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Strategies for Increasing Wastewater Reuse Opportunities in Small Communities in the Southern Mediterranean Region Countries

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STRATEGIES FOR INCREASING WASTEWATER REUSE OPPORTUNITIES IN SMALL COMMUNITIES IN THE SOUTHERN MEDITERRANEAN REGION COUNTRIES

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ABSTRACT

Small communities of the Southern Mediterranean Region countries are generating increased volumes of wastewater which require adequate sanitation practices and systems. Effluents may be reused after appropriate treatment for different purposes. However, suitable solutions to sanitation-reuse-disposal are generally site-specific and community-specific. They require proper planning and management as well as consideration of technical and economic capabilities, institutional, legal, social and environmental conditions. Some propositions for wastewater collection, treatment and reuse approaches for these areas are presented.

INTRODUCTION

In the small communities of the Southern Mediterranean Region countries, increasing volumes of wastewater. which require adequate treatment to prevent health risks and environmental degradation, are generated. Due to unplanned development, lack of funds, limited access to existing technologies and low level of technical expertise, these populations suffer from inadequate sanitation practices and systems. Many residents have no acceptable sanitation systems and domestic or industrial wastewaters are discharged untreated into the receiving environment. These effluents are causing diffuse pollution, major eutrophication threat to downstream waters and health hazards. Uncontrolled and direct reuse of raw wastewater is often taking place in the vicinity of these areas to irrigate vegetable crops sold in the markets. Such a practice is a major threat to public health and should be discontinued through installation of local treatment facilities. Technologies for wastewater treatment and reuse that can be locally and properly operated and maintained should therefore be adopted.

The provision of environmentally sound systems for water supply, wastewater treatment and discharge for such areas requires an integrated approach. However, several prerequisites must be satisfied such as (i) appropriate water supply, sanitation, treatment and reuse systems in order to reduce water-related diseases and environmental degradation, (ii) ways of minimising net water consumption, (iii) means for closing the water and materials cycles, such as reuse of solid and liquid wastes as much as possible after adequate treatment and careful control, (iv)

an institutional and legal framework, and (v) a high level of engineering expertise. Several key questions need to be addressed, such as what kind of appropriate sanitation can be provided to the small communities? Where and how can reclaimed water and other materials cycles be closed? Which institutional settings are suitable for sanitation and reuse in such areas? Which engineering capacity needs should be developed?

In view of the above, this paper aims at discussing strategies for increasing wastewater reuse opporttmities in small communities in the Southern Mediterranean countries.

I. WASTEWATER PLANNING AND MANAGEMENT IN SMALL COMMUNITIES

In the small communities of the Southern Mediterranean countries, population is either connected to a water supply system through house connections or relies on standpipes and public or domestic wells. Water supply, sanitation, treatment, reuse, and disposal have been managed separately and planned and designed for different time-scales. The links between these different water and wastewater components as well as the way to solve problems related to them require re-thinking and new approaches.

Decentralised wastewater management. In the case of the small communities, dcccntralised wastewater systems can collect and treat wastewater locally while using appropriate technologies. Different treatment processes and consequently different reuse options may emerge from this approach. Local recycling and reuse may reduce the total water withdrawal. Smaller amounts of wastewater flows will be generated and more easily controlled; less cnergy might he consumed and less sludge produced (Harremoes, 1997). Transfer over long distances may be avoided. The technical, institutional and economic aspects of the question require the development of appropriate strategies and qualified bodies for local implementation and management of treatment and reuse projects (Tchobanoglous and Angelakis, 1996). Such projects could be designed to complement classical centralised large-scale systems.

From an end-of pipe to a source approach. The most frequent approach is, up to now, the centralised sewerage system. The end-of-pipe technology reduced or eliminated, in a first step, problems such as water-borne diseases, eutrophication, etc. However, it also transferred pollution from one place to another when it would often be more convenient to remove pollutants closer to pollution sources. Since wastewater may be recycled or reused for different purposes, wastewater quality should be protected from different kinds of pollution sources. Major pollutants such as persistent trace organics, trace minerals, and radioactive components, which might affect human health through the food chain, should be prevented from being discharged into public sewers. Pollutants should be removed at the source and, to the extent feasible, be retained in closed-loops and reused within the industry by which they are produced (Goodland and Rockefeller, 1996). Many industrial pollutants can be removed more easily in their concentrated form at the source than in a dilute from after introduction into a municipal sewer system. Some industrial or commercial pollutants are toxic to biological systems commonly used for municipal wastewater treatment. Treatment at the source is then required to minimise costs and environmental exposure to hazardous materials and to protect the integrity of municipal wastewater treatment systems. Realistic regulations for the discharge of industrial wastewaters have to be set up and, moreover, really enforced in order to protect treatment plants and prevent the accumulation of potentially toxic compounds in the soil and groundwater aquifers. In order to facilitate recycling and reuse schemes,

discharge of industrial waste in public sewers must be minimised. Use of clean production and energy- and water-saving processes and technologies have to be promoted. Waste material composition will then be closer to that of reusable products.

Sanitation in small communities. A small percentage of households located in the small communities are connected to a collective sewage system or have on-site sanitation facilities (dry-toilet, composting toilet, cesspool, septic tank and subsurface infiltration). With the tendency of scattered populations to cluster more closely together and to get connected to the water supply network, the issue of the safe evacuation of wastewater is becoming a matter of pressing concern. On the other hand, extending the area covered by public sanitation systems is costly. In addition, only a small percentage of septic tanks is appropriately sited, designed, constructed, maintained and connected to an efficient soil infiltration system. On-site facilities create the most acute problems because they pollute, in most cases, aquifers or watercourses. Moreover, because of inadequate water quality and insufficient water quantity, on the one hand, and lack of sanitation facilities or improper disposal, on the other hand, the population is exposed to water-borne and faecal diseases.

For social equity and environmental concerns, there is a need to consider appropriate sanitation and treatment systems for these communities. Appropriate technologies, that are suitable to a particular socio-economic context, may be conventional appropriate technologies or advanced or sophisticated appropriate technologies. They require supporting industries and logistics or new technological solutions. They have to be affordable, operable, and reliable (USEPA, 1992; Kreissl, 1997). Low technologies often consistently reach the standards. Using a combination of different high and low technology solutions (Dodds et al., 1993), depending on local conditions, the siting, etc, will help to solve the problem in a sustainable and environmentally sound manner.

Therefore, systems that do not harm environment and provide proper treatment should be developed. A wide range of potential wastewater treatment methods are available and several unconventional and low-cost wastewater technologies could be implemented for individual and collective (combination of composting toilet and greywater treatment) sanitation systems (Niemczynowicz, 1994; Rose, 1999). The economics of collection systems required for such methods of segregating sanitary streams are, however, still major constraints (Braden and Ierland, 1999). Because each area is unique, there is a need to establish different kinds of sanitation facilities for each set of technical, economic, environmental, and institutional conditions. Implementation of source reduction, source separation, and resource recovery and recycling technologies may then be accomplished.

Since conventional gravity sewers constitute the major part (80-90%) of the total cost of wastewater facilities, it would be beneficial to look for alternative collection systems (with small diameter and lightweight piping buried at shallow depths). Where land is available, natural systems such as waste stabilisation ponds or constructed wetlands may be applied. These reliable and cost-effective systems may be easily managed, are simple to operate, and require minimal energy. Land treatment techniques could also be implemented, such as rapid infiltration, overland flow, slow rate or subsurface infiltration. These processes can meet both the objectives of treatment and reuse. Infiltration-percolation systems may be applied when hydrogeological conditions are favourable. Sanitary precautions would have to be considered in the event of groundwater use for domestic water supply, however, and soil capacity to absorb and attenuate pollutants has to be evaluated for each site where a land treatment system is to be implemented in order to provide for a pre-treatment system, if necessary.

Adaptation and standardisation of some unconventional processes still needs to be done.

There might also be opportunities for the design of sanitation systems using local materials, technology, and know-how. Systems combining natural and conventional systems or based only on conventional practices may be used when land is not available or in the case of topographical or others constraints. Land application of sludge may also be practised after proper treatment. As regulations are more and more stringent, the amount and the quality of sludges produced by wastewater treatments are becoming a key factor of the choice of a treatment system.

The planning and management of small community systems are among the most important issues and institutional, organizational, regulatory, socio-economic, policy pricing, environmental, and technical aspects should be considered. For the sake of efficiency, for the future planning and implementation of sanitation projects, alternative options have to be examined with the involvement of the inhabitants. Responsibility for wastewater management should be granted, with the involvement of communities, to municipalities or to a special agency that would link water supply, sanitation and reuse strategies.

II. WASTE WATER REUSE OPPORTUNITIES IN SMALL COMMUNITIES

Reclaimed water may be used for different purposes depending on the water demand and the water quality. Small communities have to be supplied with water, food, and other goods provided by the surrounding or other areas. Since several activities do not require water of potable quality, reuse of reclaimed water and nutrients recycling may be substituted for conventional resources. Wastewater also constitutes a reliable resource as wastewater is discharged at a more or less constant rate throughout the year and as its volume will increase with activities development.

In the Southern Mediterranean Region countries, where 60 to 80% of national water resources are for irrigation, agricultural reuse is, together with saline water desalination, a major way of reducing pressure on the fresh water resources. Irrigation development may also create jobs, increase income and enhance food security.

2.1. Agricultural reuse

Agricultural development is based on water and land availability, which usually are the main limiting factors and which require adequate water and land management plans. As reclaimed water conveyance and distribution are major costs in reuse projects, distribution should be done at the smallest scale to minimise the costs. Treatment plants should be sited by taking the location of potential reuse sites into account with the agreement of the community members.

Storage. The use of reclaimed water for agriculture requires both seasonal and long-term storage. Storing reclaimed water, in reservoirs or aquifers, leads to more reliable supplies (meet peak demands), water quality improvement, an increase in the rate of reuse, and a better protection of water bodies. Building reservoirs in which a few days effluent production can be stored would allow matching daily variations in irrigation water demand, increase the

reliability of water supply, and upgrade water quality to meet guidelines for unrestricted irrigation. On the other hand, as demand for irrigation water is mainly during the dry season, seasonal storage during the non-irrigation period would increase reclaimed water reuse and prevent coastal waters contamination.

Effluent quality. Agriculture may be integrated, as a land treatment system, into the treatment cycle and considered as the nutrient recycling part of the loop. The soil may act as a bioreactor and attenuate contaminants. The water used for irrigation purposes should however meet quality requirements. Irrigated areas are devoted to the production of different crops, vegetables being highly rated. If reclaimed water is going to be reused to irrigate fodder crops, field crops (cereals, industrial crops) or forest trees, a secondary treated effluent should be of sufficient quality. For vegetables eaten raw, fhrther wastewater treatment is required for public health protection. In order to provide an effluent of the desired quality, secondary effluent quality has to be improved through different processes such as maturation ponds, surface or underground storage, disinfection, etc.

Irrigation management In the Southern Mediterranean Region, sewage effluents are often salt-affected. This implies specific management measures such as the selection of agricultural crops resistant to lower water quality, the selection of the most appropriate irrigation and drainage techniques (application of a leaching fraction, etc.), the adoption of specific cropping techniques, etc. (Ayers and Westcot, 1985; Pettygrove and Asano, 1985; Kandiah, 1990). Water and salt leaching requirements need to be known more precisely to avoid water losses and more studies on solute transport have to be conducted to prevent groundwater pollution. By an appropriate scheduling of leaching (autumn or winter during the rainy period), less water is needed to obtain a good leaching efficiency.

However, the major problem is generally first to improve water use efficiency. This may be achieved through a more accurate knowledge of crop water requirements for irrigation scheduling and the use of water saving application methods. Reuse of wastewater and protection of public health may be achieved through a right combination of wastewater treatment, crop restrictions, application methods, and human exposure control (WHO, 1989).

Nutrients supplied by effluents may match crop requirements. Through reuse, nutrient savings and recycling may be achieved. It is, however, required to determine optima] cropping patterns and sequences for the best use of water and nutrients and to prevent over-fertilisation problems and groundwater pollution (Bouwer, 1990).

Use of sewage sludge and other by-products. Several by-products such as sewage sludge, agro-industrial effluents, etc may be used beneficially for crop production and will lead to carbon, nitrogen and other nutrient recycling (Bahri, 1995; Chaussod, et al. 1997). To the extent that reuse applications would require less wastewater treatment than surface water disposal, there may be less production of sludge that would have to be transported to the application fields or disposed of

2.2. Other urban reuses

Wastewater may be reused for municipal purposes such as landscape irrigation (parks, green areas, golf courses, etc), recreational and environmental uses, industrial uses, groundwater recharge, and other water uses (Asano and Levine, 1996). Advanced technologies must be

applied and for microbiological safety, technologies such as UV disinfection and membrane processes may be required (Mujeriego and Asano, 1998).

III. RECOMMENDATIONS FOR A WASTEWATER REUSE STRATEGY FOR SMALL COMMUNITIES

Several water strategies that include policy statements on management of wastewater, including reuse have been issued. However and apart from national standards that have generally been released specifying the quality standards required for various wastewater uses, a more detailed strategy, specifically for the small communities, needs to be formulated to put these policies into effect and for further development of reuse practices.

Recommendations for a wastewater treatment/reuse strategy for small communities include the following steps. This strategy should be developed with the following considerations for technology selection, facility planning process, environmental impact assessment, and a sustainable community awareness component.

A wastewater reuse strategy for the small communities should be based on the following principles:

- lmprovement of the populations quality of life.
- Public health and environment protection.
- Reuse projects must meet a real water demand.

This strategy should also be based on:

- Appropriate water quality standards for the different uses
- A relevant regulation urging the users to comply with the requirements and to carry out a regular sanitary survey.
- Clarified and identified responsibilities of the different stakeholders.
- An efficient quality control programme for all the uses.

However, responsibility for wastewater management should be granted, with the involvement of communities, to municipalities or to a special agency that would link water supply, sanitation and reuse strategies. The institutional framework requires the definition of the responsibilities of the different stakeholders.

- An integrated management of water resources, solid and liquid wastes is required for the small communities.

- A strategy plan for water, sanitation and reuse should be developed for the small communities, which have significant needs in this area as well as opportunities for reuse. Land treatment processes can play an important role in matter of sanitation in small communities.

- Protection from traditional and non-traditional pollution sources is required through collection and treatment of domestic and industrial wastes and watershed management.

- The reuse potential should be assessed in a wastewater resources management plan in terms of both agricultural and non-agricultural end uses and the expected benefits of each option quantified. Reuse projects should be demand driven.

- Before designing a wastewater treatment plant, the wastewater reuse options should first be considered. The wastewater treatment process should depend on the final reuse of the water.

- The reuse and discharge wastewater quality standards should be in compliance with the intended reuse and the economic conditions. Where possible wastewater treatment, technology standards should be developed which assure suitable effluents with minimum requirements for monitoring and enforcement.

- The initial selection of the location of the treatment plant site should be based upon the location of future reuse sites with the community agreement.

- Surface or underground storage sites should he developed. Reclaimed water storage, both in a seasonal and interseasonal basis, will result in more reliable supplies, water quality improvement and hence will increase the rate of reuse. Overdrawn aquifers should be the first targets for underground storage operations.

- An adapted wastewater pricing policy should be set up with a simple and flexible cost recovery system.

- The authority responsible for approving wastewater/reuse systems should be determined and should include the different stakeholders.

- Technologies for wastewater treatment that can be properly operated and maintained should be adopted.

- Control of reclaimed water is an essential prerequisite for wastewater reuse, as users have to be provided with reliable and stable quality and quantity. Therefore, the authority responsible for monitoring and enforcement of use of reclaimed water for beneficial uses need to be determined.

- lnstitutional and organisational measures between the wastewater treatment body and the reclaimed water users guarantying a water quantity and quality level should be identified.

- Creation of local water users association responsible for water management should be encouraged.

- Wastewater reuse demonstration projects for agricultural, aquacultural and groundwater recharge purposes should be conducted concurrently with public awareness campaigns to educate the users.

- A research program in the field of reclaimed water reuse and sewage sludge application covering the different reuse opportunities should be developed.

- Training programs for the agricultural extension technicians should be developed in the different aspects of reuse, technical, environmental, socio-economic aspects, and especially those related to health issues.

- Public education programs oriented toward public health and proper management of effluent use in agriculture (education and sensitisation campaigns) should be conducted for farmers.

CONCLUSION

Wastewater management in the small communities of the Southern Mediterranean countries requires site-specific and community-specific strategies. An approach to water management and wastewater reuse integrating water supply, wastewater collection, reclamation and reuse needs to be developed in which final water end uses would determine the choices to be made.

Several challenges have also to be overcome:

- A source control program has to be set up for water quality protection.

- Innovative wastewater treatment processes should be developed, especially energy-saving ones, which allow the achievement of appropriate technologies. Alternative options have to be examined with the involvement of the inhabitants.

- Reuse projects will depend on the planning and management of reuse operations, i.e. the way technical, socio-economic, regulatory and environmental factors are taken into account; a specific institutional and organizational setting is required. Technical and administrative aspects need also further study, along with empirical research for specific applications.

- Codes of good agricultural practices for agricultural reuse could assist farmers in reusing reclaimed water.

- Education, information, and training of farmers may also play an important role in promoting reuse practices aiming to achieve higher agricultural production without adverse impacts on the environment.

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