Boletín de la Asociación de Geógrafos Españoles N.º 64 - 2014, págs. 437-441
I.S.S.N.: 0212-9426

RECLAIMED WASTEWATER AS A RESOURCE FOR IRRIGATION OF SEGURA RIVER BASIN (SPAIN) *

Alfredo Pérez Morales
Encarnación Gil Meseguer
José María Gómez Espín
Departamento de Geografía. Universidad de Murcia.
alfredop@um.es, encargil@um.es, espin@um.es

I. GEOGRAPHIC INTEREST. OBJETIVES AND METHOD

In developed and developing countries, rapid urbanization and the consequent increasing demand of water, for industrial agricultural and demestic uses is a serious problem in those countries where water resources are noted for their deficiency. These circumstances are a serious problem in the Mediterranean region, especially in arid and semi-arid areas of the South and in the Middle East, where, besides that, we must not forget the universal issue of wastewater. Both issues, shortage and pollution have tried to be solved with more or less success by developing strategies for integrated water management through large and expensive infrastructures.

In regards to the actions related to unconventional uses, the current trend seems to be related to the intensification of wastewater recycling. Treating and reusing wastewater resources include in their economic and environmental advantages compared to the desalination of sea water, and, despite the reduction of the costs of the latter technology, the difference between the two solutions still maintained by simultaneous progress of recycling (AN Angelakis, Marecos Do Monte MHF, Bontoux L, Asano T, 1999).

The Segura River Hydrological Demarcation (SHD, SE Spain) is one of these basins of the Mediterranean region who suffer water shortages. The water balance in the SHD points that water demand is well above the available water resources, accentuating its deficit (Gil, AM, Amoros, AMR, and Hernandez, MH, 2005). To this, it must be added the likely decline of these resources available in the medium and long term, either due to decreased rainfall records associated with climate change (Giorgi, F. and Lionello, P., 2008), or simply by increased demands associated mainly to farming. Under such a scenario of less and worse water distributed, re-use of treated water in the SHD is one of the main drivers in the national plan for the management of water resources is an important part of the criteria for a new environmental policy of jointly promote a new culture of water, trying to increase the use

of unconventional resources and while ensuring the physical, chemical and bacteriological water quality (Pérez, S. et al., 2011).

The purpose of this research is, precisely, to present and explain those initiatives that, in a basin with water structural deficit like Segura, are being made in order to bring new resources from reuse, and whose final destination, once regenerated, will be mostly South-east of the Iberian Peninsula irrigation areas.

II. CURRENT STATUS OF WASTE WATER USE

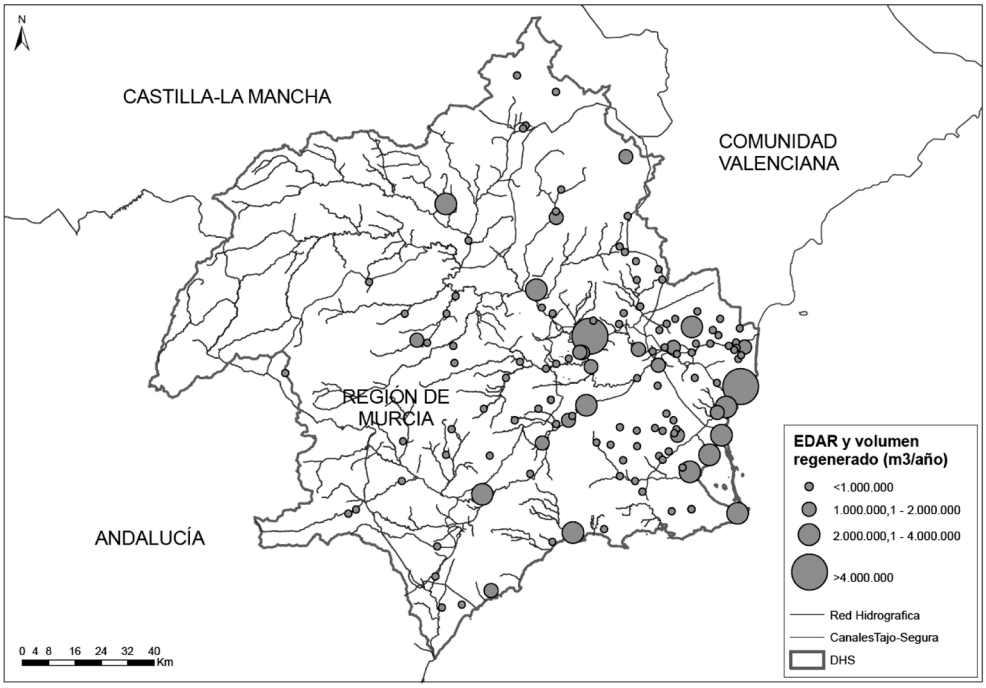
The wastewater reuse should be understood as a planned procedure, with appropriate distribution infrastructure and high standards in water management in response to the quality requirements of the uses involved. The sum of these requirements motivates that only few Spanish regions make use of these unconventional resources. According to estimates given in the National Plan for Water Quality in force, in Spain there are currently more than 2,500 Waste Water Treatment Plant (WWTP) that purify more than 3,375 m³ of wastewater annually. Of these, an estimated reused at present only about 450 hm³ / year, which represents a little more than 13% of the total, it shows the high potential of this technology for the generation of new water resources, in a scenario future where the prospects of climate change involve a decreasing availability of natural water resources. According to the latest available data, the distribution of treated water use stands at about three-quarters for agricultural use, the order of 12% for recreation and golf courses, 6% for urban services, 4% for ecological uses and groundwater recharge, and around 3% for industrial use (MMA, 2007).

The reuse of wastewater in the two main provinces (in surface terms) of the Segura River Basin, Alicante and Murcia, have experienced different levels of development: Alicante is a pioneer in Spain in this respect, for example, since 1980 they are raising and driving Alicante wastewater to irrigation areas of Middle Vinalopó bagged table grape, with a height of 400 meters which is saved through costly pumping. Wastewater are also used in many municipalities of the coastal strip as in the irrigation of crops medlar of Marina Baja, in irrigation under plastic of the old orchard of Alicante, Elche, Torrevieja and Pilar de la Horadada (RICO, AM, 1998, 119). However, the real impulse in expanding treatment of wastewater occurs with the implementation of the Master Plan for Sanitation and Treatment of Valencia, whose first two phases (1992-1996 and 1997-2005), time when were undertaken actions to try to cover municipalities with over 2,000 inhabitants. Although these two stages failed to provide the benefits that would be expected from the planned investment, the efforts in subsequent years have significantly improved the treated water from 64 million cubic meters in 1994, to 134.13 million cubic meters in 2010, of which tertiary treatment were regenerated by a 93.03 in the 146 hm³ WWTP installed (EPSAR, 2010). The 29 WWTP of Vega Baja, in 2012, treated to 22,081,638 m³ / year.

The case of the Murcia region is particularly interesting because it is one of the regions that, in general, has been one of the fastest growing in terms of reuse compared to other Spanish regions. Until the passage of the law 3/2000 of Sanitation and Wastewater Treatment in the Region of Murcia, the regional administration efforts had focused mainly on the coast of the Campo de Cartagena, in order to improve the quality of water discharged into the lagoon of the Mar Menor area designated "vulnerable" according to the European Directive

91/271. It was carried out the renovation of the sewerage network and construction of two wastewater treatment plants, located north and south of the inland sea. However, the rest of the territory of Murcia, presented a critical environmental water situation, so it was imperative the Regional Plan passage to carry out the necessary progress in the management of sanitation and wastewater treatment. With the promulgation of this rule were made investments worth about 584 million euros until 2010 that materialized in the maintenance, replacement and new construction of the 97 stations that were in operation (all cores of more than 500 people had one station). Among all, it was treated, for the same year, around about 110.9 hm ^{3} / year, of which, approximately, it was regenerated almost more than half. The 2012 data points that number of WWTP have been reduced, however, almost all population entities count with treatment services. Of those managed by ESAMUR, it was treated 109 406 674 m^3 / year, increasing the proportion of regeneration for irrigation.

Figure 1
LOCATION OF THE SHD WWTP RECOMBINED VOLUMES AND IRRIGATION



Source: Compiled from data of the Water Board of the CHS (2012).

In regard to the SHD administrative term, the actions taken previously by Administrations, each in the scope of its powers, have produced a substantial change consistent with the above mentioned. On balance, according to the CHS, the supply of drinking water generates returns of more than 80% of water supplied that are treated by the Demarcation WWTP. However, there are still villages that for reasons usually associated with their small size or location geo-

graphically dispersed discharge their waste water directly into streams and soil, without pre-treatment. According to available data, it is a total of 7.5 hm³ / year, however, the application of technologies cheaper and simpler as symbiotic treatment, will reduce the number of small villages without waste water treatment. In these circumstances, a total of 189 hm³ / year of water that were intended in 2010 to urban and industrial use, that volume returns considering that 80% of water supplied, would be 151.2 million cubic meters / year. At that volume should detract 7.5 hm³ / year and 8.3 untreated hm³ / year are lost in the process, giving a total flow of about 135.4 hm³ / year treated, of which, 74.4 hm³ / year and were able to regenerate irrigation. Negligible amount but still could be expanded, because we must not forget that in 2012, the top candidate for treatment be extended to include WWTP Albacete and Almeria, as well as the amount of reclaimed for irrigation volumes. The maximum volume regenerated granted in 2012, was 109 972 596 m³ / year, however, the use of irrigation communities was lower, as some of them failed to recover the maximum volumes WWTP those granted by the CHS. The reality of the analysis of recent years, including volume treated and reclaimed for irrigation has been applied to irrigated perimeters in the Segura Basin, lies between 50 and 75% of the treaty. Of the 155 grants of reclaimed water for irrigation in the SHD (12/17/2013), the regenerated volume 75.09% corresponded to concessions in the Region of Murcia, the 19.06% to Alicante (Vega Baja), the 4.00% to Albacete and Almería 0.95%.

Table 1
TREATED WATER VOLUME AND REGENERATED IN DHS (MURCIA AND PART OF ALICANTE) 2007 AND 2012 HM³

2007	**Treated**	**Regenerated**	**Ratio treated/regenerated (%)**
Murcia	101,00	45,6	45,14
Alicante	27,00	20,2	74,81
TOTAL	128,00	65,8	51,40
2012	**Treated**	**Regenerated**	**Ratio treated/regenerated (%)**
Murcia (ESAMUR)	109,41	82,58	75,47
Alicante (EPSAR)	22,08	21,95	99,41
TOTAL	131,48	104,53	79,50

Source: Compiled using data from the Survey of Major Themes in the DHS for 2007, and ESAMUR and EPSAR for 2012.

III. CONCLUSIONS AND PROPOSALS

The Segura River Basin (DHS), located in the southeast quadrant of the Iberian Peninsula has a structural water deficit than 300 hm³/year. In recent years, to meet EU directives 91/271/EEC and as 60/2000/CE, has developed the National Plan for Water Quality (2007-2015), and regionally, Law 2/1992 of the Valencian Community, and Law 3/2000 of the Region of Murcia.

The Plan of cleansing and purifying of the Region of Murcia (2001-2010) seems to be a success. The ninety WWTP in operation in 2012, nearly treated 110 hm³/year. Almost 99%

of the population is covered with collection and treatment systems of wastewater. Most of these volumes receive biological treatment, and further, more than half were subjected to tertiary treatment regeneration including physicochemical flocculation, decantation tertiary filtration, disinfection, chlorination and, in some cases, to ultrafiltration or microfiltration membranes.

More than half of treated water in the DHS is regenerated and take to irrigation areas (up to 110 hm^3 / year granted). In this sense, the role of these is very valuable, as well as partially cover the needs of irrigated areas also plays an environmental task, because in times of drought there is avalaible some ecological flow in sections of the Segura river and streams.

In short, in the DHS the public and private investments have generated an infrastructure network for the purification and wastewater treatment as well as for reuse, which makes it a model for the use of these resources with a public awareness to accept the canon as necessary to maintain these purification and sanitation infrastructure, and achieve quality returns.