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THE USE OF RAINWATER IN THE CITY OF ALICANTE. OLD IDEAS TO NEW APPROACHES

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1. INTRODUCTION

On the Spanish Mediterranean coast, water has become a vital resource for socio-economic development, especially for the tourism sector and agriculture (HERNÁNDEZ, 2013). Up until the drought in the Iberian Peninsula that was recorded between 1992 and 1995, the solution for the problems associated with the lack of water resources was based on the possibility of obtaining new volumes of water to guarantee that the users' demands were satisfied (MORALES, 2001). Procedures and policies aimed at creating a wider range of resources without taking measures to control the demand formerly took precedence (SWYNGEDOUW, 2015).

The importance of the unconventional water resources becomes even more noticeable if anything, when the consequences of the Climate Change and how to adapt to this are taken into account, and it is one of the biggest challenges of societies on a global scale (IPCC, 2014). Countries such as the USA, UK, France, Sweden or Australia have been using SUDS for more than a decade, thus improving the environmental quality of their cities (CIRIA C521, 2000). On the international scene, many experiments have been carried out and numerous publications have been written about the use of rainwater for urban purposes to meet this aforementioned double objective (DE GOUVELLO *et al*., 2009). In terms of the sustainable urban drainage systems, firstly it is worth mentioning those that analyse rainwater harvesting to cut down on the surface run-off and minimize the risk of flooding, especially in the light of the Climate Change, that is to say, with presuppositions of future extreme episodes of heavy precipitation per hour (NOTARO *et al*., 2013). Secondly, those which consider using rainwater harvesting to store the surface run-off that is loaded with pollutants and therefore prevent the contamination of the rivers and the marine ecosystems (SALES-ORTELLS *et al*., 2015). In terms of a subsequent use, the studies that deal with *sensu stricto* about the rainwater harvesting, storage systems using tanks or rainwater tanks must be mentioned (DELANEY et al., 2015) along with those that analyse the use and purpose of these resources to replace certain urban consumptive water uses (KIM *et al*., 2016).

2. PRELIMINARY WORKING HYPOTHESIS, OBJECTIVES AND METHODOLOGY

The preliminary working hypothesis of this research work argues that the use of the rainwater is becoming increasingly more important in the comprehensive planning and management of water resources in the urban-tourist areas of the Spanish Mediterranean coastline. However, at the same time, it is obvious that there is still limited systemized knowledge about the characteristics of these flows of water, their history, the existing degree of implementation, and in particular, about their role in the hydro-social cycles on a local scale.

The objectives of this research work are: a) to highlight the potential of rainwater in environments where water is scarce and where urban typologies with outdoor uses are well

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[2] Instituto Interuniversitario de Geografía, Universidad de Alicante. Cta/ San Vicente del Raspeig s/n, Apartado 99, Alicante (03080). maria.hernandez@ua.es. Este artículo es resultado del Proyecto de investigación "Usos y gestión de recursos hídricos no convencionales en el litoral de las regiones de Valencia y Murcia como estrategia de adaptación a la sequía" (CSO2015-65182-C2-2-P) financiado por el Ministerio de Economía y Competitividad.

established; b) to analyse the current use of the rain water in the city of Alicante; and c) to pinpoint the strengths and weaknesses of the rainwater so that it can become a strategic resource and therefore improve the environmental sustainability in the city of Alicante. To this end, the evolution and the importance acquired by this water resource in the city over the last few years will be analysed, as it is considered to be a "new" and "alternative" water resource, which, apart from increasing the city's water supply, helps solve problems of contamination and the risk of flooding in specific areas of the city.

To carry out this study, qualitative and quantitative working methods have been combined. With regard to the former, different interviews were conducted in May 2016 with the managers and the experts of the company that is in charge of the hydro-social system of the city of Alicante (supply, drainage, treatment and purification, collection of rainwater, etc.), Aguas Municipalizadas de Alicante, Empresa Mixta S.A. (AMAEM). In this way, qualitative information could be collected about the current situation, the advantages, inconveniences and the future projects concerning the potential use of this resource in the city. These were rounded off with the visit to the two existing storage tanks in Alicante in the month of September 2016: the tank designed to reduce contamination called the Tanque anticontaminación Ingeniero José Manuel Obrero Díez (located in the district of San Gabriel, in the south of the city) and the urban flood defence park called the Parque Inundable La Marjal (located in the north east part of the city, in Playa de San Juan).

3. THE USE OF RAIN WATER IN THE CITY OF ALICANTE: "REDISCOVERING" A NEW RESOURCE

As a result of the increase in the water volumes associated with the spread of the urban typologies since the end of the nineties, where there is a predominating need to use water for outdoor purposes (gardens and swimming pools), and the new ideas on water resource management, which advocate the differential use of the water qualities according to the specific purpose, plus the need to minimize the impact related to precipitation of a certain intensity, in the last few years the company in charge of supplying drinking water in Alicante (AMAEM) has taken new measures to incorporate water sources that have traditionally been ruled out, such as rainwater. The collection and the subsequent use of the surface run-off rainwater not only can help increase the availability of the resource (once it has been treated and purified), but it also has a triple environmental purpose:

1. Minimize the risk of flooding in certain areas that are repeatedly threatened with the risk of being flooded.
2. Cut down on the level of contamination from the urban surface run-off given the high percentage of lead in it due to the pollution from vehicles and other waste that this water contains.
3. Alleviate the damage caused by this waste dumped on the beaches, which has a subsequent negative impact on the quality of their water. These last two factors are extremely significant in view of how important the sun and sand tourism activity is in the city of Alicante.

So far, two major projects have been carried out by AMAEM to harvest rainwater: the Tanque Anticontaminación Ingeniero José Manuel Obrero Díez, which is designed to reduce the contamination of the initial surface run-off that moves around the permeable areas of the city, and, in this way, stop it from going into the sea and the Parque Inundable La Marjal, built to solve the problems of flooding in the urban district called "Alicante Golf". This tank has been used on numerous occasions since it was completed in May 2011, mainly in autumn and, to a lesser extent, in spring, which highlights the characteristic rainfall pattern of the south east peninsula (Figure 3). A brief analysis of the volumes harvested shows that 2012 was the year in which the highest amount of water was accumulated up until the present day (454,383 m^3), highlighting the volume harvested in the autumn, especially in November with 145,651 m^3 (31% of the total of 2012). Furthermore the drought affecting the southeast peninsular from 2014 to December 2016 explains why this infrastructure has only been used a few times since it became operational and also the low volumes collected in 2014 and 2015. The torrential rainfall,

which is concentrated into a few episodes a year, is represented by the very prominent peaks in certain months and years such as, for example, April 2013 (148,060 m^3) or December 2016 (170, 432 m^3), the monthly maximum harvested so far. Once treated and purified, these volumes have been reused to water parks and gardens and to wash down the streets.

The second rainwater harvesting project is the Parque Inundable La Marjal, located in Playa de San Juan (north east of the city), which was completed in 2015. The project costing 3.6 million euros consisted in building a public park with greenery, walkways, and play areas for children, etc. Not only is it a recreational area (with landscaping and physical features similar to that of marshland) (Figure 5) it is also designed to reduce the risk of flooding. This park, located in an endorheic area, is like a tank (total capacity of 45,000 m^3 and a flood benchmark level of 5.60 metres) that temporarily stores the volumes of water that accumulate in this sector. The tank fills up slowly, coinciding with precipitation of certain intensity per hour, to minimize any potential risk to the recreational area, and also to laminate the effect of water accumulating in the urban areas nearby. In the event that the precipitation exceeds the capacity of the park, there is an overflow in Avenida de Oviedo, which would evacuate the excess surface run-off into the sea.

4. DISCUSSION AND CONCLUSIONS

Since the end of the nineties, sustainable drainage and the rainwater harvesting systems have become increasingly more popular in countries such as the USA Australia, UK, France, Sweden or Denmark, among others (DE GOUVELLO *et al*., 2014). The need to make a change to the unsustainable model of urban drainage management, which is based on the continual expansion of inefficient sewage networks (OLSSON *et al.*, 2009) and the waterlogging of areas due to the increasing number of impervious surfaces, which consequently alters the water cycle, is why these more sustainable drainage systems are being adopted. This approach has been favoured by the promotion of rainwater harvesting. This could be an efficient alternative solution to store water in areas that are under this water stress, either due to the weather conditions (aridity) or due to the increasing use and the activities that demand considerably more water. So in the last decade it has become an increasingly more popular option used in arid and semi-arid areas like the Mediterranean Basin for example, especially considering its numerous benefits and reasonable costs (LIUZZO *et al*., 2016). Nowadays, this practice is recognised as being an effective tool to make the drainage systems more sustainable in the urban environment, thus significantly helping to limit the demand for drinking water by setting aside significant volumes of non-drinking water for other household uses such as, for example, watering the garden, cleaning toilets or washing clothes (MERCOIRET *et al*., 2007) and, in turn, to mitigate the surface run-off (CAMPISANO *et al*., 2013). The adoption of regulations that endorse the use of this technique and the granting of subsidies or tax exemptions to buy the water harvesting devices are some of the factors that help explain why this practice is catching on. A good example of this is in France, where the approval of the Law dated the 21st of August, 2008 has helped consolidate and spread the use of this practice. It is included in the most far-reaching context of water resource management where one of the objectives is to promote the diversification of the water resources for domestic use. Previously the use of rainwater was only applicable to areas that were not connected to the water distribution network or isolated buildings, but now there is growing general trend in the interest to use it and implement it in individual and group projects in homes and buildings (commercial and industrial buildings, etc.), and, more recently, in large scale urban projects ("eco-towns") (DE GOUVELLO *et al*., 2009).

In conclusion, and in view of the advantages and the disadvantages of using rainwater, based on the proposals for a more comprehensive and sustainable management of the demand, it is highly likely that in the near future it is going to become a widely used resource in urban environments with limited water resources. According to the analysis of the case study done on the city of Alicante it is worth mentioning the interest shown by the company in charge of supplying the water (Aguas Municipalizadas de Alicante, Empresa Mixta –AMAEM-) to harvest rainwater and then reuse it for certain activities that do not require a specific

environmental water quality in contrast to the more individual type of ventures advocated by citizens, as in the case of San Cugat del Vallés (Catalonia). This has resulted in an improved management and more sustainable use of the water (less drinking water is used and water can be reused), which can set an example for other cities and areas with similar weather conditions and water supply characteristics. Therefore, the more that is known about the features of these resources, how they can be used, the corresponding management systems and their potential, the more progress can be made for a more sustainable and resilient planning model to combat any possible effects of the Climate Change in Spain.

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