Positive aspects of the use of water: the reuse of urban wastewater and its effect on areas of tourism

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Positive aspects of the use of water: the reuse of urban wastewater and its effect on areas of tourism

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SUMMARY - The object of the present document is to describe the recently installed infrastructure for the reuse of wastewater for agricultural purposes from the city of Santa Cruz de Tenerife. It also summarizes the present work for studying the performance of these installations within the framework of the Project for the Monitoring of the Introduction of Irrigation with Treated Water from the City of Santa Cruz de Tenerife, in the San Lorenzo Valley (Tenerife. The Canary Islands).

Key Words: Wastewater, reuse, irrigation, hydrological planning, areas of tourism.

RESUME *- La présente communication a pour objet de décrire l'infrastructure de réutilisation d'eaux résiduelles de la ville de Santa Cruz de Ténerife pour usages agricoles récemment implantée. Elle résume aussi les divers travaux actuellement en cours pour l'étude du comportement de ces installations dans le cadre du "Projet de Suivi de l'Implantation de l'Irrigation avec des Eaux Dépurées de la Ville de Santa Cruz de Tenerife dans la Vallée de San Lorenzo" (Ténerife. Îles Canaries).*

Mots-clés: *Eaux résiduelles, réutilisation, irrigation agricole, planification hydrologique, zones touristiques.*

INTRODUCTION

The known axiom that in certain world regions "water is a scarce and limited resource" is specially relevant in areas where as a result of their climatic characteristics, there is a clear competition between high productive agriculture and an important tourism offer.

The simplified diagram (it does not consider other uses) proposed in Fig. 1 represents a former period when the highest water demand was required by agriculture which was the main source of wealth. Urban water demand was much smaller and wastewater was disposed of without further use. On the other hand, it is also true that neither the flows nor the pollution produced were important.

From this starting point, new problems arrive as time goes by. Regions which are capable of holding a competitive and high intensive agriculture are at the same time very attractive for tourism. This implies an increase in population that, along with an improvement in the quality of life, has supposed an important increase in domestic water demand to the detriment of agriculture, that does resist to the loss of its historical rights.

Therefore, this is the way in which dramatic competition is established between agriculture and tourism, two sectors that have an undoubtable and important influence on the National Trade Balances.

The problem in these areas is often associated with the fact that the scarce water resources come mainly from aquifers in which overexploitation drives to a decrease in water quality making it no potable and not always suitable for agricultural use.

To cope with these changes on demand, it is necessary the application of new technologies able to optimize the available resources allowing an integral water exploitation.

The new situation is represented in Fig. 2, putting *special emphasis on the importance of the reuse of* urban wastewater, which has reached an important magnitude in terms of flow, given the one needed to cope with urban demand.

The treatment technology applied to urban wastewater must ensure for the reclaimed water an adequate quality for the irrigation of the existing crops.

The main objectives that may be achieve are:

i. An exploitation of these reclaimed flows in agriculture that will result in a higher availability of fresh water for domestic supply in cities with an increased demand due to tourism.

ii. The elimination of the negative environmental impact produced by the pollution by means of control and treatment of the disposed urban wastewater.

The problems above mentioned are mainly located in Spain at the South-eastern Mediterranean Coast and The Balear and The Canary islands.

The case study here presented on the reuse of the reclaimed water of Santa Cruz de Tenerife (Canary Islands) is an example of an outstanding technological solution. A brief description of the implemented infrastructure, the monitoring plan, the evaluation and the compiled experience has been included.

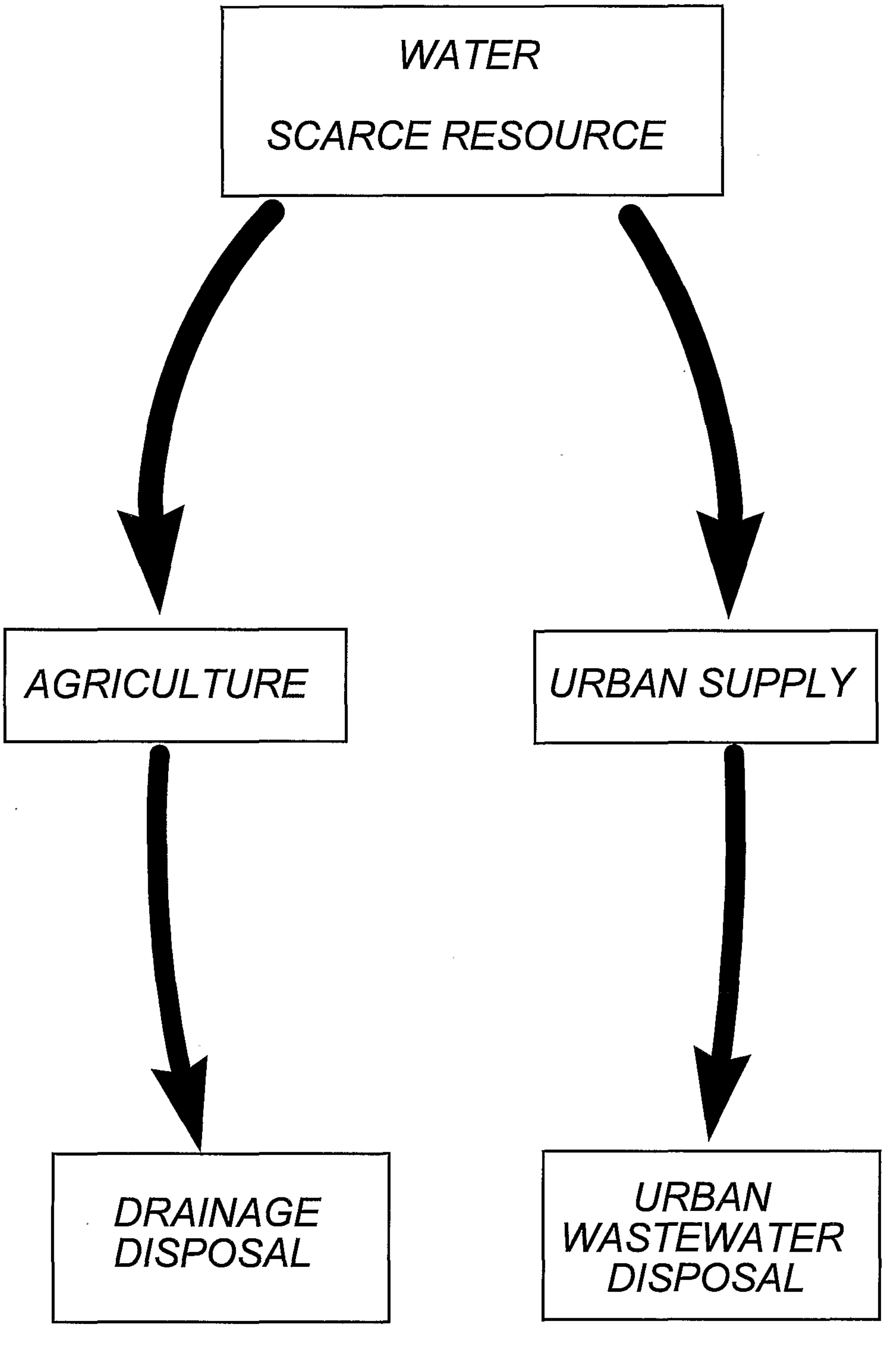

***Fig. 1** - Former scheme of the water use*

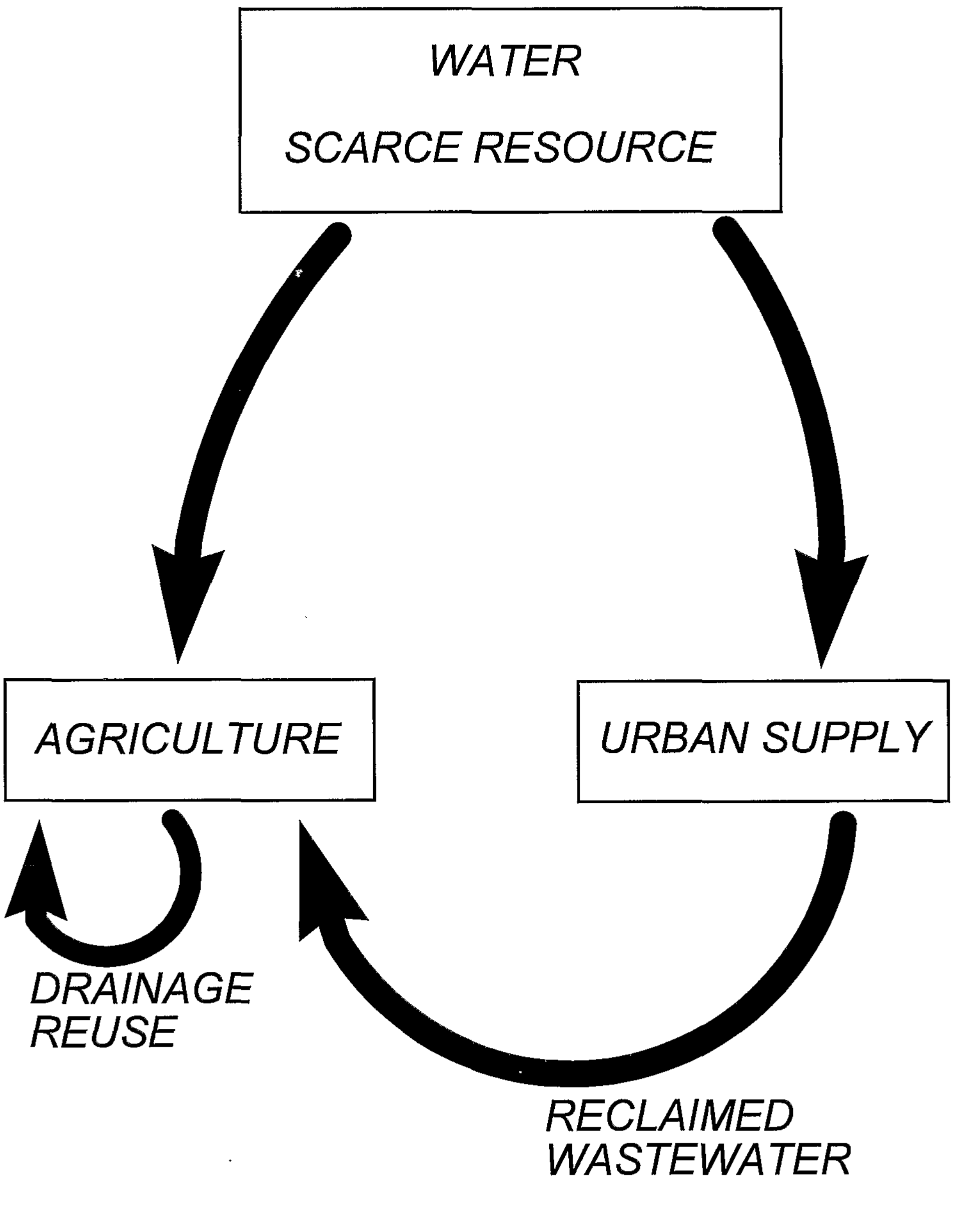

Fig. 2 - Current scheme of the water use

BACKGROUND

The Island of Tenerife, with a surface area of 2.058 square kilometres, is the largest of the seven that make up the Canary Island Archipelago. Its economy is based on the Tertiary sector, especially on tourism. However, agriculture does represent an important sector for the population of 630.000 people.

The surface area under irrigation is 12.400 hectares, of which 5.100 are dedicated to banana production, 1.500 to tomatoes and the rest among various crops, notably avocado, citrus fruits, various tropical fruits and ornamental plants.

Water in the Canary Islands is a scarce natural resource indispensable for the majority of economic activities. The annual total volume of water resources on Tenerife for the year 1991 was 212 cubic hectometres, of which 109 were used for irrigation, making it the highest consumer activity on the island (53%).

The *Island Hydrological Plan* estimates that to be able to meet the requirements for the year 2,000 (230 hm^3/year), 25 hm^3/year of treated urban wastewater have to be reused.

The advantages of re-using treated water range from avoiding third stage treatment for the elimination of nitrogen and phosphorous, reducing dumping at sea in accordance with the European Union environment policy, reducing the use of chemical fertilizers in agriculture, to what is most important in these islands, that is availability of a new resource within the hydrological planning. This programme will enable the future demands for potable water in such areas as tourism to be met.

With the completion of construction in 1979 of the wastewater treatment plant for the city of Santa Cruz de Tenerife, *The Santa Cruz de Tenerife Treated Wastewater Reuse Project*, was launched. In this project, the Ministry of Transport & Public Works (Ministerio de Obras Públicas y Transportes, M.O.P.T.), the National Institute of Agricultural Development and Reform (el Instituto Nacional de Reforma y Desarrollo Agrario, I.R.Y.D.A.), the local Government of The Canary Islands and the Island Town Council of Tenerife (el Gobierno de Canarias y el Cabildo Insular de Tenerife) all collaborated. It incorporated a number of works with a total budget of 50 million dollars, executed between 1984-1993, including transporting the water to the San Lorenzo Valley Pond (66 Km) and its later distribution from a regulating reservoir (250.000 m^3) via a network (41 Km), to a total of 230 agricultural areas, the best on the Island, totalling more than 750 hectares under cultivation, fundamentally banana.

The Tenerife Ponds Local Autonomous Organism (El Organismo Autónomo Local Balsas de Tenerife, BALTEN), assigned to the Tenerife Island Town Council, is responsible for the management of the whole infrastructure, with the object of encouraging the introduction of irrigation with treated water in the San Lorenzo Valley. With this objective in mind, BALTEN has designed a number of activities integrated in the *Project for the Monitoring of the Implementation of Irrigation with Treated Water from the City of Santa Cruz de Tenerife, in the San Lorenzo Valley* (BALTEN, 1993b), which can be outlined as follows:

i. Monitoring of all the elements integrated in the system.

   Wastewater treatment process.

   Feeder, storage and distribution of the treated water.

   Irrigation with treated water.

ii. Environmental impact assessment.

   Assessment of pathogen risks for the fruit and for the system users.

   Aquifer contamination.

   Modifications of the soil.

iii. Pilot test.

   Establishing norms for irrigation with treated water.

   Conclusions and recommendations for similar initiatives which may be deve-l oped in the Canary Islands and in the rest of the country.

Although activities in this field are not new in our country and less so elsewhere in the world, we are aware the circumstances occurring in Tenerife are quite unique. It is not easy to find an agricultural area such as the San Lorenzo Valley (2.500 hectares), where more than 230 farms are dedicated fundamentally to the cultivation of bananas, (750 ha) with state of the art irrigation techniques and with a high percentage in plastic greenhouses (39%). The yearly irrigation quota provided fluctuates between 15.000 and 20.000 m^3/ha.

There is a 16.000 m^2 experimental area in the valley itself beside the pond regulating reservoir, fully equipped with regulating reservoirs, filters, greenhouses, meteorological stations, etc. This property is the place where new techniques to improve the use of this water may be tested and used as an exhibition and demonstration area for farmers.

In conclusion, the Project described here represents the start of the use of a new water culture in an area with difficulties not exclusive to island territories, but are repeated in the entire Mediterranean Basin and in arid countries.

DESCRIPTION OF THE INFRASTRUCTURE

The reuse infrastructure which is currently being completed (distribution to farms) began in 1979 after the termination of the wastewater treatment plant in Santa Cruz de Tenerife. It contains the elements shown in Fig. 3. (BALTEN, 1993a):

The Wastewater treatment Plant in Santa Cruz de Tenerife.

The Santa Cruz de Tenerife plant treats the wastewater and part of the run off from the urban centre and the suburbs.

The pre-treatment plant, situated practically at sea level, receives a flow of approximately 35.000 m^3/day. It has a coarse and fine auto-cleansing unit made of parallel rods and a grit removal unit. It also has an overflow structure and general by-pass with submarine disposal.

The pre-treated wastewater reaches the wastewater treatment plant, situated approximately 100 m above sea level, by a pumping pipe made of cast ductile iron 1,10 m in diameter and 2.500 m long.

The wastewater treatment plant has primary treatment and a secondary biological treatment with activated sludges, with three lines in parallel with a unit capacity of 30.000 m^3/day. The principal elements are:

i. Grease and oil interceptor unit.

ii. Three primary settling rotatory tanks.

iii. Three aeration tanks with six turbines per tank.

iv. Three secondary settling rotatory tanks.

v. Final settling and chlorination tank.

vi. Activated sludge treatment that includes recirculation to the aeration tanks and anaerobic digesters.

The plant has also a small pre-treatment for the wastewater from the higher districts of Santa Cruz for which elevation is not required.

At the present, the plant only treats about 10.000 m^3/day, of which 2.500 m^3/day are used for the irrigation of gardens and parks.

Pumping Regulation Reservoir

The Pumping Regulation Reservoir is situated below the treatment plant at 80 m above sea level, made of reinforced concrete and formed by two open compartments with a total capacity of 15.000 m^3. Its function is to regulate the flow from the treatment plant so that pumping may take place principally at night.

The treated wastewater is conducted from the plant chlorination tank by a ductile iron pipe, 0.80 m diameter and 130 m long, to the regulating reservoir, where there are protection structures and a pumping inlet vessel.

Pumping Station

The pumping station chamber, with an area of 100 m^2 and attached to the pumping regulation reservoir, holds 4 motor pump groups with a nominal power of 800 kw capable of pumping a flow of 233,3 l/s to a manometric height of 233 m with a performance of 81%.

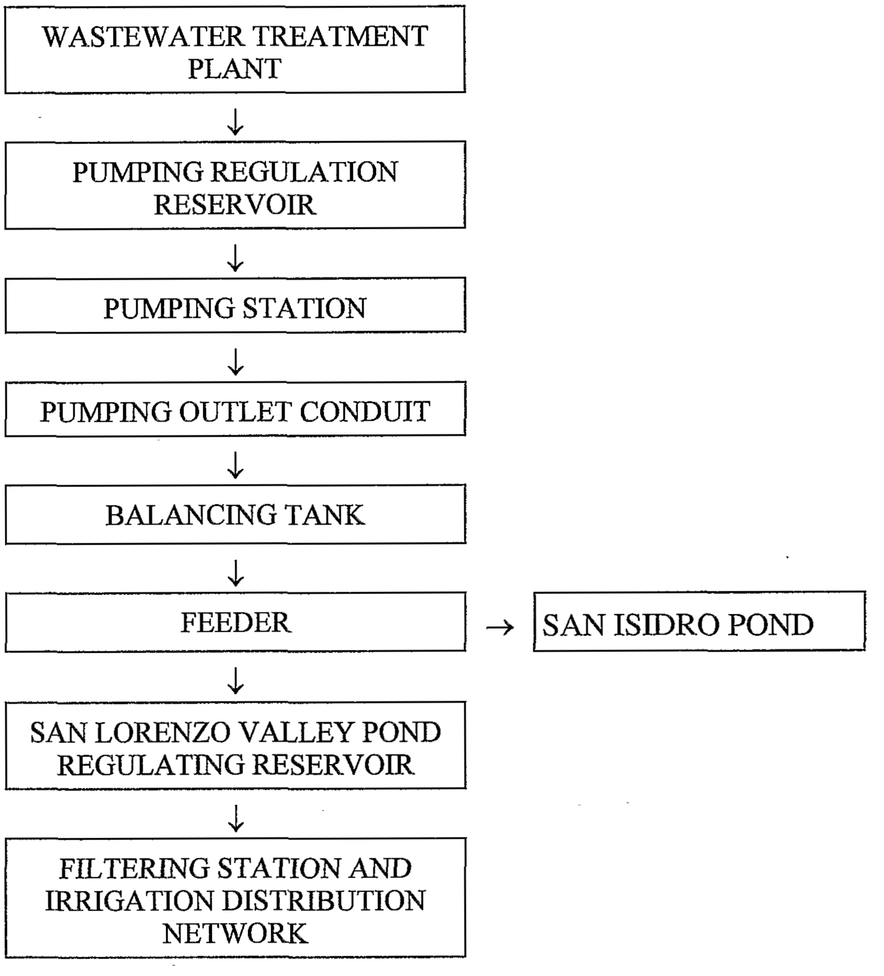

***Fig. 3** - Diagram of the reuse infrastructure system*

Pumping Outlet Conduit

This connects the pumping chamber with the Balancing Tank, situated 300 m above sea level.

The pipe made of cast ductile iron has 0.8 m diameter and 6.400 m total length. It is laid entirely in a trench, except for 7 aqueducts for taking the flow over gullies. The maximum working pressure to which this pipe will be exposed is 27,6 Kg/cm^2 and the flow (with the four pumps in operation) is 933 l/s.

Balancing Tank

This balancing tank has two reinforced concrete units with a capacity of 7.500 m^3 each, both being covered. Their function is to permit a continuous flow in the feeder to the South of the Island.

Feeder

The feeder is a ductile cast iron pipe 0.6 m in diameter, with a length of 60 km. It begins in the Balancing Tank and ends in the San Lorenzo Valley Pond, running parallel to the motorway that joins the North and the South of the Island. The nominal flow in the feeder is 300 l/s, remaining in the pipe an average of 16 hours.

At different points along its length there are several diversions, notably that located at kilometre 49.5 where it is connected to a 0.25 m diameter pipe 1.550 m long to the San Isidro Pond (203 m above sea level).

The conduit has 13 outlets at all the low points and a similar number of air release valves at the high points. There are 4 pressure relief valves combined with stop valves to avoid problems of increasing speed of flow and pressure.

The San Lorenzo Valley Pond

The pond has a capacity of 250.000 m^3, and is situated beside the previously mentioned motorway in the San Lorenzo Valley.

The reservoir is shaped like a truncated pyramid with a standard hexagonal floor. The interior walls are protected with a layer of HDPE 2 mm thick and a total surface area of 28.000 m^2. The depth is 15-16m.

The reservoir has an overflow structure and a maintenance gallery, where the inlet pipes, taps and outlets are housed. From this point, a primary distribution network in the form of a "T" begins, 6.700 m long and 0,6 m diameter.

Filtering Station and Irrigation Distribution Network

The San Lorenzo Valley Pond has a filtering station, consisting of 15 sand filter units with a filtering capacity of approximately 1.840 m^3/h.

Each of the filters is 2,5 m in diameter and 2,5 m high, with a depth of 1,5 m of sand.

It has a semi-continuous backwash and air system, each individual filter cell being backwashed sequentially while the other 14 continue with the filtering process.

The final distribution irrigation network of the treated and filtered water is still under construction, covering an extensive area of the San Lorenzo Valley (230 farms) with a surface area of 750 hectares.

The area to be irrigated with the treated wastewater is one of the least sloping areas of the Island of Tenerife. Its climate favours the cultivation of the most demanding species in terms of light and temperature, although it is somewhat windy. Rainfall is very scarce.

These conditions have encouraged its transformation into irrigable land by the costly construction of terraces. The problem of the wind was precisely the reason why this area was used for testing the first plastic greenhouses for bananas. The average area of each farm is 3,20 ha, a little above the usual in the Canaries.

The methods of irrigation most used are drip and microsprinkler for 70% of the total surface area, followed by sprinklers with 25% and other methods (surface irrigation, microtube, etc.) for the remaining 5%.

The total length of ductile piping will be approximately 40 Km distributed in four branches, with diameters varying between 0.5 and 0,1 m.

The whole installation will be fully automatic and operated by a telematic control located beside the pond, which will control 7 satellite stations and 230 cable linked remote field units.

The San Isidro Pond

The pond is located 212 m above sea level with a capacity of 50.000 m^3. Its characteristics are similar to those of San Lorenzo, the difference being in the square floor and a depth of 10-11 m.

TREATED WATER REUSE AND ITS EFFECTS

Diverse work has been carried out up to the present to characterize the treated wastewater from Santa Cruz de Tenerife, with the conclusion that a priori, the use of the water does not present any problems to impede its use for agriculture. The consequence of using this water is also being monitored in the cultivation of banana trees.

Experience with treated water in the Canaries and specifically in Tenerife has yielded the following results (Hernández Moreno *et al*, 1994):

Agricultural quality of the treated water

The treated urban wastewater from Santa Cruz de Tenerife has agricultural characteristics the same or superior to the natural sources and springs in the southern area of Tenerife (Pérez García *et al.*, 1984; Pérez García, 1992).

The use of this water, which has a high electrical conductivity, (1,5-1,7 ds/m), implies a moderate risk of salinization of the soil. (Hernández Suárez, 1989; Rodrigo López, 1993; Martín Rocha, 1993).

The water shows a high content of sodium, requiring appropriate measures to avoid sodification and the loss of permeability of the land under irrigation (Hernández Suárez, 1989; Rodrigo López, 1993; Martín Rocha, 1993). The authors also registered a high chloride content, which could be harmful to sensitive crops like avocado.

The level of Boro in the water could be equally problematical for sensitive crops such as avocado and citrus fruits. The same authors found a high content of nutrients in the water, considerably reducing the doses of fertilizers required. However, problems could potentially arise from the contamination of underground water.

Effects of the treated water on the soil

There is a risk of salinization and sodification of the soil with this water, sodification being already noticeable after one year of use.

Martín Rocha (1993) and Rodrigo López (1993) have found that, in spite of the high conductivity of the water, its use in irrigation does not significantly increase the soil values, applying a 20% washed dose.

The same authors observe that in acid soils, secondary problems may be caused in the form of the appearance of a lack of microelements (Fe, Zn, Cu).

A possible positive effect has also been attributed with reference to the fertility of soils low in phosphorous and organic matter.

The Effects of Treated Water on Plants

Hernández Suárez (1989); Pérez García (1992); Rodrigo López (1993) and Martín Rocha (1993) find that irrigation with treated water does not produce changes in the rhythm of plant development, nor in the production of fruit. According to the latter two authors, with appropriate handling of fertilization, problems of toxicity or a deficiency of macro or micro nutrients in plants do not appear. Neither have any effects been noted in the phytosanitary state of the plants with the use of the water.

Effects in Irrigation

Several authors have noted that the use of treated water may cause problems of plugging in localized irrigation systems, so the filtering system should be carefully observed, using sand filters sufficiently uniform and fine grained so as to guarantee the retention of the particles suspended in the treated water.

A moderate corrosive effect has also been detected in irrigation systems. (Hernández Suárez, 1989; Martín Rocha, 1993; Rodrigo López, 1993).

Sanitary Considerations

From a sanitary point of view, the treated water contains a certain degree of faecal contamination. Pérez García (1992) and the other authors previously mentioned, noted that no type of microbiological contamination of the skin or pulp was detected in fruit irrigated with treated waters.

Effects on the Reuse Infrastructure System

The studies carried out to date on the test plots in Tenerife have revealed very important information with reference to the effects of treated water on plants and soils. For the Project to be a success, it is absolutely vital that the tests continue, and that the technicians involved in the tests collaborate to disseminate the techniques and special agricultural practices in the use of treated water in irrigation. Within the activities considered to be fundamental to the control of the system, it must be mentioned (Zafrir Weinstein Engineers & Consultants Ltd. - AGAMIT, S.A., 1993):

i. Frequent monitoring of the quality of the out going water from the treatment installation, the processes of biofilms in the feeder pipes, the reservoirs, the points of consumption and the soils and plants.

ii. Establishing control parameters and indicators to detect processes and tendencies to prevent deterioration of the System.

iii. Joint monitoring with farmers concerning the effects of irrigation on the health of users and on the sanitary state of crops and soils.

iv. A study of the necessity of mixing fresh water with treated water. Localization and proportions.

v. A study of problems derived from: filtering and operating parameters, anaerobic conditions in conduits, operation with chlorine and other oxidants, the necessity of supplementary aeration, etc.

vi. A study of the effects of irrigation with treated water on the quality of underground areas. Potential risk of contamination in the short and long term.

In conclusion, the responsibility acquired by BALTEN in putting an infrastructure into operation whose scope has been sufficiently described and, more importantly, starting a new culture in the use of water on Tenerife, more than justifies a Project whose goal is none other than that of obtaining answers for all the questions posed.

MONITORING OF THE IMPLEMENTATION OF IRRIGATION WITH TREATED WATER FROM THE CITY OF SANTA CRUZ DE TENERIFE IN THE SAN LORENZO VALLEY

As mentioned previously, this Programme has the following basic objectives:

i. Monitoring of the elements in the system.

ii. Assessment of environmental impact.

iii. Carrying out pilot studies.

Based on these general objectives, BALTEN has started to carry out a series of tasks in collaboration with several bodies, notably: the University of La Laguna Chemical Engineering and Pharmaceutical Technology Department, the University of La Laguna Departament of Edaphology and Geology and the consultant AGRIMAC S.L. These tasks have been in operation since 1994, with an estimated minimum duration of three years and include the following activities:

Compilation of documentation and available information

The object is to compile and analyze all the documentation relative to the Project, of both the descriptive and regulatory aspects. It will also serve to collect and compare similar experience from other countries.

Monitoring of the treatment process. Analysis of the quality of the effluent

The aim is to periodically verify the quality of the water received at the pumping station from the wastewater treatment plant, and to suggest the appropriate modifications to correct any eventual treatment anomalies.

Weekly analyses are carried out based on basic monitoring parameters such as: BOD, COD, SS, residual chlorine, pH, turbidity, conductivity, pathogene analyses. In addition and as a complement to the above, complete chemical analyses will be carried out every month.

Monitoring of the treated water feeder

As the treated water remains in the feeder a long time, the principal effects to be considered are:

i. Problems of deposits, by sedimentation in the pipes, of material in suspension carried by the water.

ii. The generation of SH_2 by the action of anaerobic bacteria. The SH_2, as well as being toxic and responsible for bad odours, is highly corrosive and may damage pipes.

Although mathematical models do exist to predict the speed of SH_2 generation, there is nothing that describes such long distances. Given the importance that SH_2 may have in the feeders, parameters are checked every fifteen days at three points in the conduit, such as: BOD, COD, Sulphide, Sulphidric acid, Redox Potential, Sulphur-reducting Bacteria, SS, dissolved Oxygen, pH, temperature, etc.

Monitoring of the development of the stored water

The study of the development of the stored water includes the possibility of carrying out observations in the two ponds of the System. These are done preferably in the San Lorenzo Valley (final pond).

Three monthly observations are carried out at different points of the surface and in depth in order to detect possible stratifications, anaerobyosis, rates of eutrophication such as an increase of salinity due to evaporation. Some of the parameters analyzed are:

dissolved Oxygen, redox potential, BOD, COD, SS, turbidity, phosphorous, Nitrogen and Conductivity.

Quality control of the treated water to be distributed to irrigation zones

With the aim of maintaining control of the chemical and bacteriological quality of the final treated water, analyses are carried every fifteen days after the sand filtering, using parameters of agricultural and bacteriological interest.

Among these parameters, namely: Ca, Hg, Na, K, PO_4^{2-}, Cl^-, NO_3^-, NO_2^-, NH_4^+, CO_3^{2-}, HCO_3^-, SO_4^{2-}, SiO_2, BOD, COD, SS, conductivity, pH, turbidity, bacteriological analyses , etc. Analyses for heavy metals are also performed: Fe, Mn, Pb, Cu, Ni, etc. and other elements such as B, Al, F, etc.

Aquifer monitoring

Pre-selected test wells are sampled every six months where chemical and bacteriological parameters are determined to control possible affection of underground water.

The Establishment of experimental farms and collaborators

During the first months of the development of the Project, 5 collaborating farms were chosen that represent equitably the crops and irrigation procedures in the area. Cultivation plots have been defined on these farms from which samples will be taken. In addition, on the experimental farm owned by BALTEN plots have also been defined which will be added to the others for the scientific study of the Project.

Monitoring of soils

The monitoring of the soils is carried out based on an initial analysis of the characteristics of the physical and chemical state of the soils of the selected plots. This will serve as a starting point for the assessment of the effect of the treated water on the mentioned parameters.

In addition to this study of the initial state, the variables that exist in each plot for each parameter have been analyzed, in order to carry out selective sampling throughout the different phases of the Project.

The monitoring of soils includes the analysis every two months of chemical parameters such as: pH, conductivity, organic matter, nitrogen, phosphorous, carbon-nitrogen comparison, soluble elements, changeable elements, etc. Every year, heavy metals and microelements are studied: Al, As, Be, B, Cd, Co, Cu, Cr, Fl^-, Fe, Li, Mn, Hg, Mb, Ni, Pb, Se, Va, Zn, Sn.

Independently of the chemical analyses, physics is equally developed among which includes: hydraulic conductivity, speed of infiltration, texture, apparent density, micromorphology, etc.

Monitoring of plants and fruits

This monitoring has begun with an assessment of the initial nutritional state of the crops and will serve as a starting point for the study of the effect the treated water has on them.

The monitoring takes into account a bi-monthly assessment of different chemical and bacteriological parameters in plants as well as annually in fruits.

Included in the chemical parameters to be investigated, namely: nitrogen, K, Mg, Fe, Ni, Cr, Zn, P, Ca, Na, Mn, Cu, Cd, Pb, etc.

Visits to farms

Independently of the analytical sampling, the Project also considers visits every three months to each of the selected farms. The purpose of the visits is to check the state of the crops, soil and irrigation systems after continuous use with treated wastewater.

Study of tendencies

Based on the results of the analyses and the visits to the different elements in the system and to the farms selected, a twice yearly Monitoring Report is considered, where, in addition to effects detected, foreseeable tendencies will also be studied: salinization, changes in the pH, changes in the fertility of soils, variations in permeability, the accumulation of toxic elements, nutritional state of crops, effects on the development of crops, uniformity of irrigation systems, effects on localized irrigation points, effects on filter systems, state of conservation of elements in the system, etc.

These studies of tendencies will enable recommendations to be made for irrigation, the application of fertilizer and the handling of the elements in the system.

Dissemination of details

The final purpose of this Project is not only the appropriate management and operation of the reuse infrastructure but also to draw conclusions for other similar initiatives developed in the Canaries and in the rest of the country. In addition, the Project includes an advisory service for the farmers in the area, seminars and the production of informative leaflets on the use and handling of treated water in agriculture.

THE IMPORTANCE OF THE REUSE OF WASTEWATER IN TENERIFE

Water is at the present time the scarcest of resources in the Canary Islands. In contrast with the situation in the rest of Spain, here the degree of the wealth of farmers has been traditionally defined by the amount of water owned and not by the surface area. With regards to this, it must be mentioned that although the water Law (Ley 29/1985) defines the concept of hydraulic ownership to be of public domain, all surface and underground water being of a public nature, the extension of all concessions for the next 50 years makes the use of this resource to continue to be private. In the local vocabulary, the terms private water, rented water and purchased water give some idea of how important this resource is in the agricultural economy of the Islands.

The magnitude of the works and infrastructure described in this article raises the question of their profitability. The answer is neither easy nor direct, as there are financial, social and environmental considerations that must be taken into account, all being extremely difficult to assess correctly.

The investments in infrastructure may be divided into three parts: treatment works, feeder works and distribution network. The justification for water treatment is founded on the reclaiming of the resource and the impossibility of it being discharged directly into the sea. The cost of the feeder and the distribution network would therefore be the only costs directly attributable to the water reuse project.

Among the benefits of the project should be considered those directly derived from the use of the water for irrigation and other indirect benefits of an economic, social and environmental kind.

The principal direct benefit is the availability of a volume of water that at times of peak demand acquire considerable value. There are other, secondary benefits, such as the increase in productivity and a reduction in the use of fertilizers.

However, the indirect benefits are those which fully justify the reuse of the water in agriculture. In the first place, a series of economic activities exist to provide the necessary production factors and to commercialize the agricultural products that are seen to be potentially strengthened by the increase of production implied by reuse. And they are: manure, fertilizers, phitosanitaries, machinery, packaging, transport and others.

Social benefit must also be considered, associated with the maintenance of jobs in an area severely affected by unemployment.

The last and most important is the increase in the availability of the resource for other uses and in particular, for tourism. Tourism may be considered as the first industry on the Island, being located in the proximity to two important centres: Los Cristianos and Playa de las Américas. There are also two golf courses with an unquestionable attraction for tourists, given the climate in the area.

For all these reasons, the construction of new wastewater treatment installations and the reuse of their treated water for agriculture is considered in the Insular Hydrological Plan.

CONCLUSIONS

The reuse of treated wastewater in agriculture, in addition to being an overall objective, is today a permanent topic of conversation in any debate. However, while on the one hand, the future users of this type of water magnify its drawbacks, on the other, those charged with providing adequate handling conditions and the appropriate infrastructure adopt a somewhat frivolous and simplistic standpoint.

The infrastructure and the criteria of management and control laid out here purport to be an example of that, the use of these resources being necessary, it is important to have the opportune mechanisms to guarantee the appropriate sanitary conditions available. We should not forget that treated waters, as well as being water and as well as being treated, are waste, and this condition should impose certain restrictions on us.

The example of the Canaries which leads to a diversion of potable water resources away from agriculture for human consumption, invites a final thought : Do we differentiate our hydraulic resources according to levels of quality to adapt them to the varying types of demand?.

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