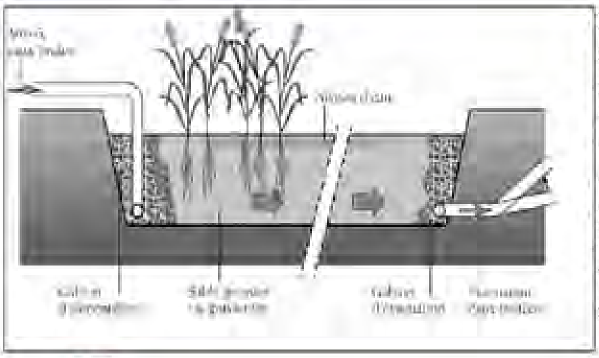
non-conventional water resources



Natural wetlands act as bio-filters, removing sediments and pollutants from the water, and constructed wetlands can be designed to emulate these features.
Vegetation in a wetland provides a substratum (roots, stems, and leaves) upon which microorganisms can grow as they break down organic materials. The plants remove about 70% to 90% of pollutants, and act as a carbon source for the microbes when they decay.

- Effective in wastewater treatment
- Tolerant of fluctuations in hydrological and contaminant loading rate
- Relatively inexpensive to construct and operate
- Easy to maintain
- Low energy requirements

- Requires a large amount of land
- Biological and hydrological complexity
- Rise in mosquito population
- Evapotranspiration and infiltration losses

8

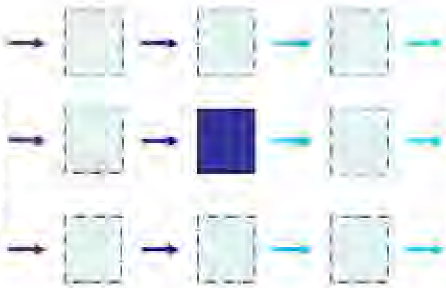
wastewater treatment module

The wastewater treatment module is composed of:

- ➔ CELL 1: Preliminary sedimentation, with a water level up to 30cm. Emergent vegetation with a density of 90%
- ➔ CELL 2: Anaerobic digestion of cell 1 effluent, water level never exceeds 60cm. Vegetation is submerged with a density of 20%.
- ➔ CELL 3: Completes the water treatment of cell 2 effluent through aerobic process. Water level up to 30cm. Vegetation is emergent with a density of 90%.
- ➔ WSTR (Water Storage Treatment Reservoir): Designed to store cell 3 effluent during the winter season, with a water level up to 5.5m. The storage could be considered as an auxiliary anaerobic water treatment.

wastewater

wastewater		
TSS	[mg/l]	417
BOD5	[mg/l]	161
TP	[mg/l]	0.947
TN	[mg/l]	49
FC	[cfu/100ml]	100.000
N	[egg/100ml]	1



treated water

treated water		
BOD5	[mg/l]	25
COD	[mg/l]	125
P	[mg/l]	15
N	[mg/l]	30
SSt	[mg/l]	35
FC	[cfu/100ml]	1000
N	[egg/100ml]	1

9

superficial flow constructed wetland

PARAMETER		influent	effluent		
			cell1	cell2	cell3
Wll	[m]		28	28	28
Ll	[m]		57	28	57
W	[m]		25	23	25
L	[m]		58	32	56
H	[m]		0.3	0.6	0.3
Flow	[m3/d]	100	97	80	68
Hydraulic loading	[cm/d]	2.44	5.31	9.84	4.24
Air Temp.- July	[°C]	31.5	31.5	31.5	31.5
TSS	[mg/l]	417	148.17	59.43	30.14
BOD5	[mg/l]	161	44.36	21.88	7.25
TN	[mg/l]	49	9.9	4.61	1.06
TP	[mg/l]	0.95		none	
Fecal coliform	[cfu/100ml]	100,000	1,729	786	308

Each module receives about 33,400 m3 of wastewater per year but only about 23,000 m3 per year (66%) are available for agroforestry.

10

wetland vegetation

Scientific Name	Common Name	Maximum water depth [m]	Flooding Duration [%]	Distribution in Algeria
Emergent, Herbaceous (Continuous inundation)				
Phalaris arundinacea	Reed canary grass	<0.05-0.3	13-100	native
Iris spp.	Blue flag iris	<0.05-0.2	50-100	native
Juncus spp.	Rushes	<0.05-0.25	50-100	native
Phragmites spp.	Common reed	<0.05-0.5	70-100	native
Sparganium spp.	Bur reed	0.1-0.5	70-100	Marocco
Typha spp.	Cattails	0.1-0.75	70-100	native
Scirpus spp.	Bulrush	0.1-0.5	75-100	Europe
Submerged Aquatic Species				
Myriophyllum spp.	Water-milfoil	0.25-3	90-100	native

Densely vegetated basin (0.5x0.5m²):

- *Phalaris arundinacea*
- *Juncus spp.*
- *Phragmites spp.*
- *Typha spp.*

Sparcely vegetated basin (5x5m²):

- *Myriophyllum spp.*
- *Typha spp.*

11

agroforestry project

- Agroforestry depends on the availability of treated wastewater from the constructed wetland
- A species shortlist has been compiled based on the environmental and economic benefit
- Success of agroforestry depends on stakeholder involvement

12

specie selection matrix - 1

	Distribution in Algeria	Root system	Growth rate	Drought resistance	Salinity resistance	note
Tamarix spp.	native	deep/shallow	fast	good	high	dune stabilization
Pinus halepensis	native	deep	medium	high	medium	pioneer specie
Argania spinosa	Morocco	deep	slow	high	medium	
Elaeagnus angustifolia	naturalized	deep	fast	high	good	
Ceratonia siliqua	native	deep	medium	high	high	pioneer specie
Acacia spp.	native	deep/long	fast	high	medium	<100mm rain
Pistacia atlantica	native	deep	slow	high	high	
Gleditsia triacanthos	naturalized	medium/deep	fast	low	low	
Prosopis juliphlora	naturalized	medium	fast	high	medium	
Atriplex spp.	native	medium	fast	high	high	
Prunus armeniaca	naturalized	deep	slow	low	low	
Punica granatum	naturalized	deep	medium	medium	medium	
Olea europaea	native	medium/deep	medium	good	medium	

13

specie selection matrix - 2

	Biomass for energy generation	Environmental uses	Material	Food Medicine Social use	Carbon storage	Forage	R&D
Tamarix spp.	++++	++++	0/+++	0	++++	+++	++++
Pinus halepensis	+++	+++	+++	0	+++	0	++
Argania spinosa	++	+++	?	++++	+	++++	+++
Elaeagnus angustifolia	+++	++++	0	++	++++	++++	+++
Ceratonia siliqua	++	+++	++	+++	++	++++	+++
Acacia spp.	++++	++++	0/++	0/+	++++	++++	++++
Pistacia atlantica	++	+++	+++	++	+/++	++	++
Gleditsia triacanthos	+++	+++	0	++	+++	0	+
Prosopis juliphlora	+++	++	0	0	++++	+++	+
Atriplex spp.	++	++	0/+	0/+	+++	+++	++
Prunus armeniaca	0/+	+++	0/+	++++	+	0	+++
Punica granatum	0/+	++	0/+	++++	+	0	+
Olea europaea	0/+	++	0/+	++++	++	0	+

14

international level

1. United Nations Framework Convention on Climate Change (UNFCCC)
2. United Nations Convention to Combat Desertification (UNCCD)
3. Convention on Biological Diversity (CBD)

These are the tools in place at the international level to the mainstream countries' actions for mitigating the negative effects of the mismanagement of natural resources.

Afforestation/Reforestation activities under the Clean Development Mechanisms (CDM) of Kyoto Protocol

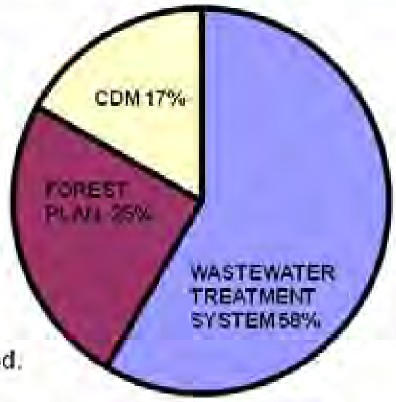
carbon credit evaluation

Eligibility verification:

- At the national level: ratification of the Kyoto Protocol, communication of forest definition
- At the project level: afforestation and reforestation
- At the site: not covered by forest before 1990

Carbon estimation covers 20 years of project lifetime.

- null baseline;
- null leakage;
- carbon stock estimated using the "Gain-loss method";
- GHG emissions estimated using the "bottom up" method.



Distribution of initial costs

HYPOTHESES 2	HYPOTHESES 1	HYPOTHESES 3
41 200 tCO_2 CER	41 900 tCO_2 CER	44 770 tCO_2 CER

preliminary conclusion

Wastewater harvesting and treatment are required in order to guarantee a sustainable development of oases.

Constructed wetland represents an interesting option to match the water quality of restricted irrigation.

The use of non-conventional water resources promote: reclamation of marginal land, reduction of wind erosion, amelioration of soil conditions, economic stimulation for timber and non-timber products and local manpower requirements for new wastewater system management.

Small scale CDMs represent an interesting opportunity to support local development.

17

open questions

Due to the low number of constructed wetland realizations in arid land, it is very important to collect real data to tune the chemical model of pollutant removal.

Reality check for side effects like wind and sand storm consequences.

Reality check for agroforestry productivity under extreme conditions.

Long term effect on palm grove depletion.

Real stakeholder involvement.

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What next?

PILOT PROJECT realization

Meeting with local authorities and stockholders

Pilot project area

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An experimental/pilot project realization

The main goal of this project is to face the challenge from **two different perspectives**: first **introducing a new water management** inspired to the collection, recycle and reuse of urban wastewater and, second, **propose a new agroforestry strategy** in order to stimulate both alternative economic chains and environmental restoration. It is important to note that agroforestry never competes with human and agricultural needs of fresh water but became an alternative resource otherwise neglected.

Wastewater treatment system

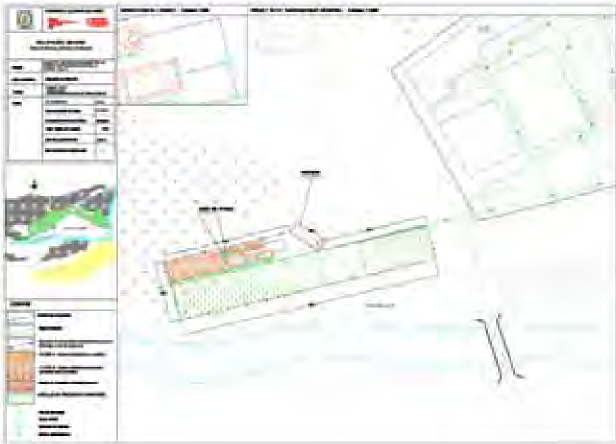
- The system is composed by two parallel treatment chains

Agroforestry testing plots:

-Species (wood & forage)

-Densities (biomass)

-Genotypes evaluation



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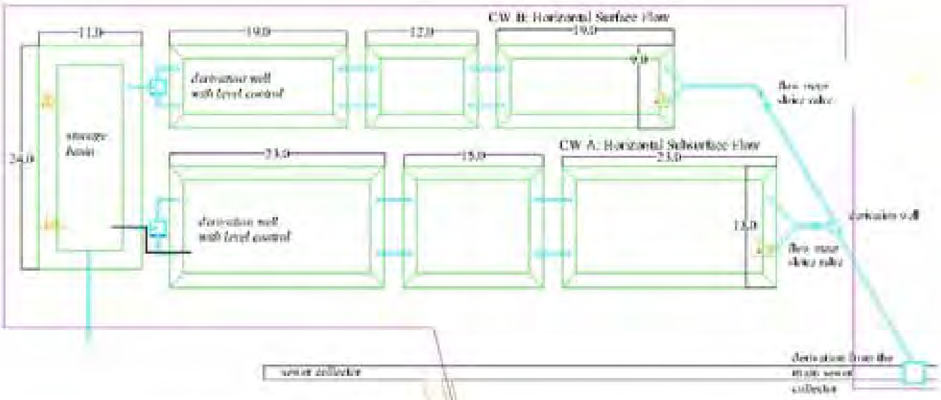
The constructed wetland scheme



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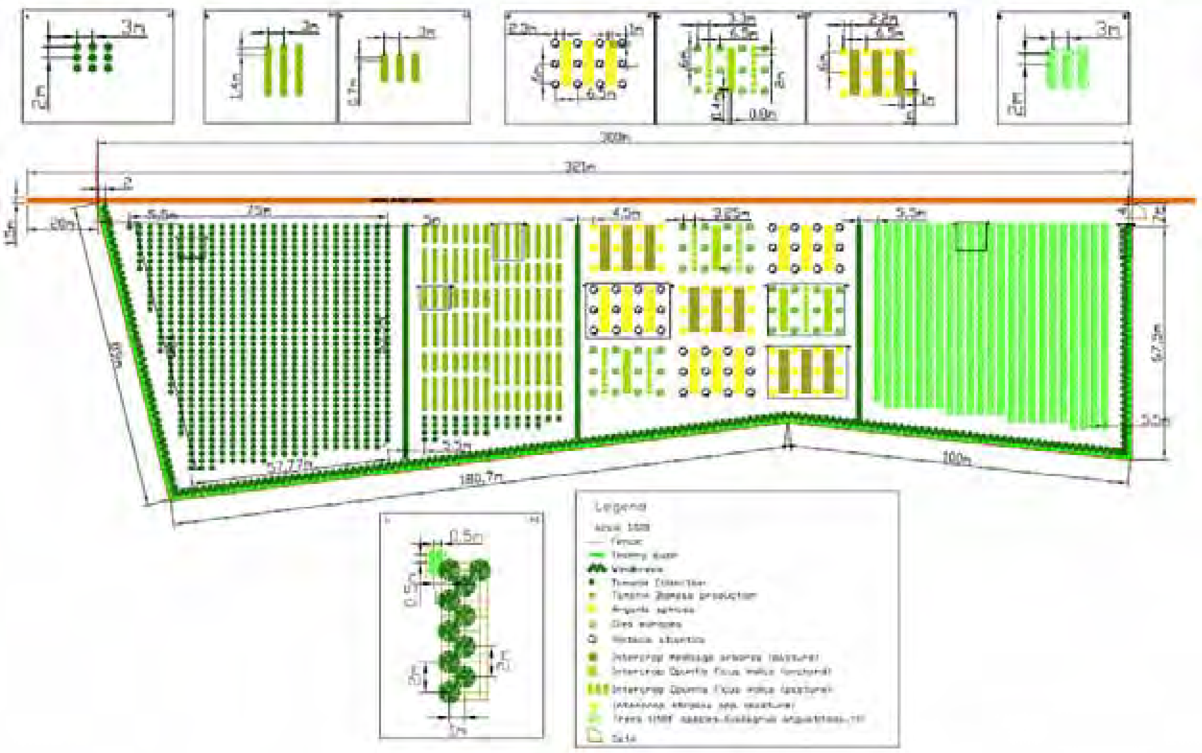

The four modules tested in the pilot plantation are:

1. *Tamarix* collection with the objective to compare among different species and populations.
2. *Tamarix* plantation to estimate biomass production and wood suitability for bio-ethanol production, in short rotation coppice (SRC).
3. Plantation of different species with a relevant ecological and economical value to produce forage, wood and non-wood products (*Argania spinosa*, *Pistacia atlantica*, *Olea europaea*). The density is 7 x 6 m with an inter row forage crop of *Atriplex* spp., *Medicago arborea*, and *Opuntia ficus-indica*.
4. *Elaeagnus angustifolia* plantation to produce wood and forage and to study the capacity of this species to ameliorate the conditions of saline and degraded soils.

scaling up

The representative condition of the Brézina oasis suggests the replication of the model for several situations in Algeria

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Merci pour votre attention !

25

The role of wastewater in agro-forestry application

Simplified treatment system for reuse of wastewater in agriculture and forestry: ten years of irrigation results on a olive tree culture in southern Italy.

Prof. Salvatore Masi, Ing. Vito Dario Colucci,
DEPARTMENT OF ENGINEERING AND PHYSICS OF THE ENVIRONMENT
UNIVERSITY OF BASILICATA

HAMMAMET, TUNISIA
16-17 OCTOBER 2010

1

3)

Reasons for the reuse of urban wastewater

Wastewater (reuse):

- Are an unconventional resource and non-competitive with other uses;
- They have a widespread availability in areas poor of surface water;
- produce environmental benefits for the receiving water bodies and CO_2 balance emissions.

2

SANITARY RISKS

The risks associated with the handling of treated wastewater, alone or in combination, are relatively low.

If conducted in a controlled way, treated wastewater reclamation for agricultural reuse is safe from health risks.

In any case, the level of risk depends on the following aspects:

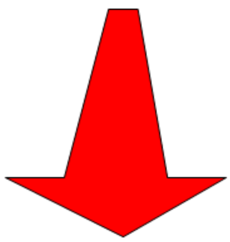
- **Types of treatment**
- **Typees of Irrigated crops**
- **Irrigation techniques**

3

SANITARY RISKS

The health risks associated with wastewater reuse can be:

- **Risk of pathogens transmission to operators and consumers**
- **Accumulation of toxic elements in crops and soil**
- **Dispersion of pollutant in the environment**

PATHOGEN	RISK LEVEL
Virus	
Bacteria	
Protozoa	
Nematodes	

4

HEALTH RISKS ASSOCIATED WITH CROPS

RISK LEVEL	TYPE OF CROP
High	▪ Vegetables to be eaten uncooked ▪ Fruit grown near the soil ▪ Gardens and parks
Medium	▪ Vegetables to be eaten cooked ▪ Fruits harvested in the irrigation period
Low	▪ Forage consumed after drying ▪ Crop seeds (maize, soybean)
Very Low	▪ Fiber crops (cotton, hemp) ▪ Energy crops

5

HEALTH RISKS ASSOCIATED WITH DIFFERENT IRRIGATION TECHNIQUES

RISK LEVEL	IRRIGATION TECHNIQUE
High	SPRINKLING
Medium	INFILTRATION
Low	DRIP IRRIGATION
Very Low	SUB-SOIL IRRIGATION

6

INDICATIONS OF THE INTERNATIONAL REGULATION

- Usually the presence of pathogenic microorganisms is expressed by indicators, in particular enteric organisms (e.g. fecal Coliforms).

- The regulations impose limits more or less restrictive. Are also associated with various restrictions on the irrigation use.

REGULATIONS	MICROBIOLOGICAL LIMITS Coliform /100 ml	RESTRICTIONS OF USE
Italy	10* (80% of sample) 100* (single maximum value)	Agricultural Reuse
US EPA, 2004	≤ 200	food crops transformed
US EPA, 2004	≤ 2 NTU	food crops unprocessed
US-Washington	230	Fodder and fiber crops
US-California	23	Pastures, fruit crops
US-California	2,2	Products to be consumed raw
South Africa	1000	Indicative limit (WHO 1999)
Israel	2,2	Products to be consumed raw

*Escherichia Coli (UFC/100 mL) (colony-forming units)

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ENTERIC MICROORGANISMS IN WATER USED FOR IRRIGATION

Coliforms in the waters of some rivers used for irrigation. (WHO 2005)

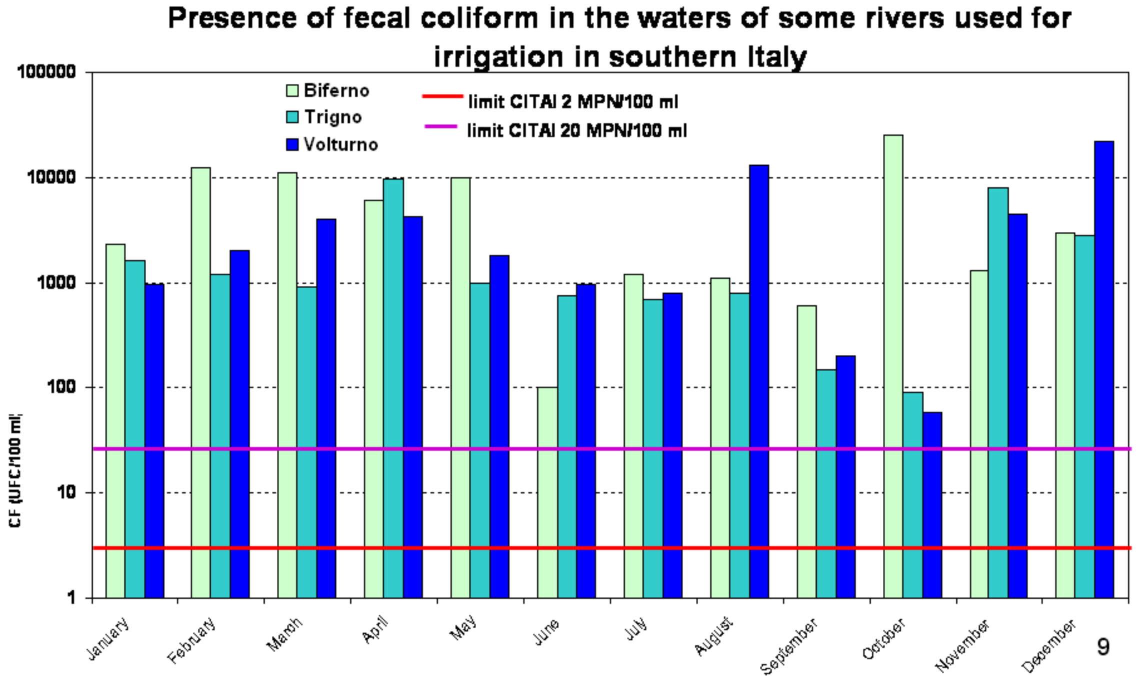
Coliform /100 ml	NORTH AMERICA	SOUTH AMERICA	EUROPE	ASIA
<10	8	0	1	1
10-100	4	1	3	2
100-1000	8	10	9	14
1000-10000	3	9	11	10
10000-100000	0	2	7	2
>100000	0	2	0	3

- The contamination capacity of untreated wastewater is very high (order of 1 in 1.000.000)

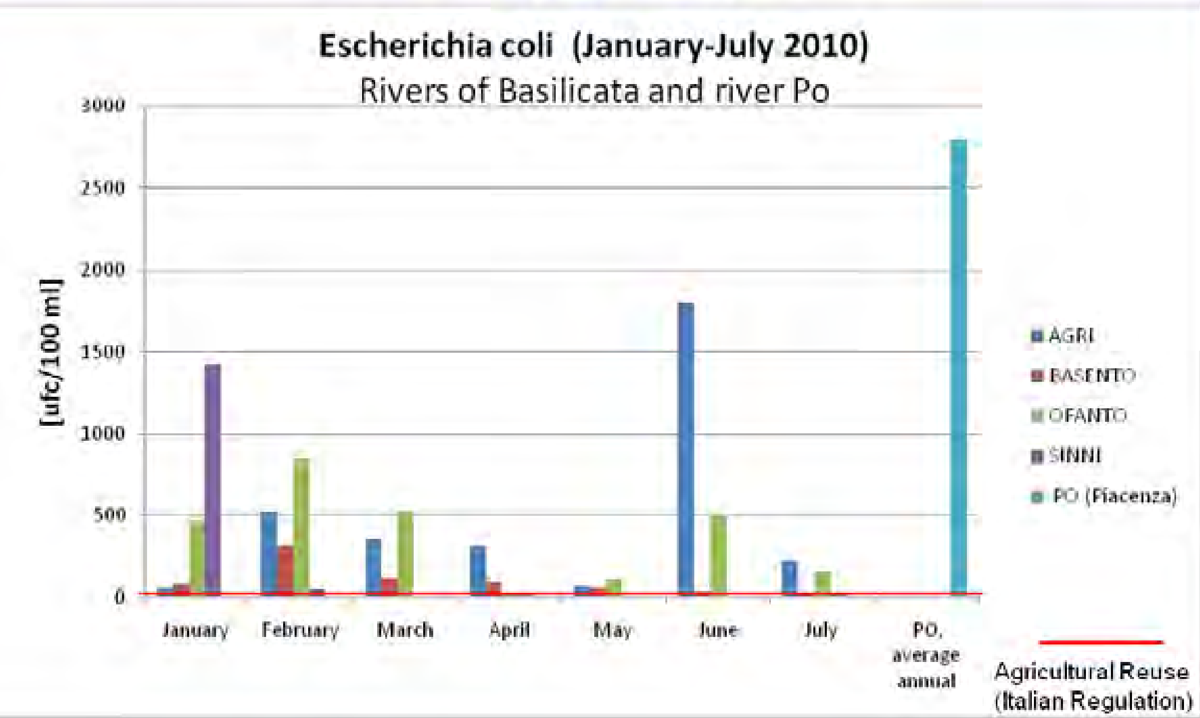
- 1 m^3 of untreated wastewater can contaminate 10.000 m^3 of natural waters with concentrations up to 100 Coliforms in 100 cl

8

ENTERIC MICROORGANISMS IN WATER USED FOR IRRIGATION



ENTERIC MICROORGANISMS IN WATER USED FOR IRRIGATION



APPROPRIATE TREATMENT FOR WASTEWATER AGRICULTURE REUSE

- ✓ REDUCE THE MICROBIAL LOAD TO ACCEPTABLE LIMITS
- ✓ RELEASE OF THE AGRONOMICALLY USEFUL SUBSTANCES

11

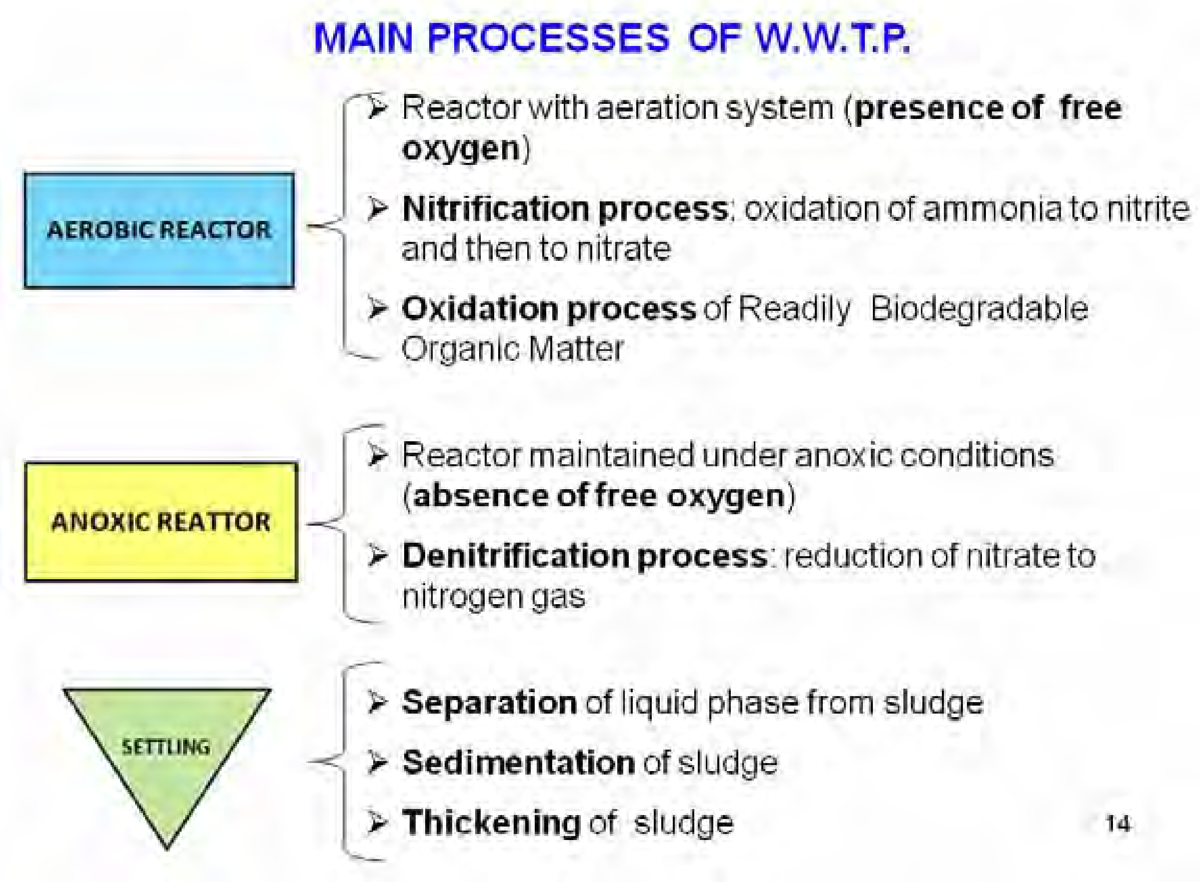
APPROPRIATE TREATMENT FOR WASTEWATER AGRICULTURE REUSE

12

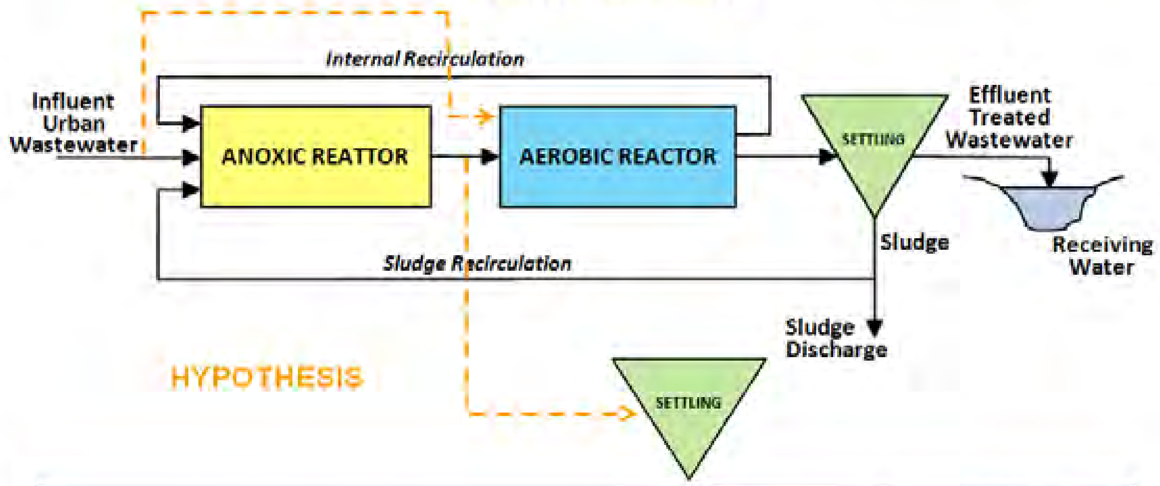
TESTING OF WASTEWATER TREATMENT PLANT FOR CONTROLLED RELEASE OF NUTRIENTS AND ORGANIC MATTER

- Modification of the conventional scheme of treatment plant.
- Definition of the monitoring program for control the inputs of organic matter and nutrients to the irrigated soil.
- Elaboration of "guidelines" for the choice of the simplified treatment and reuse.

13

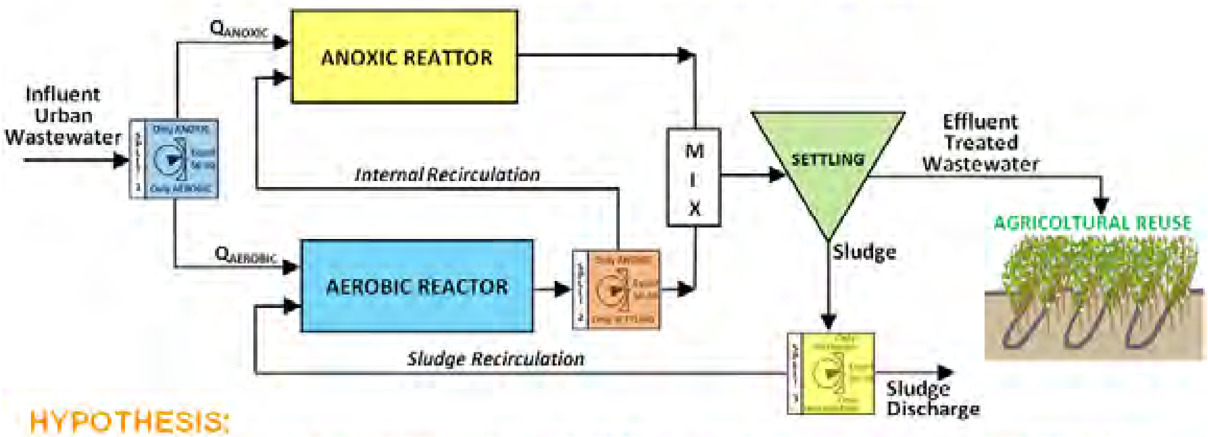


CONVENTIONAL W.W.T.P. TO DISCHARGE WASTEWATER INTO THE ENVIRONMENT



Main compounds	Wastewater Influent	Treated Wastewater Effluent
Ammonia	High	Low
Nitrate	Low	Low
Readily Biodegradable Organic Matter	High	Low
Slowly Biodegradable Organic Matter	High	Low

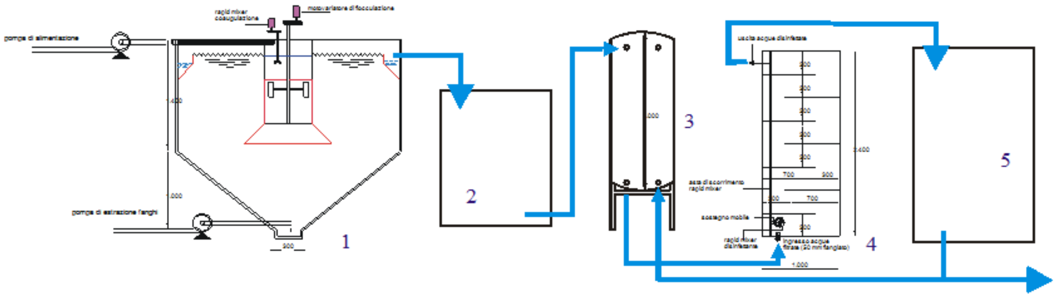
LOW REMOTION SCHEMES FOR WASTEWATER AGRICOLTURAL REUSE



HYPOTHESIS:
partial, selective and modular removal of the agronomically useful substances

Main compounds	Wastewater Influent	Treated Wastewater Effluent
Ammonia	High	Medium-Low
Nitrate	Low	High
Readily Biodegradable Organic Matter	High	Low
Slowly Biodegradable Organic Matter	High	High

PILOT PLANT SCHEME



1. **Dortmund clariflocculation unit**
2. **Storage tank water to be filtered**
3. **Filtration pressure on quartz san**
4. **Disinfection**
5. **Disinfected water storage tank for backwashing filter**

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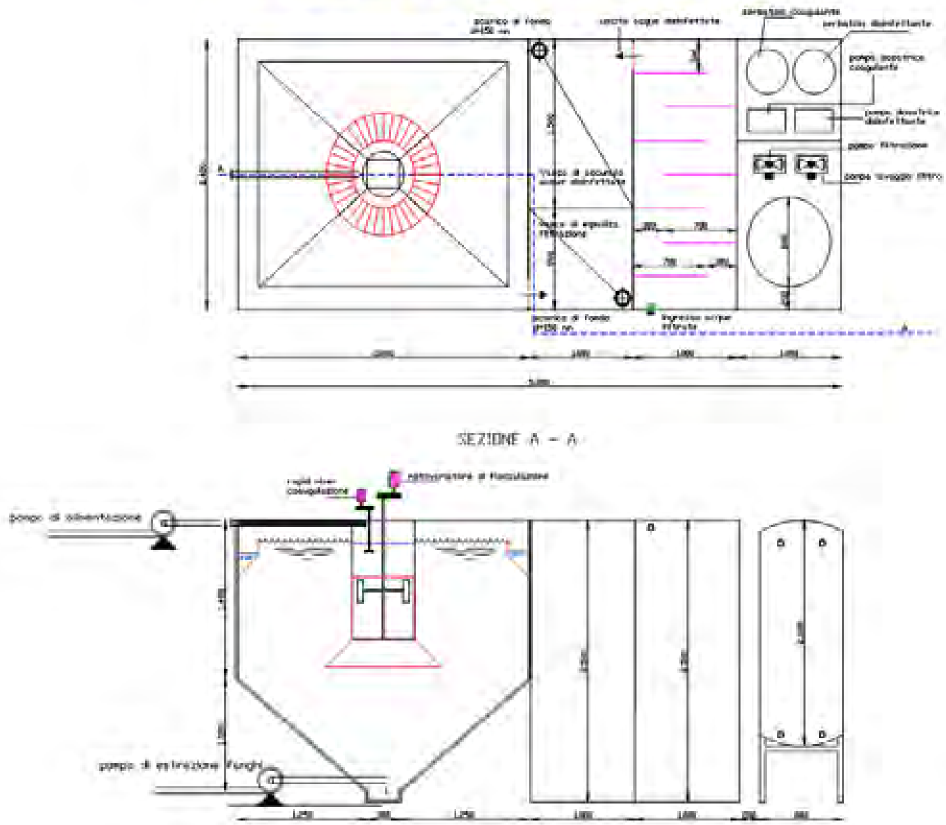
PILOT PLANT SCHEME



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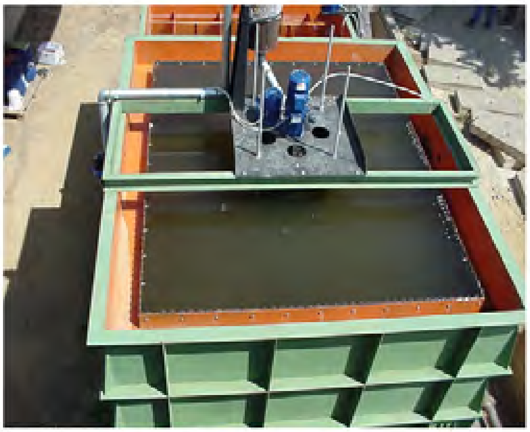
PILOT PLANT



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PILOT PLANT

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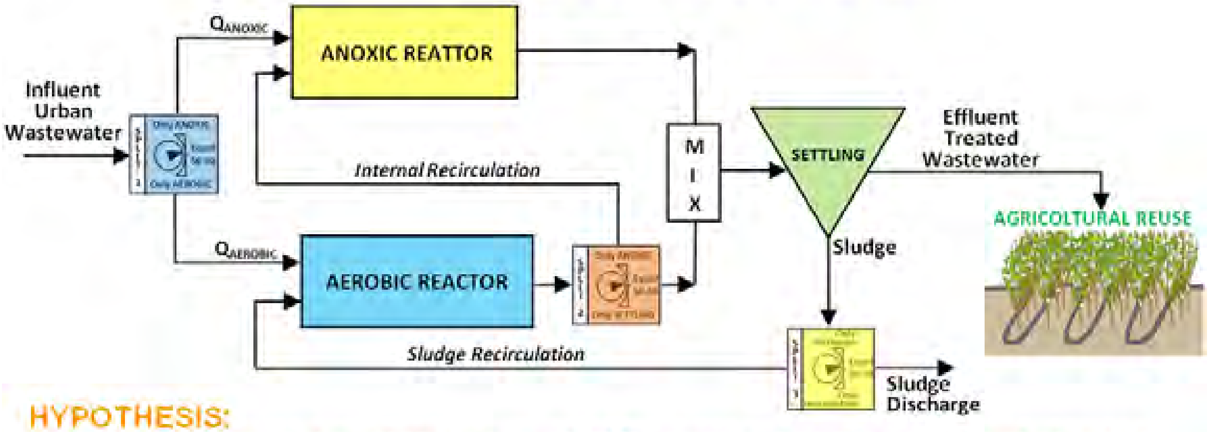
LOW REMOTION SCHEMES
FOR WASTEWATER AGRICOLTURAL REUSE



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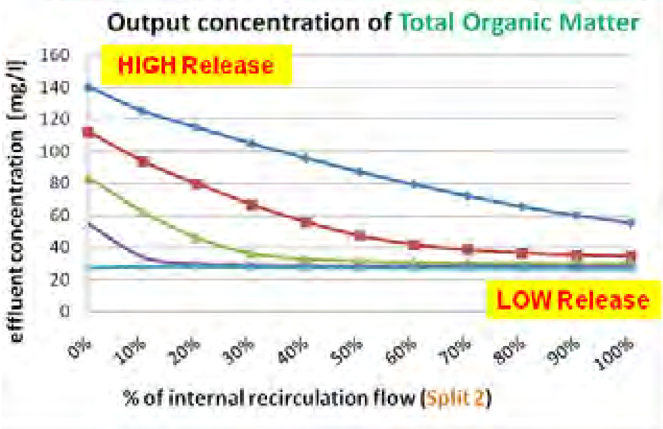
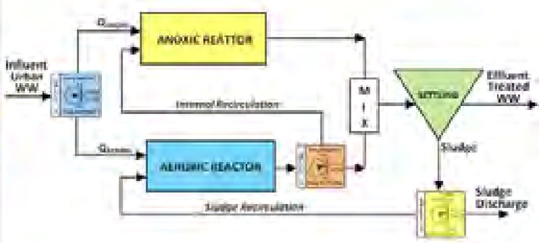
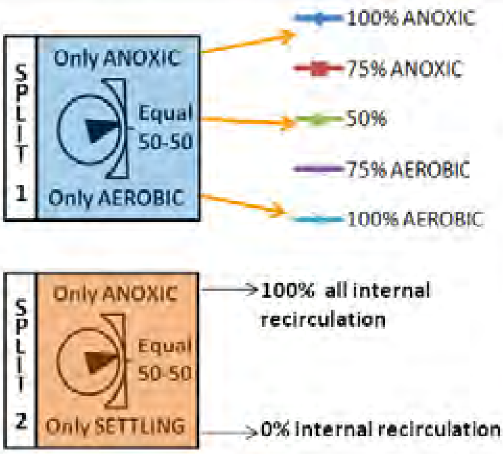
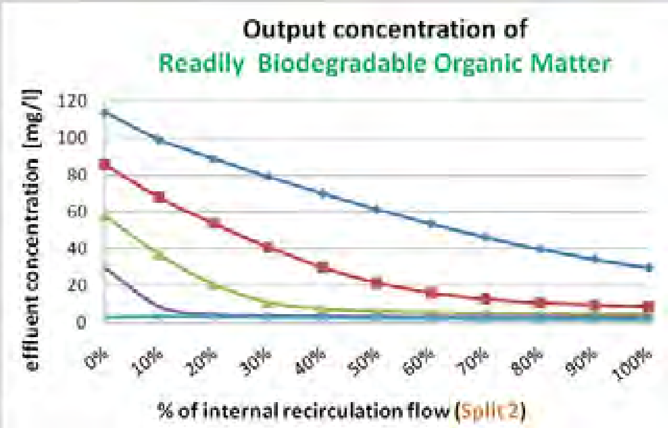
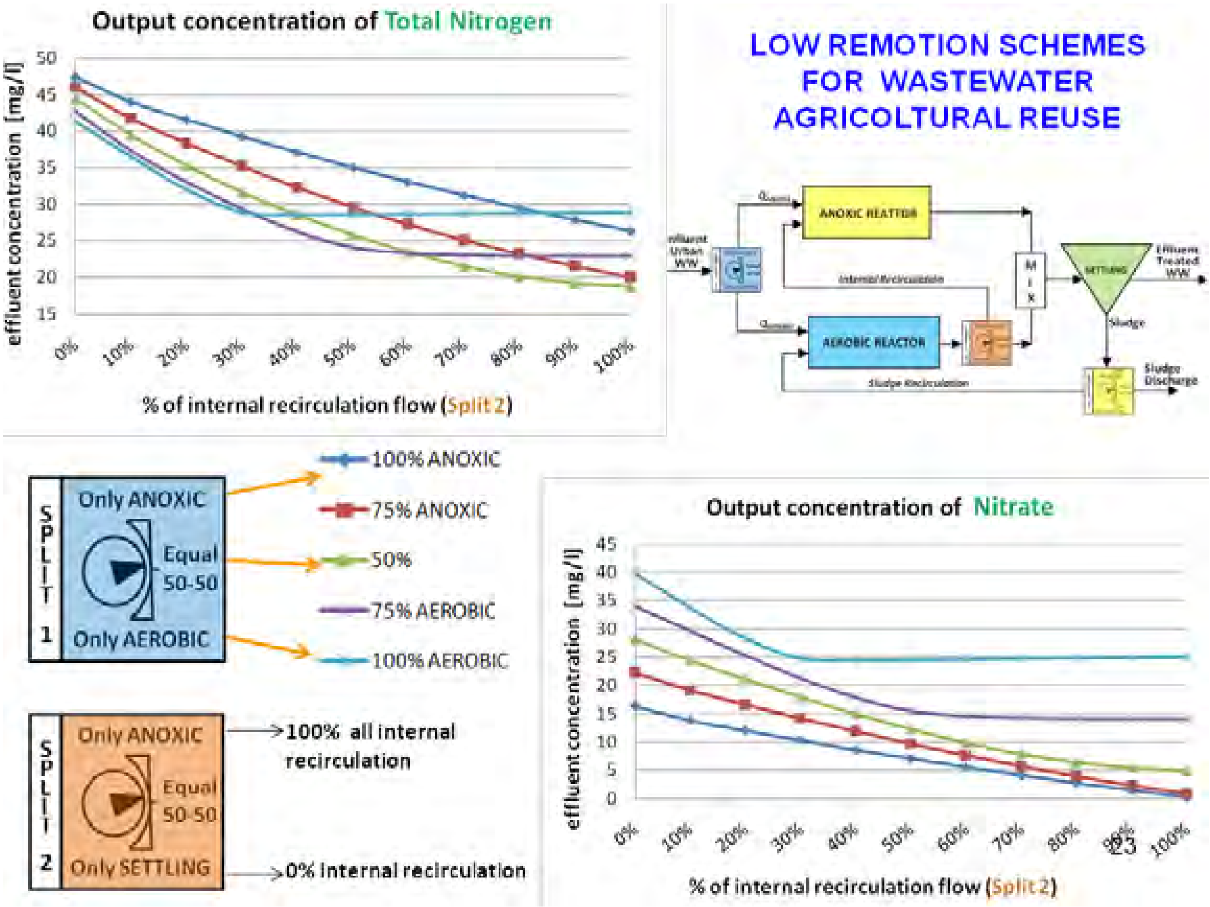


LOW REMOTION SCHEMES FOR WASTEWATER AGRICOLTURAL REUSE









ANALYSIS OF THE MICROBIAL CONTENT OF WASTEWATER REUSE

Treated WW	W.W.T.P. scheme	Average content of fertilizing substances (mg/L^{-1})			Disinfection		Residual microbial contamination (MPN/100 ml)	
		COD	N_{tot}	P_{tot}	Disinfectant	mg/L^{-1}	Total Coliforms	Streptococchi
Sheme n° 1 **Raw water**	Grilling Grit removal Flocculation Filtration Disinfection	300	50	10	PAA	5-15	100-10^4	10-100
					NaOCl	5-25	100-10^5	10-100
Scheme n° 2 **Output by anoxic reactor**	Sedimentation Flocculation Filtration Disinfection	250	35	8	PAA	2-10	10-100	0-10
					NaOCl	5-10	10-1000	1-10
Scheme n° 3 **Output by secondary settler**	Flocculation Filtration Disinfection	60	15	2	PAA	0.5-2.5	0-10	0
					NaOCl	1-5	0-100	0

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EXPERIMENTAL FIELD FOR IRRIGATION OF OLIVE TREES

EXPERIMENTAL FIELD

Trees	Mature plants– cv Maiatica (dual purpose)
Distances	8 m x 8 m (156 trees ha^{-1})
Soil	Lime – Sandy
Sustainable Management	Spontaneous grassing + pruning mulching material + fertigation controlled

MICRO-IRRIGATION SYSTEM FOR TREATED WASTEWATER: WHY?

- ✓ High efficiency of water distribution (90-95%)
- ✓ Reduction of leaching and contamination of groundwater (low-volume irrigation)
- ✓ Low sanitary risk due to the reduced contact with agricultural products and operators

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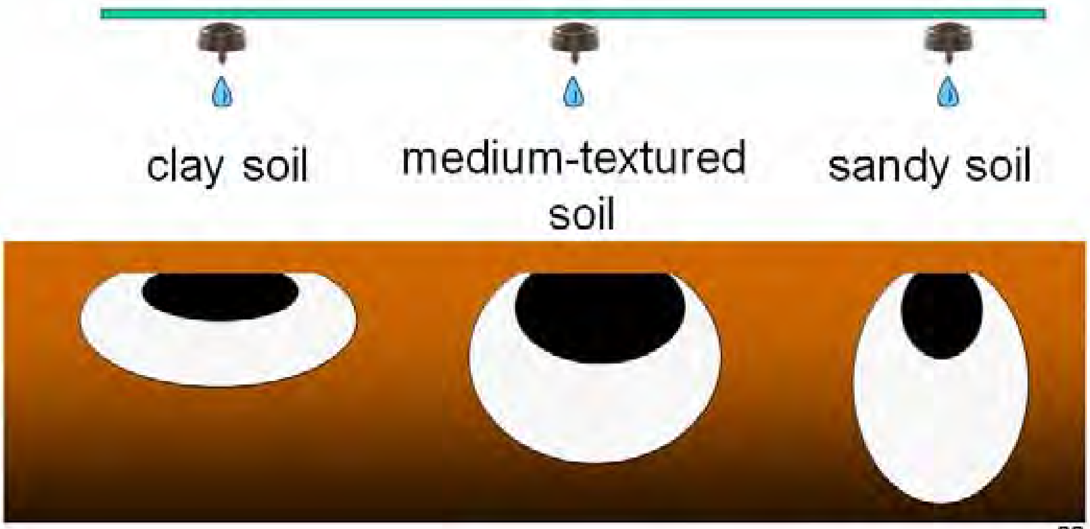
SPATIAL DISTRIBUTION OF WATER DELIVERED BY DROP



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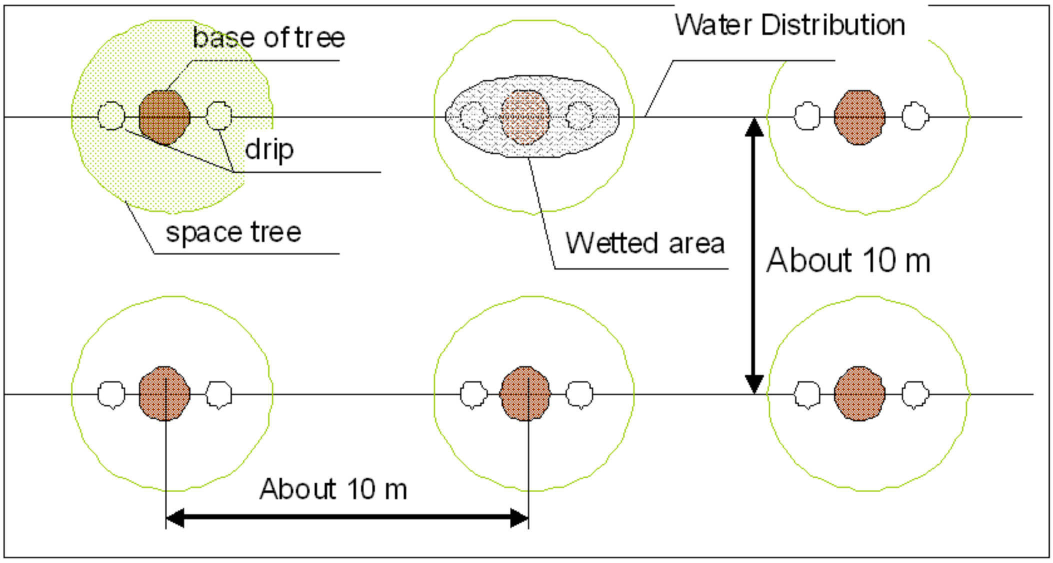
IRRIGATION SCHEME OF THE EXPERIMENTAL FIELD



- The water is distributed in a restricted area at the foot of tree
- The average water allocations were about 3000 m3/hectare concentrated in less than a tenth of the total area irrigated
- The specific contributions were estimated equal to 18 m3/m2 in 10 years

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Water supply: 3000 m^3/ha y

Substance	($kg\ ha^{-1}$)
Organic matter	120 - 250
Nitric nitrogen	40 - 100
Ammonia Nitrogen	1 - 10
Phosphorus	3 - 10
Potassium	50 - 70
Calcium	200 - 250
Magnesium	40 - 50
Boron	2 - 3

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Conventional System, CS

milling at 10 cm soil depth performed 2-3 times per year

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Sustainable System, SS

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Production (average 2001- 2008)

	Sustainable	Conventional	Sustainable	Conventional
	Kg trees^{-1}		*t ha^{-1}*	
average	62.4	27.0	9.7	4.2

Sustainable practice   Conventional practice

Average characteristics of the fruit
(average 2001-2008)

	Sustainable	Conventional
Wet weight of the fruit (g)	*3,8*	*2,5*
Dry weight of the fruit (g)	*1,5*	*1,2*
Weight of the wet core (g)	*0,6*	*0,5*
Longitudinal diameter (mm)	*23,1*	*20,3*
Equatorial diameter (mm)	*16,7*	*15,5*
Ratio pulp / core	*6,1*	*4,4*

34

C in the soil (0-10 cm layer)

	t_{2000}	t_{2006}
	g kg^{-1}	
Sustainable system	**9.40**	**18.73**

35

CO_2 fixed in the two management systems

(average 2000-2008) (t ha^{-1} $year^{-1}$)

	Sustainable		Conventional	
	D.M	CO_2 Fixed	D.M	CO_2 Fixed
Fruits	4,9	9,0	2,1	3,8
Vegetation cover	7,6	13,9	-	-
Pruning material	3,3	6,0	2,6	4,8
Leaves	0,9	1,6	0,9	1,6
TOTAL	**16,7**	**30,5**	**5,6**	**10.2**

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Fruits hygienic quality
(2000-2006)

	Sustainable			Conventional		
	EC	Ent	CSR	EC	Ent	CSR
	CFU/100 g pf					
foliage	0	0,8	4,0	-	-	-
net	2,0	19,4	3,0	0	11,8	3,6

- EC: Escherichia Coli
- Ent: Enterococchi
- CSR: Sulphite- reducing clostridia spores
- **Salmonella spp: Always absent**

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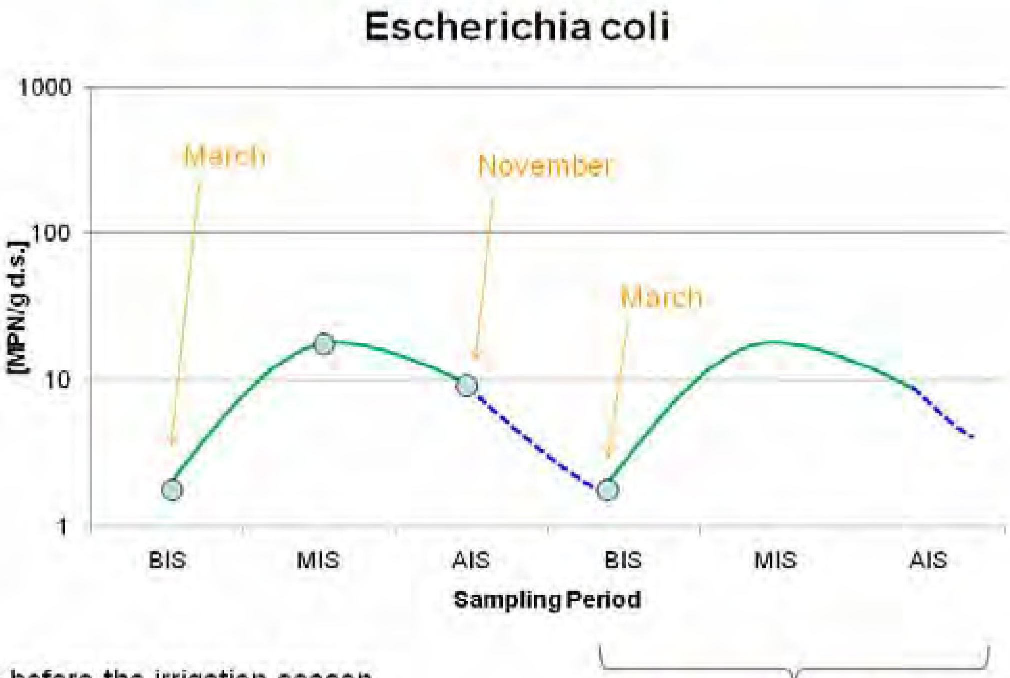
Soil hygienic quality (2000-2006)



BIS: before the irrigation season
MIS: mid-season irrigated
AIS: after the irrigation season

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ANALYSIS AT DIFFERENT SOIL DEPTH

		SAMPLING DEPTH		
ELEMENTS	**UNITS**	**0 - 0,3 m**	**0,3 – 0,6 m**	**0,6 – 1 m**
Boron(Bo)	mg/Kg	1-2	1-2	1-2
Cadmium(Cd)	mg/Kg	< 0,5	< 0,5	< 0,5
Total Chrome (Cr)	mg/Kg	10-15	10-15	10-15
Hexavalent chromium(Cr VI)	mg/Kg	< 1	< 1	< 1
Nickel(Ni)	mg/Kg	15-20	10-15	10-15
Lead (Pb)	mg/Kg	10-15	10-15	10-15
Copper (Cu)	mg/Kg	20-30	10-20	20-30
Zinc (Zn)	mg/Kg	40-60	30-50	30-50
BTEX	mg/Kg	< 1	< 1	< 1
Light hydrocarbons(C<12)	mg/Kg	< 10	< 10	< 10
heavy hydrocarbons (C>12)	mg/Kg	50-60	50-60	50-60

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After 10 years of application treated wastewater:

Were monitored elements foreign to the lithology of the site.

These elements are indicators for the problems of accumulation and long-term damage to the soil.

The analysis protocol aims to search related compounds to urban wastewater and road run-off.

The analysis protocol including:

- Heavy metals (Cu, Pb, Cr, Zn, Cd)
- Indicators salification (Na, Mg, Ca)
- Sulphates
- Chlorides
- Indicators of organic contamination (BTX, IPA)

➢ The indicators of microbial contamination are part of a protocol drawn up together with the expert agronomists.

YOU DON'T HAVE ANY FAILURE OR VALUE INDEX OF LAND DEGRADATION

➢ The work in progress are measures of soil moisture in the soil irrigated with tools like geoelectric. the goal is to assess the risk of leaching to groundwater where increased inputs of water in seasons of low evapotranspiration. 40

	Units	Quantity	Unit Cost (€)	Total cost (€)
Organic matter as BOD (per kg removed)				
Construction and maintenance	€/kg	1	0,06	0,06
Electricity for oxidation	kw*h	2	0,10	0,2
Electricity for sludge dewatering	kw*h	0,05	0,10	0,005
Landfilling of sludge (with 25% humidity)	kg/kg	2	0,15	0,3
				0,565
Per m3 of treated water (recovery of 150 mg / l BOD)	€/m³			0,085

Ammonia nitrogen (per kg removed)				
Construction and maintenance	€/kg	1	0,12	0,12
Electricity for oxidation	kw*h	5	0,10	0,5
Electricity for sludge dewatering	kw*h	0,05	0,10	0,005
Landfilling of sludge (with 25% humidity)	kg/kg	2	0,15	0,3
				0,925
Per m3 of treated water (recovery of 40 mg / l of N-tot)	€/m³			0,037

	Units	Quantity	Unit Cost (€	Total cost (€)
Phosphorus (per kg removed)				
Reagent (chemical precipitation)	€/kg	5	0,8	4
Landfilling of sludge (with 25% humidity)	€/kg	6	0,15	0,9
				4,9
Per m3 of treated water (total release of the contents of Phosphorus not metabolized)	€/m³			0,025

Overall savings for non-removal	€/m³	0,146

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ECONOMIC VALUE OF THE SUBSTANCES RECOVERED FROM WASTEWATER

Equivalent Inhabitants	E.I.	10.000
Water supplied per capita	(m3/d)	0,30
Amount of treated water in a year	(m3)	864.000
Total cost of treatment	(€)	302.400
Lower costs (removal of 50%)	(€)	126.360
Equivalent value of organic matter recovered	€/kg	0,030
Equivalent value of nitrogen recovered	€/kg	0,5
Equivalent value of phosphorus recovered	€/kg	1,2
Commercial value of the recovered substances per m3 of water	€/m^3	0,050
Commercial value of the recovered substances for 10.000 E.I. / year	**€**	**43.000**

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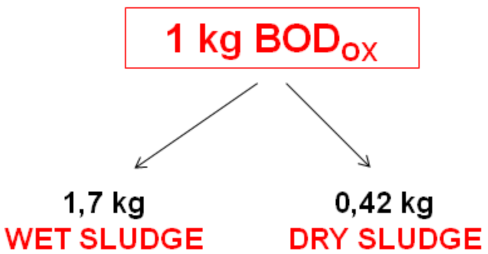
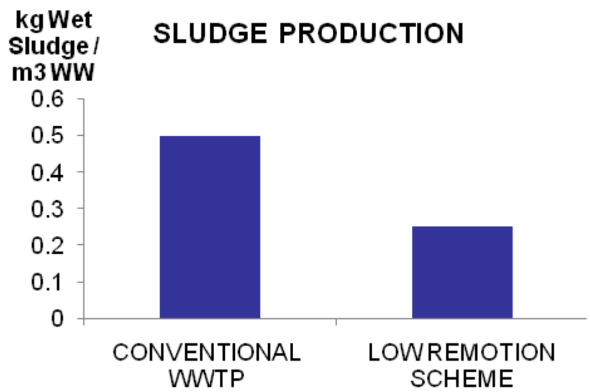
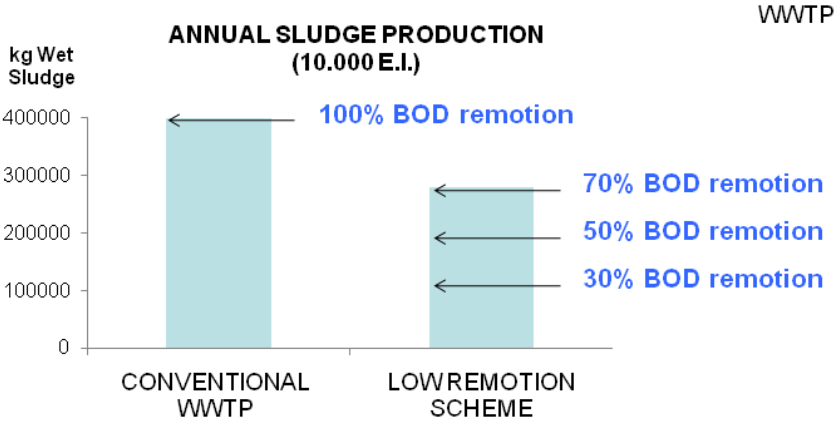
SLUDGE PRODUCTION







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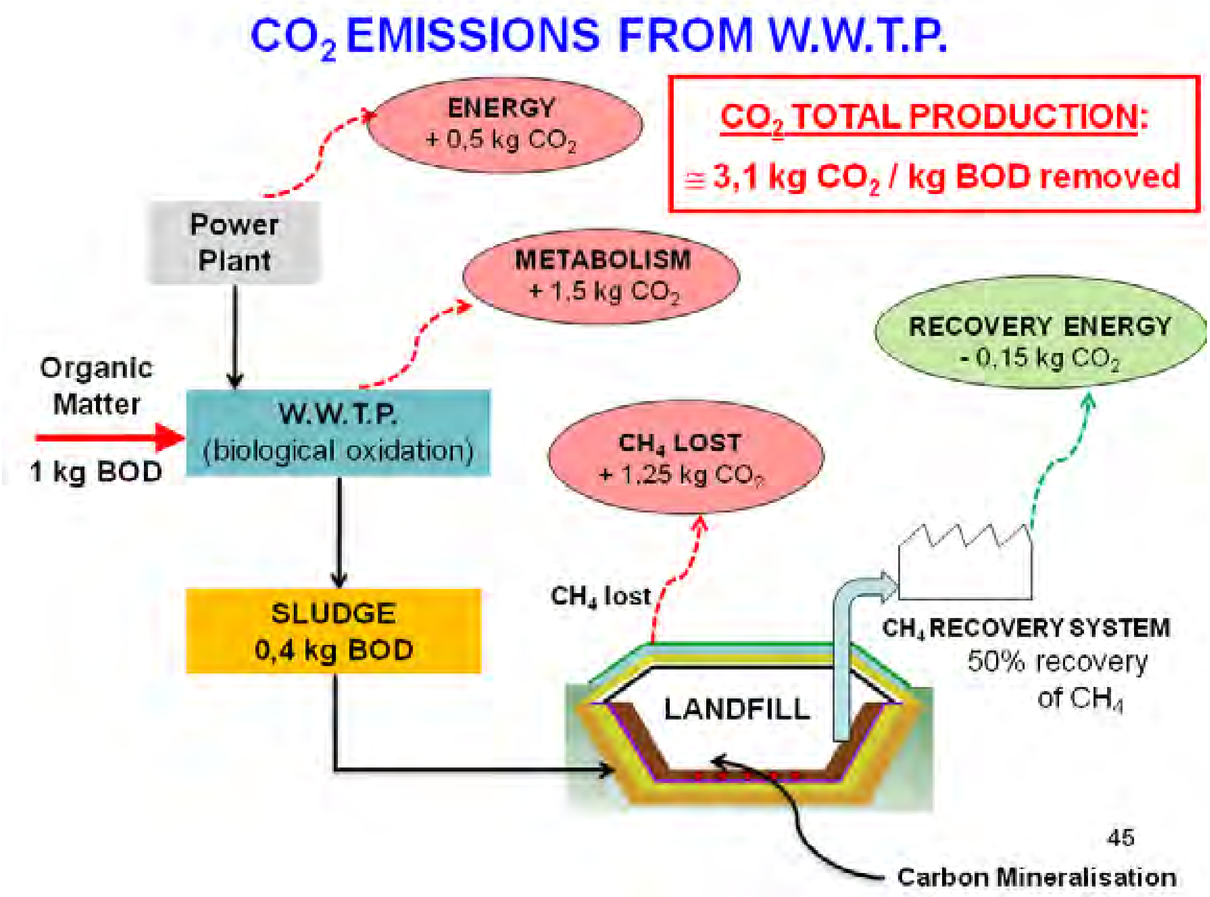

CARBON CREDITS

In usual practice, the treatment of **1 kg of organic matter** (as a pollutant in wastewater) involves the production of about **2 kg of CO_2**.

If the sludge produced is disposed of in landfills, even assuming 50% recovery of methane, there is a residual production of methane of about **0,1 kg CH_4 / kg sludge**.

GWP = 1 CH_4 → 23 CO_2 eq

In terms of equivalent CO_2 , corresponds to about **2,3 kg CO_2 / kg sludge**.

The reuse of 1,000,000 m3 of water ,can reduce emissions by about **600 tonnes of CO2 equivalent** (savings in terms of emissions of about **60 years kg / CO_2 inhab. year).**

At **15.50 € / t CO_2** * you have an equivalent of **9.300 € / year** 46

*CO_2 exchange, october 2010 (EU) (kyotoclub.org)

CARBON SEQUESTRATION IN SOILS
(literature)

C. S. Zan et al., 2001

The study results suggest that perennial energy crops grown on relatively fertile soils, have the potential to increase levels of soil carbon than conventional agricultural systems or unmanaged systems.

R.M. Rees et al., 2005

- About 50% of carbon assimilated by young plants can be transferred into the soil.
- Has been estimated that the potential accumulation of carbon in European farmland is **9-120 x 10^6 tons C / year**.

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CARBON SEQUESTRATION IN SOILS
(literature)

CAST 2004, C. Mondini et al., 2008

- Sustainable agricultural practices effectively increase carbon levels in soil.
- After 20-30 years, however, the carbon content in the soil tends to stabilize.

C. Mondini et al., 2008

- In this study have estimated that around 2 billion hectares of land are affected by degradation, and these represent over **30%** of all Worldwide soil..
- The potential for **carbon sequestration** in agricultural land worldwide is significant: **from 0.6 to 1.2 x 10^9 tons C / year**..
- Carbon sequestration can reduce overall emissions of greenhouse gases by **2-5%**

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Project Title

Forest restoration in Algeria, Egypt, Morocco and Tunisia using treated waste water to sustain smallholders and farmers livelihood

Project Goal/Impact

The livelihood of the population in arid and semi-arid zones is improved and the effects of climate change are mitigated through the utilization of treated waste water in forestry and agroforestry

Project Outcome/Purpose

Capacity and capability in the use of treated waste water in forestry and agroforestry production systems towards achieving sustainable livelihoods in selected countries of the Mediterranean region are strengthened

Project Outputs

1. *Operational concepts and sustainable agroforestry and forestry production systems using treated waste water are developed, and the institutional and regulatory framework is improved.*
2. *Innovative management and production systems are adopted, contributing to the mitigation of, and adaptation to climate change effects.*
3. *Knowledge and technology regarding the use of treated waste water in agroforestry and forestry production systems are acquired and harnessed.*

Activities by country

Algeria

Working group members: Nasr Eddine Kazi Aoual, (Ms) Sabrina Rachedi, Paolo De Angelis
Resource persons: Walter Kollert, Salvatore Masi, Giovanni Mughini, (Ms) Maria Pia Rizzo, Mohamed Saket, Aleksander Zaremba

- ***Activities related to output 1:***

a) Identify production systems in the oases that are suitable for irrigation by TWW
b) Develop, in cooperation with concerned stakeholders, the priority objectives to be pursued by irrigated production systems
c) Develop international and national joint research programmes on the use of TWW in forestry and agroforestry and in monitoring soil conditions
d) Support capacity building in all sectors related to irrigation with TWW, forestry and agroforestry
e) Strengthen the policies of rural development in Algeria and adapt the institutional framework to the use of TWW in forestry and agroforestry
f) Review and analyze the rural policies to improve forestry and agroforestry practices in oases

- ***Activities related to output 2:***

a) Review, analyse and adjust the existing techniques and methodologies for irrigation using TWW in oases
b) Develop an administrative and commercial concept for production and commercialisation of products from TWW production systems
c) Conduct inventories of unused (marginal) lands and assess the suitability for irrigation with TWW
d) Establish and maintain forest plantations with tree species (tamarix – atriplex, etc.) for biomass production and sand dune fixation to ensure environmental protection of the oasis

- ***Activities related to output 3:***

a) Establish and evaluate phytodepuration production systems in pilot areas
b) Establish nurseries with plant species needed in the phytodepuration process
c) Identify methodologies to control soil salinization and accumulation of pollutants
d) Establish monitoring and control system for soil salinity and soil pollution

Egypt

Working group members: Ahmed El Baha, El-Said Ali Mohamed Khalifa, Maurizio Sabatti.
Resource persons: Walter Kollert, Salvatore Masi, Giovanni Mughini, (Ms) Maria Pia Rizzo, Mohamed Saket, Aleksander Zaremba

- ***Activities related to output 1:***

a) Analyse and adopt the regulatory and institutional framework to increase the impact of treated waste water in forestry and agroforestry
b) Adopt improved crop protection methods and systems such as windbreaks, strip tree planting with fast growing species along irrigation channels, plantations for road protection and sand dune fixation

- ***Activities related to output 2:***

a) Improve field work experience through the introduction and testing of new species and clones (poplars, willows, eucalyptus)
b) Verify resilience to pest and diseases
c) Compare growth performance and productivity of different production systems

- ***Activities related to output 3:***

a) Raise public awareness through campaigns in schools, universities and government departments
b) Initiate capacity building on water quality control through the training of scientists, administrative staff and workers
c) Analyse and review the quality of fresh water used for irrigation for comparative studies
d) Implement tests on the efficiency of low-cost treatment plants (e.g. aerated lagoons and short time aeration, phytoremediation systems)

Morocco

Working group members: (Ms) Kawtar Gazoulit, Mourad Taroq, Michele Baldasso, Alberto Del Lungo
Resource persons: Walter Kollert, Salvatore Masi, Giovanni Mughini, (Ms) Maria Pia Rizzo, Mohamed Saket, Aleksander Zaremba

- ***Activities related to output 1:***

a) Elaborate technico – economical studies on the potential of using treated wastewater in forestry, agroforestry and sand dune stabilization
b) Elaborate a Geographical Information System with associated data base on the location of wastewater treatment plants (STEPs), climatic conditions, conventional water resource availability (dams, etc.), vulnerable river basins situated at the upstream of dams to erosion. This activity will consist to identify the treated wastewater reuse opportunity in terms of site and type of potential use.
c) Analyse and strengthen the institutional and organizational framework facilitating planning and implementing TWW reuse for forestry purposes.
d) Define regulations, standards and guidelines for the use of TWW in agroforestry, forestry and sand dune fixation according to different ecological contexts (climate, soil, environmental vulnerability and accessibility)

- ***Activities related to output 2:***

a) Establish demonstration and pilot projects on the use of TWW in forestry and agroforestry using tree species adapted to dry areas and soil salinity and testing different irrigation systems (drip and subsurface irrigation, etc.)
b) Establish green belts and windbreaks in towns and villages for combating desertification and sand dune stabilization along the coast and in the desert with tamarix, acacia, retama, poplars, eucalyptus
c) Test the suitability of agroforestry irrigation systems for the regeneration of *Argania spinosa*
d) Study and evaluate adapted options for the treatment and the use of the sewage sludge resulting from wastewater treatment (production of compost to be used in forest nurseries or for degraded soil rehabilitation)
e) Evaluate the impact of the use of WWT sub-products (treated wastewater and sewage sludge) on the adaptation to climatic change and on to combate desertification

- ***Activities related to output 3:***

a) Implement training sessions on the potential and the best practices of the TWW reuse for engineers and technicians involved in TWW reuse projects, and information and communication campaigns for direct users (technicians), farmers and public
b) Prepare and edit guidance manuals relating TWW use in forestry, pertinent results of conducted studies (Outputs 1 & 2) and disseminate to engineers and technicians at the regions levels. Facilitate the implementation of research programs and the exchange of students and researchers to contribute to enrich findings in adapting the TWW reuse in the contexts of the Morocco.
c) Support regional networks on the integrated use and valorisation of TWW in forestry, agroforestry, and the combat of desertification.

Tunisia

Working group members: Rafik Aini, (Ms) Raqia Al Atiri, Mauro Centritto.
Resource persons : Walter Kollert, Salvatore Masi, Giovanni Mughini, (Ms) Maria Pia Rizzo, Mohamed Saket, Aleksander Zaremba

- ***Activities related to output 1:***

a) Elaborate a report on the status of TWW plants in Tunisia to be compared with other more advanced countries
b) Evaluate and introduce new systems to produce TWW of higher quality, at lower cost and utilise sludge for soil fertilisation according to the methodology developed by the University of Basilicata in Italy
c) Identify suitable plantation areas in villages for farmers following the methodology developed in Algeria by the University of Tuscia in Italy
d) Establish TWW plants using phytoremediation technology with native species or introduced adapted species for desertification control
e) Define priority areas for the establishment of TWW plants for productive and protective purposes
f) Develop standards and guidelines and improve the institutional frameworks for the use of TWW
g) Implement political and public lobbying to promote the guidelines

- ***Activities related to output 2:***

a) Implement feasibility studies on different agroforestry/forestry production systems with regards to the ecological conditions and the suitability to improve carbon sequestration, facilitate land rehabilitation and combat desertification
b) Implement field trials to test the suitability and resilience of native species and fast-growing introduced species and clones
c) Establish tree nurseries for the production of suitable planting material
d) Improve agroforestry production systems in dry areas through the use of new irrigation methodologies (drip irrigation and subsurface drip irrigation)

- ***Activities related to output 3:***

a) Implement capacity building events and educational programmes for young researchers, extension workers and young professionals (e.g. training measures, field excursions, study tours)
b) Establish an informative database on the use of TWW for irrigation, that is accessible by all arid-zone countries
c) Improve information and communication among arid-zone countries through networks, meetings, workshops, round tables and the design and maintenance of a website
d) Establish permanent plots suitable for demonstration purposes

Indicators

Design Summary	Indicators/Targets	Data Sources	Assumptions
Project goal: ***The livelihood of the population in arid and semi-arid zones is improved and the effects of climate change are mitigated through the utilization of treated waste water in forestry and agroforestry***	By the end of the project the use of TWW for forestry and agroforestry in the project area has increased by 30% in terms of number of users and/or area of usage		
Project outcome: ***Capacity and capability in the use of treated waste water in forestry and agroforestry production systems towards achieving sustainable livelihoods in selected countries of the Mediterranean region are strengthened***	1) By the end of the project the number of formal meetings, workshops, protocols between research and forestry institutions of arid zone countries has increased by 20% 2) Formal protocols (e.g. MOUs) with national meteorological authorities to regularly provide agro-meteorological data suitable to determine irrigation water requirements have been concluded in each participating country by the end of the project		
Project Outputs **1) Operational concepts and sustainable agroforestry and forestry production systems using treated waste water (TWW) are developed, and the institutional and regulatory framework for the use of TWW is improved**	1.1) The revision of the regulatory framework developed by the project is officially adopted by the concerned national institutions by the end of the project 1.2) The forestry and agroforestry area irrigated sustainably by TWW has increased by 30% by the end of the project.		

2) Innovative management and production systems are adopted contributing to the mitigation of and adaptation to climate change effects **3) The knowledge and technology regarding the use of treated waste water in agroforestry and forestry production systems are strengthened and disseminated**	2.1 Crop yields per hectare of agroforestry production systems have increased by 20% through the use of treated waste water by the end of the project. 2.2 The resilience of forestry and agroforestry production systems against droughts, diseases and pests (measured by means of survival rates) has increased by 20% by the end of the project. 3.1 By the end of the project the number of professional institutions dealing with TWW has increased by 30% 3.2 By the end of the project the number of people benefitting from the project in rural areas has increased by 30%.		
Activities			


Forest restoration in
Algeria, Egypt, Morocco and Tunisia
using treated waste water to
sustain smallholders and farmers livelihood
Workshop results, conclusions, further steps
Hammamet, Tunisia, 16 – 17 Oct 2010


Workshop Objectives
• knowledge transfer and future interactions
• to better understand forestry in Mediterranean countries
• transfer of scientific research into forest policies, plans and forestry practices,
• Logical framework: outcome, outputs, activities,

Logical Framework Approach

Column 1 Objectives	*Column 2* Indicators / targets	*Column 3* Data sources	*Column 4* Assumptions
Impact / Goal: The higher order long-term **development objective** to which the project contributes ***The Greater Why?***			
Outcome: The specific and immediate **beneficial changes achieved by** the project ***The Why?***			
Outputs: The deliverables of the project or the terms of reference ***The What?***			
Activities: The main activities that must be undertaken to deliver the outputs ***The How?***			

Project Goal/Impact

The livelihood of the population in arid and semi-arid zones is improved and the effects of climate change are mitigated through the valorization of treated waste water in forestry and agroforestry

Project Outcome/Purpose

Capacity and capability in the use of treated waste water in forestry and agroforestry production systems towards achieving sustainable livelihoods in selected countries of the Mediterranean region are strengthened

Project Outputs

1. Operational concepts and systainable agroforestry and forestry production systems using treated waste water are developed and the institutional and regulatory framework is improved.
2. Innovative management and production systems are adopted contributing to the mitigation of and adaptation to climate change effects.
3. Knowledge and technology regarding the use of treated waste water in agroforestry and forestry production sysyems are acquired and harnessed.

Activities: 4 country packages

Algeria	Oasis development community forest management phytoremediation
Egypt	Crop protection methods, improved waste water quality, introduction of new species and clones, Public awareness and capacity building
Morocco	Research studies (ecology, legislation), Demonstration projects, Awareness raising, guidelines
Tunis	Documentation and definition(research) Feasibility studies Country capacity building

Further Steps - FAO

• Workshop Report and Webpage	2 weeks
• Draft Concept Note	3 weeks
• Reconciliation with countries	1 month
• Presentation & Preliminary Submission to Donors	Dez/Jan 2011
• Detailed Proposal Preparation With participation of countries (Feasibility Study, Appraisal, Approval)	4 to 6 months

Funding Options

- Multi-lateral funding agencies:
  - IFAD
  - EC
  - The World Bank (loans, technical assistance grants, GEF)
- Multi-lateral technical agencies:
  - FAO (TCP),
- Bi-lateral donors:
  - Italy, Germany, Spain, China, Other?

Further Steps – Countries

- political & public lobbying to increase awareness of benefits of wastewater usage, e.g. prepare a briefing report, conduct briefing meeting, share messages & photos with colleagues & relevant institutions
- use logical frameworks to market project proposals
- inputs to concept notes, proposal preparation upon request


Thank you for your
Attention & Commitment
Remember Planted Forests website
http://www.fao.org/forestry/plantedforests/en/