TREATED WASTE WATER USE IN FOREST PLANTATION DEVELOPMENT IN THE NEAR EAST REGION

A Paper presented at the Near East Forestry Commission, January, 2002

INTRODUCTION

1 This paper is based upon a number of reports from individual countries of the Near East Region and selected FAO documents. The document may not represent a fully comprehensive view of the use of treated wastewater in forest plantation development for control of desertification in the region, but is representative of the overview and key issues prevailing. National reports and statements by delegations should supplement this paper.

SUMMARY OF RECENT DEVELOPMENTS, TRENDS AND PROSPECTS

2 Although the Near East Region occupies about 14 percent of the world area and embraces almost 10% of the world population, it only receives 3.5 percent of total precipitation and only 2.2 percent of the annual internal renewable water resources. Some 16 countries, out of 30 member states of the region are classified as water-deficient, that is having less than 500 m^3 per capita of annual renewable fresh water resources (FAO, 1997).

3 Irrigated agriculture in the region accounts for 91 percent of water withdrawals; industry, 4 percent; and the domestic sector, 5 percent. Only 30 percent of the cultivated area is irrigated, however this area produces 75 percent of the total agricultural production. More than 50 percent of all food requirements are imported and the rate of increase in demand for food exceeds the rate of increase in agricultural production (Papadopoulos, 1995). The rapid demand and development of irrigated agriculture in the Near East has meant that easily accessible water resources, such as river flows and shallow good-quality groundwater, are now almost entirely committed. The resulting scarcity of water is cause for national and regional concern. The UN Population Division predicts that by 2025 the population of the Middle East will be double that of 1994. Expansion of urban population and increased coverage of domestic water supply and sewage systems will give rise to greater quantities of municipal wastewater.

4 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 forests, forest plantations, greenbelts and amenity trees. Wastewater re-use for forest plantation 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 (Braatz and Kandiah, 1996).

5 Desertification control and forest plantation development are crucial in the region, 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 have led to the depletion of the scarce natural wood resources resulting in a negative impact upon the livelihoods of rural communities (El Lakany, 1994 and Abdel Nour, 2001). 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 forest plantations and tree planting in various settings have been established in many countries of the region, particularly using multi purpose and fast growing species of the genera *Eucalyptus*, *Acacia* and *Pinus*

to provide wood, fodder and protection as well as increasing soil fertility (Omran, 1996 and Anon, 2000).

6 Whereas the use of wastewater for agriculture and landscape irrigation is now quite widespread in many regions, wastewater irrigation of trees has been much less explored. Shade and amenity trees and urban green areas are irrigated with treated sewage effluent transported by tanker in some cities (e.g. Cairo, Teheran and others) in the Near East and the literature gives examples of effluent use in production forestry. Overall, however, large-scale use of wastewater for the irrigation of tree plantations or forests is still relatively limited and, where it is practised, it is generally more for reasons of waste disposal and treatment rather than for enhanced forestry production. The use of TWW for forest irrigation has become an option in most of the countries of the region. However, the cost of treatment using conventional methods is prohibitively high for most developing countries. As a result, countries are experimenting with other forms of treatment, among which are land application methods, including irrigation of forest plantations. When practised properly, these are simple, low-cost and effective means both to dispose of water and to improve quality of forest plantations (Braatz and Kandiah, 1996).

USE OF TWW IN FOREST PLANTATIONS IN SELECTED COUNTRIES

Egypt

7 In Egypt, where wastewater is estimated at 4,930Mm^3/year, there are 22 wastewater treatment plants, and there are about 150 plants under construction (Hamdallah and Gawhari, 2000). No guidelines have yet been adopted but the 1984 law regulation prohibits the use of effluent for irrigating crops unless treated to the required standards of agricultural drainage water. The irrigation of vegetables eaten raw with TWW, regardless of its quality level, is forbidden. Crops chosen for cultivation using sewage effluent are those that cannot be contaminated, such as trees grown for wood products. Some communities in Egypt already use sewage or drainage water after primary treatment to irrigate woodlots. The most commonly used species are *Casuarina glauca*, *Eucalyptus camaldulensis* and *Tamarix aphylla*. These provide for local fuelwood consumption and the production of poles for sale in the local markets (El Lakany, 1995). The first tree plantation using TWW in El-Gabal El-Asfar farm (about 30 km from Cairo) was established in 1911 to dispose of the city wastewater. Certain wastewater treatment plants such as El-Gabal El-Asfar and El-Berka in Cairo produce tertiary treated wastewater that can be safely used for irrigation of timber trees and other types of plantations (Omran, 1996). The Undersecretariat for Afforestation and Environment of the Ministry of Agriculture and Land Reclamation is taking the responsibility for establishing tree plantation irrigated with TWW around cities for greening the urban areas and producing timber. The afforestation activity started in earnest in 1994 in Luxor where 200 Feddans have been planted with *Morus spp* and *Khaya ia senegalensis* in a furrow irrigation system. Secondary treated wastewater is the main water source for this site. There are many other sites in Ismailia, Sadat City, Qena and Edfo where Mahogany (*Khaya senegalensis*), Neem (*Azadirachta indica*), *Cupressus* and *Casuarina* are used. Egypt has cooperated with many countries and international agencies in this endeavour. FAO supported the initiative through the TCP project TCP/EGY/7821 (Preparation of a National Tree Planting and Development of Peri-Urban Forestry Plan) which helped in improving technical aspects in the implementation of the plantations and in drafting proposals for continuation.

Jordan

8 The wastewater produced in Jordan is reported at 300 Mm^3 and the volume of TWW available was 50 Mm^3 in 1993 and 69 Mm^3 in 1995. At present, Jordan has 16 major wastewater treatment plants. Arable land makes up less than 50% of the 89.2 thousand Km^2 area and low quality forests cover 1% only. Irrigated agriculture area is 69,900 ha, 49% of which is located in the Jordan rift valley. The other main irrigated area is in the highlands and Badia (desert) region.

9 The main irrigated plantings include *Eucalyptus* plantations which are generally small areas, scattered and under five years of age; and *Casuarina*, *Cupressus* and *Tamarix* (Azraq basin) windbreaks and shelterbelts which are irrigated primarily by furrow systems. *Eucalyptus* plantations can be utilised at 8-10 years rotation in Jordan valley conditions where the growth in the best sites is (25 m^3/ha/year) and in less fertile soils (15-18 m^3/ha/year). In the uplands and Badia the rotation for *Eucalyptus* is 10-12 years where growth is 15-18 m^3/ha/year on good soil conditions. In less favourable conditions this growth ranges between 10-12 m^3/ha/year. For *Casuarina* and *Cupressus* in the Jordan valley conditions the most suitable rotation period is 20-25 years where growth is 5-8 m^3/ha/year. The cost of establishment of *Eucalyptus* plantations varies from JD.541/ha in the Jordan valley to 596 JD./ha in the highlands. Watering is the major cost component. In the case of windbreaks, which have the most potential in irrigated areas, the cost of establishment is JD.162/Km in the Jordan valley and JD.207/Km in the Highlands.

10 According to cost/benefit analyses forest plantations under irrigation, can not compete financially with agriculture as a viable land use for wood production only. However, taking full consideration of the environmental and wider economic benefits, forest plantations are a wise choice for solving disposal of treated sewage water (Abu-Setta, 1996).

Kuwait

11 Untreated sewage has been used for many years to irrigate forestry projects far from the inhabited areas of Kuwait. Effluent from the Giwan secondary sewage treatment plant has been used to irrigate plantations on an experimental basis since 1956. Two shelterbelts of *Tamarix aphilla*, *Eucalyptus camaldulensis* and *Acacia salicina* were successfully established. Following extensive studies by health and scientific committees within the country and by FAO, the government of Kuwait decided to proceed with a program of sewage treatment and effluent use. In all, by 1987 four sewage treatment plants were in operation: the 150,000 m^3/day Ardiyah sewage treatment plant (secondary stage) was commissioned in 1971; the 96,000 m^3/day coastal villages and the 65,000 m^3/day Jahra sewage treatment plants were commissioned in 1984 and a small (10,000 m^3/day) stabilisation ponds treatment plant has also been installed on Failaka Island.

12 Wastewater can not be used for amenity uses and for agricultural crops. Furthermore, the area of tree and shrub planting and the agricultural farm have to be fenced to prevent public access. An efficient monitoring system for the treated effluent, the soil and the crops has been implemented since the experimental farm was initiated.

13 The Ministry of Public Works has initiated the preparation of a Master Plan for effective use of all treated effluent in Kuwait, covering the period up the year 2010 (Cobham and Johnson, 1988). Implementation of the plan began in 1985. The first priority is the production of fodder and hay and vegetable crops. The second is the development of environmental protection forestry and commercial timber production is to be developed if trials prove successful. The overall Master Plan is based on modern irrigation techniques, strengthening of shelterbelts and provision of adequate effluent storage facilities. The ultimate project design provides for the development of 2700 ha of intensive agriculture and 9000 ha of environmental forestry (shelterbelts and sand dune stabilization trees) and 213 ha of commercial forestry by 2010. The projected use of wastewater by 2010 is 125 million m^3, up from 27 million m^3 used in 1985 (Cobham and Johnson, 1988).

Yemen

14 It is estimated that some 74 Mm3/year of effluent will be potentially available for reuse in the near future and that up to 15,000 ha of land will be irrigated with treated wastewater. There is no formal national policy on wastewater reuse, although the practice is encouraged by officials in the Ministry of Agriculture and Water Resources. In the absence of a formal policy and governing legislation with appropriate regulations, reuse is widespread through private initiatives with limited surveillance and public health safeguards. Irrigation with wastewater in forestry plantations is

practised in Yemen. The principal species used for windbreaks and roadside plantations are *Acacia cyanophylla*, *Casuarina cunninghamiana* and *Eucalyptus camaldulensis* (Omran, 1996). The first plantation irrigated with wastewater was established at Aden on 7 ha as a part of a green belt around the city. Treated wastewater was transported by tankers. Also in Al-Hodeydah, the local Tihama Development Authority has sponsored various studies for developing a multi-layer crops and trees area using treated wastewater. A project began in April 1995 to establish a green belt around Al-Hodeydah city along 7 km of the Al-Hodeydah - Jizan road and along 7 km of the Al-Hodeydah - Sana'a road to the east. The total length of the belt is about 14 km and the width is 100 metres and species used are the same as above with the noted addition of *Conocarpus lancifolia*. The activities earlier developed with the support from FIDA are being continued within the Watershed Management and Waste Water Reuse in Peri-urban Areas of Yemen (GCP/026/Net).

Other Countries

15 TWW is used in various degrees in establishing forest plantations, greenbelts and stabilization of sand dunes in many other countries of the region. These include Sudan, Kingdom of Saudi Arabia,the United Arab Emirates, Dubai, Sharjah and Qatar.

HEALTH CONCERNS

16 There are genuine concerns about infectious agents from raw wastewater such as bacteria (eg. *Salmonella, Mycobacterium, Clostridium leptospira, Escherichia coli,* and *Pseudomonas*); protozoan parasites (eg. *Entamoeba histolica, Giardia lamblia* and *Cryptosporidium spp*.); helminthes worm parasites (eg. *Schistosoma haematobium, Schistosoma mansoni* and *Ascaris lumbricoides*); and a wide variety of viruses capable of producing infection or disease eg. entroviruses such as polio, rotaviruses and hepatitis viruses (Hurst et al. 1989). However, with TWW or where pretreatment is available, the risk of disease and environmental damage is significantly reduced. The irrigation of trees and forest plantations poses fewer health risks and is more socially acceptable than the irrigation of agricultural crops (Braatz and Kandiah, 1996).

CONCLUSIONS

17 Generally, the inclusion of planned TWW reuse in water resources management systems reflects the application of complementary developments in technology, health risk understanding, and public health acceptance to mitigate limitations imposed by the increasing scarcity of water resources.

18 Different problems and constraints have been reported such as the inadequate planning of the wastewater reuse projects, the insufficient resources to monitor and control treated effluents and products, insufficient medical control of workers, some equipment and management problems, and inadequate education, training and extension services.

19 Although some countries have had long experience in the use of wastewater and TWW for irrigation, historically, the objective has been largely disposal-oriented. Only relatively recently has greater emphasis been put on the productive and purification aspects of the practice. The prevailing tendency has been to allocate wastewater to agricultural uses. Existing quality standards and guidelines for wastewater use and TWW use in irrigation apply to agricultural crops; no detailed standards and guidelines have been developed for trees and forest plantations. There are compelling reasons to examine more closely the feasibility or irrigating trees and forests plantations with wastewater. These include: health factors (the reduced risk compared to food crop contamination with pathogens or heavy metals); environmental considerations (benefits provided by greenbelts and other urban and peri-urban forestry plantings, conservation of water resources, rehabilitation of desert

lands); economic benefits (the value of forest products and environmental services); and social and aesthetic values (Sorour, 2001 and Braatz and Kandiah, 1996).

20 Issues related to use of TWW in agriculture and forestry require inter-sectoral collaboration. In the region the main institutions are:

- the Ministry of Agriculture and/or Forestry is responsible for the overall planning, the installation and operation of irrigation infrastructure, the management of state-owned lands, the agriculture extension, the control of marketing and assist in preparing national standards.
- The Water & Wastewater Authorities is responsible for wastewater collection, wastewater treatment, pre-treatment of any industrial wastewater before discharging into the municipal wastewater treatment plants and to achieve wastewater effluent quality, which complies with the recommended guidelines and standards.
- The Ministry of Health is responsible for health protection, health education, disease surveillance and treatment and it also assists in preparing national standards.

21 The national standards should consider the current situation of the wastewater treatment plants in the Near East Countries and the problems, which they suffer from. In many cases, wastewater quality standards have been adopted from other countries with no consideration of their suitability for local conditions. Borrowing over-stringent standards can cause an unnecessary fear of prosecution or disease and thus squander resources by discouraging reuse of TWW. For example, it is not suitable for the Near East countries to adopt the wastewater standards of other developed countries, where they use tertiary treatment processes and implement restricted guidelines to achieve several reuse purposes. A more realistic set of standards, which are totally adequate to safeguard public health, would be based on the WHO and FAO guidelines (Sorour, 2001).

ITEMS FOR CONSIDERATIONS OF THE NEFC

22 Given the forgoing, members of the NEFC may wish to consider the following:

- design of an integrated inter-sectoral TWW strategy with supporting legal, policy, regulatory and planning framework with identified responsibilities to optimise the net benefits from implementation of TWW reuse, including in forest plantation development;
- establishment of an executive body, such as an interagency technical standing committee, under the aegis of a leading ministry, supported by an inter-ministerial committee to give policy directions on issues;
- preparation of national standards or quality guidelines for the re-use of TWW for agriculture and forest plantation irrigation, taking into account the legal and regulatory framework (eg. environmental pollution, water quality, food hygiene and occupational health);
- establishment of monitoring data and reporting systems, including responsibilities for enforcement and penalties for non-compliance with standards; and
- exchange of of lessons learned within the region in the use of TWW in forest plantation development supported by networking and technical meeting opportunities;.

23 Should members decide to pursue initiatives related to the re-use of TWW for forest plantation development within the region, the FAO is ready to further support the NEFC in its efforts.