Experimental plant of Carrión de Los Céspedes (Seville): model of technological transfer in international cooperation about sustainable solutions for wastewater treatment

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Experimental plant of Carrión de Los Céspedes (Seville): model of technological transfer in international cooperation about sustainable solutions for wastewater treatment

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Abstract. The access to drinking water, proper sanitation and treatment of urban wastewater provide the backbone of development in a country. When we analyse the situation worldwide, we can state that the problem in this field is more or less solved in large and medium cities and in those areas with adequate social, economic and technological development. On the contrary, the population most affected in terms of lack of water basic services is concentrated in rural and scattered areas, as well as in the marginal zones of the large cities in underprivileged countries. In this context, where the main economic and technical limitations occur, it is necessary to have solid and adjusted solutions that guarantee the elimination and adequate treatment of wastewater with minimum implementation costs and affordable service costs for the benefited population. The non-conventional or extensive treatment technologies are a solution to this problem, given their resemblance with natural treatment process and the fact that their simplicity regarding their management and exploitation considerably reduce infrastructure and service costs. In Seville, Spain, since 1990 the Experimental Plant of wastewater treatment of Carrión de los Céspedes (EPCC) has been working on the development, implementation and diffusion of non-conventional and conventional technologies for the wastewater treatment which are generated by small communities. Nowadays, with a surface of 35,000 m^2 and a wide range of technologies, this experimental Plant is a model of technological transfer and a point of reference in the framework of wastewater depuration in small agglomerations. The high experience in the field of wastewater treatments in small agglomerations in the EPCC has been extrapolated to other countries as Morocco and Uruguay. In the North of Morocco, Tetouan, the Technological Transfer Centre is a single area covering 30,000 m^2, with different non conventional treatment systems; in the South of Uruguay the Experimental Plant of Canelones has been planned which covers all Latin America and allows the exchange of experiences and transfer of successful technologies in this area. The present document intends to illustrate these Experimental Plants and their contribution to development in small communities.

Keywords. Wastewater treatment – Small communities – International cooperation – Experimental plants.

Installation expérimentale de Carrión de Los Céspedes (Séville): un modèle de transfert technologique dans la coopération internationale de solutions durables pour le traitement des eaux usées

Résumé. *L'accès à l'eau potable, des mesures d'hygiène appropriées et le traitement des eaux usées urbaines représentent l'ossature du développement d'un pays. Si on analyse la situation mondiale, il est possible d'affirmer que les problèmes dans ce domaine sont plus ou moins maîtrisés dans les grandes et moyennes villes et dans les zones qui se caractérisent par un niveau suffisant de développement social, économique et technologique. En revanche, les populations les plus touchées par les insuffisances des services de l'eau fondamentaux sont concentrées dans les zones rurales et dispersées, et dans les zones marginales des grandes villes dans les pays les plus démunis. Dans ce cadre, là où des limitations techniques et économiques importantes interviennent, il est nécessaire de mettre au point des solutions solides et ciblées, capables d'assurer l'évacuation et le traitement appropriés des eaux usées avec des coûts de réalisation minimaux et des coûts des services abordables pour la population qui en bénéficie. Les technologies de traitement non conventionnelles ou extensives constituent une solution à ces problèmes en raison de leur proximité des processus de traitement naturels et de leur simplicité sur le plan de la gestion et de l'exploitation, qui réduit considérablement les coûts des infrastructures et des services. A Séville, en*

Espagne, à partir de 1990, l'Installation expérimentale pour le traitement des eaux usées de Carrión de los Céspedes (EPCC) s'est engagée dans le développement, la mise en œuvre et la diffusion des technologies conventionnelles et non conventionnelles pour le traitement des eaux usées qui sont générées par les petites communautés. A l'heure actuelle, avec une superficie de 35.000 m² et une vaste gamme de technologies, cette installation expérimentale représente un modèle de transfert technologique et un point de repère pour l'épuration des eaux usées dans les petites agglomérations. L'expérience considérable acquise par l'EPCC dans le domaine du traitement des eaux usées dans les petites agglomérations a été transférée à d'autres pays tels le Maroc et l'Uruguay. Dans le nord du Maroc, à Tetouan, le Centre pour le Transfert Technologique couvre une étendue de 30.000 m² et maîtrise différents systèmes de traitement non conventionnels, alors que dans le sud de l'Uruguay, l'Installation expérimentale de Canelones, qui couvre l'Amérique latine dans son ensemble, favorise un échange d'expériences et le transfert des technologies les plus performantes dans la région. Dans le présent travail, on va illustrer ces installations expérimentales, en mettant en évidence leur apport au développement des petites communautés.

Mots-clés. *Traitement des eaux usées – Petites communautés – Coopération internationale – Installations expérimentales.*

I – Introduction

Although water has always been considered as a good to be consumed, we currently talk about water as a scarce resource not accessible to everyone in the same way. There is an important imbalance between developed and developing countries regarding the access and purification of water.

In the World Summit on Sustainable Development in Johannesburg (2002), the need was acknowledged for specific actions at a global level to solve water problems, due to the strategic role that this resource plays in order to achieve the Millennium Development Goals (MDG) (2000) related to water.

Currently, more than one billion people are deprived of their right to clean water, most of them from the poorest countries, while **2.6 billions** do not have access to adequate sanitation. The differences between rich and poor communities and urban and rural ones, make this situation even worse, whilst the lack of basic sanitation negatively affects health and social development.

The access to adequate sanitation and wastewater treatment has a double benefit: it improves the life conditions of the affected population (poverty, hygiene, healthiness, etc), and it is a conservation strategy of the good ecological status of water resources.

The problem is more or less solved in large and medium cities and in those areas with adequate social, economic and technological development. On the contrary, the most affected population in terms of lack of basic services (drinking water and sanitation) is concentrated in rural and scattered areas, as well as in the marginal zones of the large cities in underprivileged countries.

It is in this context where the main economic and technical limitations occur, where it is necessary to have solid and adjusted solutions that guarantee the elimination and adequate treatment of wastewater with minimum implementation costs and affordable service costs for the benefited population. The decentralized systems at small scale, as well as the non-conventional or extensive wastewater treatments, are a solution to this situation, given their similarity with natural purification processes and the fact that their simplicity regarding their management and exploitation considerably reduce infrastructure and service costs.

During the last years, we have been able to observe a remarkable scientific progress concerning the development of sanitation and purification technologies, especially extensive technologies, which have been the object of numerous and important research studies by the scientific community. Nonetheless, such progress has not turned into a solution for this problem. In this

context, it is necessary to rely on resources that contribute to improving basic sanitation and purification, and to achieving the MDGs related to water.

In this context, some international platforms for the wastewater treatment, as the Experimental Plant of Carrión de los Céspedes (EPCC) (www.plantacarrion-pecc.com), South of Spain, the Technological Transfer Centre (TTC), North of Morocco, and the Experimental Plant of Canelones (EPC), South of Uruguay, where extensive technologies are implanted at small scale, are unique places that allow managers and researchers involved in purification to assess on the ground the different options offered by these technologies, and to apply them in their own management settings.

II – Area of study

Experimental Plant for wastewater treatment of Carrión de los Céspedes (EPCC), Spain.

Andalusia has a great amount of experience in research and development regarding water purification in small towns, with its main point of reference in the EPCC, in Seville.

This Experimental Plant, belonging to the Andalusian Department of the Environment and run by the Centre for New Water Technologies (CENTA) as agreed upon with the Water General Secretariat, is part of the Andalusian Strategy for Research, Development and Innovation on wastewater purification, mainly extensive technologies, launched about 20 years ago with the main characteristic of combining purely scientific studies with an extensive knowledge of purification adjusted to specific areas. The EPCC has been working on the development, implementation and diffusion of extensive technologies for the treatment of wastewater generated by small towns. In a single area covering 35,000 m^2, both extensive and intensive technologies have been studied. The extensive ones are: green filter planted with *Populus euroamericana* and *Eucalyptus camaldulensis*, stabilisation ponds (two anaerobic, one facultative and two maturation ponds), peat filters, constructed wetlands (3 horizontal, 3 vertical and 1 free flow constructed wetland, with different substrate, planted and without plants working as secondary or tertiary treatments in combination and with an Inmhoff Tank as a primary treatment), trickling filters in combination with peat filters and anaerobic ponds and rotating biological contactors. The intensive technologies are: extended aeration, Sequential Batch Reactor (SBR), bio-catalysis, Membrane Biological Reactor (MBR), multistage reactor, etc. The EPCC has also 1,900 m^2 plot for testing the treated effluents from stabilisation ponds and constructed wetlands for agricultural irrigation purposes. On the other hand, there are six fibreglass reinforced plastic tanks where plant and animal biomasses are cultivated and a meteorological station from the State Meteorological Agency. The treated water for the irrigation of green zones comes from different points: (1) combination between vertical flow constructed wetland without plants with free flow constructed wetland planted with *Typha* sp., *Iris* sp., *Cladium mariscus* and *Cyperus* sp., (2) second maturation pond, and (3) extended aeration with sand filter and coloration system. All systems are monitored and measurements are made of some physicochemical and biological parameters, related to wastewater treatment and reuse, as well as to biodiversity in the systems. The EPCC receives numerous visits from different national and international organizations and institutions, and many activities related to training and knowledge dissemination on wastewater treatment are carried out. Figure 1 shows a view of EPCC with different installed systems. In the near future, the Experimental Plant is to be enlarged in order to create two different zones, one devoted to extensive technologies and the other for intensive technologies, and also to improve the sludge treatment line.

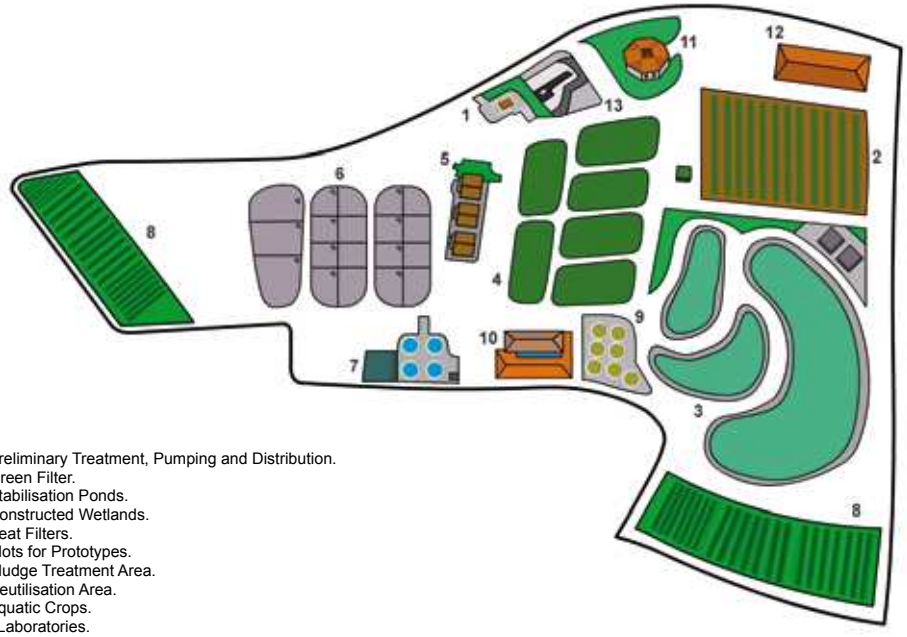

Figure 1. The Carrión de los Céspedes Experimental Plant. Spain. (Fahd *et al.*, 2007).

1. Technological Transfer Centre (TTC), Morocco

The experience and the knowledge acquired in EPCC were transferred to Morocco. Within the framework of the Interreg II Program Spain-Morocco, the TTC came up between the Moroccan Ministry of Urban Planning, Water and Environment, and Andalusia Government of the Environment.

Since 2000, the TTC has been working on the development, implementation and diffusion of extensive technologies for the treatment of wastewater generated by small towns in the North of Morocco. In an area covering 30,000 m^2, there are six extensive technologies: green filter, planted with *Populus sp*., stabilisation ponds (one anaerobic, two facultative and two maturation ponds), constructed wetland with an Inmhoff Tank as a primary treatment and planted with *Typha sp*., peat filters, rotating biological contactor and a combination of anaerobic pond and trickling filter. There are three experimental ponds of 17.5 m^2 each, aimed to perform tertiary treatment experiences.

The facilities of the Centre include also a fully-equipped laboratory (to complete the physico-chemical and biological analysis), cooperation headquarters, meeting halls and students' rooms, conference hall, meteorological station and a permanent exhibition. Figure 2 shows the flow diagram of the different systems installed in the TTC.

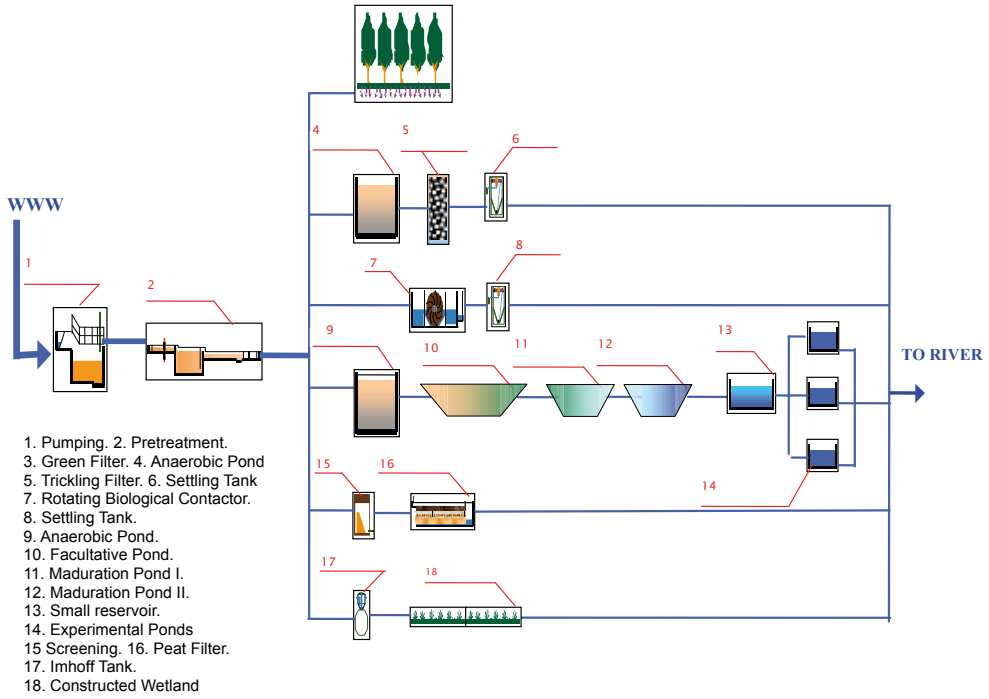

Figure 2. Flow diagram of the Technological Transfer Centre, Morocco. (Fahd *et al.,* 2007).

2. Experimental Plant for wastewater treatment of Canelones (EPC), Uruguay

In Uruguay, like in Morocco and Spain, the main problem is sanitation and wastewater treatment in small communities. In this context, during the XVII Summit of the Heads of State and Government held in Chile in 2007 the Initiative of the Latin America Cooperation was approved for the training and technological transfer in integrated management of water resources, supported by Chile, Peru, Uruguay and Spain. This initiative will be mainly supported in the Experimental Plant of Canelones, Uruguay.

This Plant will rely on different extensive and intensive urban wastewater technologies, as well as an area for industrial wastewater treatments, principally from agro-feeding sector and fundamentally dairy. The extensive systems that will be installed are: stabilisation ponds (one anaerobic pond, one facultative pond and two maturation ponds), constructed wetlands (3 vertical flow, 5 horizontal flow and one free flow), with an Inmhoff Tank as a primary treatment. The intensive systems are: Upflow Anaerobic Sludge Blanket (UASB) reactor. There will be six aquatic crops for phytoplankton and zooplankton cultures as well as a meteorological station and an area for commercial prototypes, administrative activities and a laboratory.

Finally, the EPC will include a combination of septic tanks and horizontal flow constructed wetlands, treating the effluents from the administrative area, laboratory and class for training. This system is based on that used in MEVIR system (Movement for the poverty eradication of rural and unhealthy housing). Figure 3 shows the systems that will be built in the EPC.

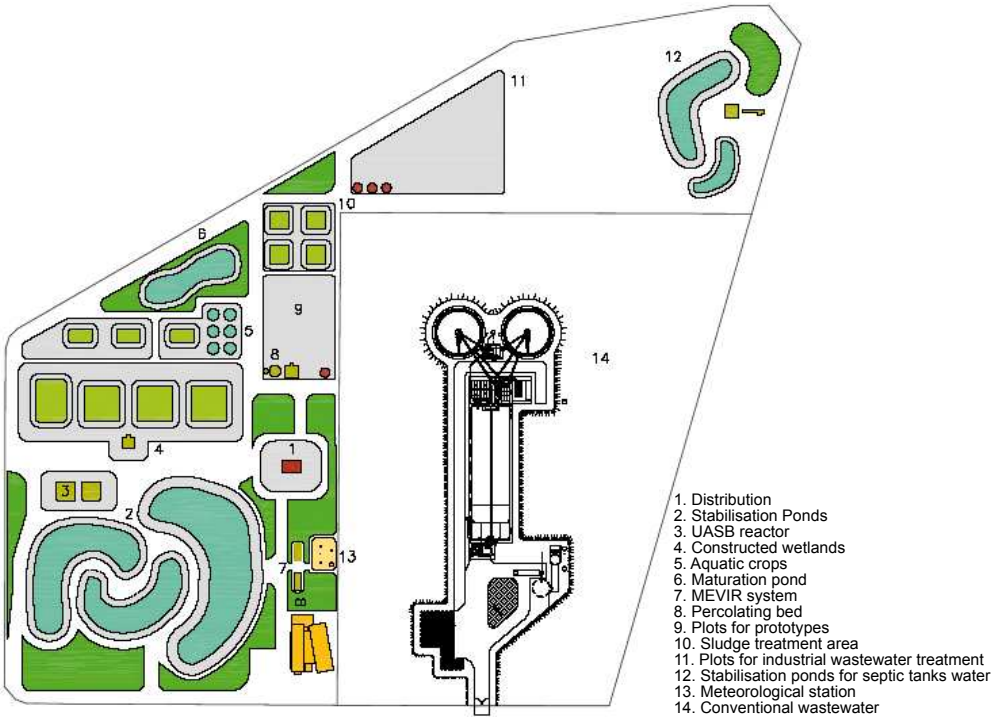

Figure 3. Experimental Plant of Canelones, Uruguay.

III – Results and discussions

Over 18 years of operations at the EPCC and 8 years at the TTC, many studies have been made on the treatment of urban wastewater using extensive technologies. The results obtained have been published in different journals, books, memories and guidelines. Conferences, Meetings and Seminars have been organised and attended, both in Spain, Morocco and abroad. The experiments performed have allowed the training of highly-qualified personnel who are able to transfer their knowledge and provide technical assistance in the field to individuals, organisations and institutions with an interest in the subject.

These two platforms achieved concrete results in the optimisation of the design and operation of these kinds of technologies, adapting them to the climatic and socio-economic conditions in many towns in Andalusia, Morocco and further areas, where the geo-climatic conditions are very similar to those of the Mediterranean area.

In the specific case of Andalusia, the direct results of the work performed by the EPCC show that more than 50% of the existing treatment plants use extensive technologies and today, a large proportion of plants currently under construction in small towns, are of this type (Centre for New Water Technologies, 2008).

On the other hand, the numerous visits made to the EPCC and TTC and the training of the technical staff and students in the wastewater treatments are part of the results of the dissemination activities undertaken at both centres.

It must be mentioned that, under the auspices of the United Nations Office, the EPCC has been assigned the task of supporting the International Decade for Action "Water for Life, 2005-2015"; it is recognized that the activities carried out in this centre may help both developed and developing countries improving their basic services of water sanitation and purification and reaching the Millennium Development Goals (2000).

Regarding Morocco, it must be mentioned that TTC has been a springboard to promote other activities related to water and sanitation in the North of Morocco. Special mention must be made of: (i) drinking water supply to douars, small settlements in the mountain, in the North of Morocco (Rif), within the PAGER Program (1995) on "Drinking Water Supply Program in the Rural Environment" established by the Moroccan Administration in the 90s, and managed by the Moroccan Ministry of Equipment; (ii) plumbing in rural schools, in the framework of "Improvement of Life Conditions in Rural Schools Program" (2005), established by the Moroccan Ministries of Education and Urban Planning, Water and the Environment.

On the other hand, this Centre has allowed the merging between the laboratory of the Quality Service of the Hydraulic Agency of the Loukos Basin and the laboratory of TCC.

IV – Conclusions

The work of EPCC has been and is emblematic. Its aim has been to promote and diversify extensive technologies for small communities so that they can be efficiently applied. The strategy of this Centre and the diversity of technologies it uses have made it a unique reference point in Europe and in the Mediterranean basin. At present, under the auspices of the United Nations Office, it has been assigned the task to support the International Decade for Action "Water for Life, 2005-2015"; it is also recognized that the activities carried out in this centre help both developed and developing countries improving their basic services of water sanitation and purification and reaching the Millennium Development Goals.

Both EPCC and TTC are meeting points and an interface between the public administrations, private enterprises, Universities and Centres; they catalyse the growing demand for demonstrations, training, dissemination and environmental awareness in society in the framework of water.

From the technical point of view, EPCC, TCC and EPC are experimental platforms, oriented towards a series of actions mainly aimed at creating an important connection between them, so that the different research lines in the wastewater treatments in one of the Centres can be investigated in the others. They present similar technical characteristics, with the possibility of varying the water level, modifying the volume and retention times of systems and the working conditions, allowing for different combinations between them. On the other hand, they have got their own laboratories, where all physicochemical and biological parameters are analysed together with their own meteorological stations. These working conditions make it easier the exchange of results and conclusions and the possibility to transfer the knowledge to other countries.

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