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EARTH SCIENCES

Comparative Analysis of Water Stress Management's Tools Between Alicante - Spain and Caraguatatuba - Brazil

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Abstract: The Alicante's province, located mostly in Júcar's Water Basin in Spain, deals with water stress and land development since 1980s. The provisions about climate change in the area suggest that water stress will increase, so it is necessary to integrated it with spatial planning. This issues is also happens in Caraguatatuba, northern coast of São Paulo State in Brazil. There are planning tools developed for assessment the water stress, as Flooding's Risk Management Plan and Alert and Drought Period Special Plan in Júcar's Water Basin and Water's Safety Plan for Caraguatatuba. The main of this paper is to analyze the spanish tools to identify a commum structure for replicated it. Other main is, by the spanish practice, to identify opportunities for improvement the water stress management in Caraguatatuba. As results there are procedures in water stress planning, which deals with land use directives.

Key words: water basin management planning, spatial plan, drought periods, flooding.

INTRODUCTION

The Province of Alicante is mostly inserted in The Júcar River Basin District – JRBD – (78,85%), in Spain, and faces conflicts related to water resources and also to the use and occupation of its land since the 1980s. The demand for water resources in the region is related to agrarian activities (Juarez 2010, López & Melgarejo 2010) and mainly to urban growth and tourism activities (Hernández 2013, Vera & Rico 1995).

In the European Mediterranean coast, the increase of the urbanization is mainly due to the construction of houses, of main dwelling or summer resort. Spain, and more specifically the provinces of the Mediterranean coast, has maintained significant growth in the urbanized area as a consequence of the increase in residence-based tourism since the 1960s (Alaminos et al. 2004, Baños et al. 2010, Gómez-Martín et al. 2014, Mantecón et al. 2009, Rico et al. 2009).

In between 1997 and 2008, Alicante was the third Spanish city in number of housing constructions (345,410), after Madrid and Barcelona, and ahead of some provinces which populations are bigger, such as Valencia or Málaga (Morote & Hernández 2016). Alicante's urban development is associated not only to the traditional way of summer seasonal tourism but also to the new lifestyles and kinds of migration related to the construction of second homes.

The tourist activity allied to seasonality issues has a great impact potential for using and occupying land, water and energy consumption and biodiversity loss (Grindlay et al. 2011). The pressure on water resources is increased by the need for areas for urbanization and development of tourist activities, influencing

policies on land use and occupation (Valenzuela & Matarán 2008).

Having a look on the factors that affect water demand, especially to the changes in land use and occupation, allows a better understanding of the relationships established between urban sprawl and water consumption.

To manage the hydric demands along with the development of the use activities and land occupation, some tools for planning water resources covering the province of Alicante, such as the Júcar Basin Plan 2015/2021 (Confederación Hidrográfica del Júcar 2015b), Flood Risk Management Plan (Confederación Hidrográfica del Júcar 2015a), and Special Plan for Alert and Eventual Droughts in the Júcar Basin (Confederación Hidrográfica del Júcar 2006). At national level, Spain has the so-called Study of the Impacts of Climate Change on Water Resources and on Water Masses (Ministerio de Agricultura, Alimentación y Medio Ambiente 2012) and Impacts on the Spanish Coast by Effect of Climate Change (Ministerio de Medio Ambiente 2004).

According to predictions of climate change in Spain, the impact on water is negative: reducing water resources and increasing the magnitude and frequency of extreme phenomena such as floods and droughts. In the less pessimistic scenario, a 5% decrease in total contributions to the natural regime. This decrease would be followed by greater annual, interannual and seasonal variability (Ministerio de Agricultura, Alimentación y Medio Ambiente 2012).

The effects caused by climate change, also related to the risk of flood and drought, reinforce the need to incorporate territorial planning with the management of water resources. This integration can have important repercussions in some key sectors of the economy, including the tourist sector (Gómez-Martín 2017).

This paper will analyse the tools adopted in the province of Alicante, notably the Flood Risk Management Plan (Confederación Hidrográfica del Júcar 2015a) and the Special Plan for Alert and Eventual Droughts in the Júcar Basin (Confederación Hidrográfica del Júcar 2006), in order to identify a common structure in water conflict management tools.

The common structure used to manage conflicts between water resources and land use and occupation in Alicante can be used as a reference model for replication in other regions. The verification of this model will be carried out through a comparison with the water conflicts management system adopted in Caraguatatuba, a city in the north coast of the State of São Paulo, Brazil.

Caraguatatuba is a tourist destination of sun and beach, which presents a high rate of population growth in a short time. The city stands out because it is facing a strong process of accelerated urbanization, as a result of the installation of large enterprises and the growth of tourist activities in the region (Asmus et al. 2012; Seixas et al. 2010, Secretaria do Meio Ambiente & Coordenadoria de Planejamento Ambiental 2011). To manage the growing demand for water resources with urban development, the so-called Water Safety Plan for Caraguatatuba is being developed.

The purpose of this article is to identify in practices adopted in Alicante, strategies for integrating the issues of climate change to water management and land use and occupation. As a result, we propose a model of analysis of the aspects that are fundamental to the process of planning and water use and land use conflicts in order to find strategies to improve the system applied in Caraguatatuba.

MATERIALS AND METHODS

Study area

In this section, we present the current and historical characteristics of Alicante and Caraguatatuba, as well as the reasons that led to the construction of the planning tools selected for the accomplishment of this article.

Alicante, Júcar River Basin District, Spain

Alicante's localization is on Figure 1. JRBD uses an average 3.932hm³/year, with a total of 3.111 hm³/year natural regime contribution. The rest of the resources come from unconventional sources, among which the resources from the desalination processes of marine waters (3.5 hm^3 per year) and the reuse of urban waste water (Confederación Hidrográfica del Júcar 2015b).

The most relevant economic activities in the river basin are services, industry, agriculture and energy. Considering the data from the seven provinces that have territory in the JRBD, the sector that contributes most economically with the so-called Gross Added Value – GVA – (*Valor Añadid Bruto - VAB*) in the total of 65% is the services (hotel, transportation, shows, etc.), which has the biggest annual growth. One of the activities to be highlighted in this sector is tourism, which, in 2015, provided 13.2% of the GVA of the Autonomous Community of Valencia, with a contribution of 13.423 million euros.

Overall, the trend of water consumption has increased from the 1960s to 2000 in all cities where the increase of houses and population are related to tourist activities. For land use and occupation, repercussions include conflicts and increased competition for access to land

Figure 1. Province of Alicante localization (source: adapted from Wikipedia 2020).

and water resources, increased consumption of certain resources (such as water and electricity) and generation of waste (solid and liquid effluents). The increase in the number of houses, and especially the adoption of horizontal typologies, strengthen this dispute (Hernández 2013).

The fixed and seasonal population expansion, encouraged for decades by different administrations, has brought competition with other activities, such as agriculture and environmental preservation. In some cities, more than 50% of irrigated land was lost during the period 1985-2000 (De Gea 2010, Morote & Hernández 2016).

In Alicante, changes in economic activities and urban development affected natural resources and public services. Historically, periods of drought in the region have forced tourism and water supply to make changes to the water abstraction, transportation and regulatory procedures, adopting the reuse of purified water, desalination and complementary uses between irrigators and domestic consumption (Rico et al. 2014).

According to the study *Impacts on the Spanish Coast by Effects of Climate Change* (Ministerio de Medio Ambiente 2004), the vulnerability of climate change effects will be significantly increased in some parts of the coastline, and if the introduction of recommendations or regulations is necessary to incorporate consideration of climate change within the territorial planning of the coast.

Caraguatatuba, São Paulo north coast, Brazil

São Paulo State's North coast is a Water Resources Management Unit, which encompasses the cities of Caraguatatuba, Ilhabela, São Sebastião and Ubatuba. This region is classified as a set of river basins intended for the conservation of natural resources, and about 80% of its territory is protected as a conservation unit of full use in the form of a state park, which restricts the availability of areas for urbanization (Instituto de Pesquisas Tecnológicas 2009).

The diversity of natural resources and intense real estate speculation is a characteristic of the North coast. Its economy is marked by the

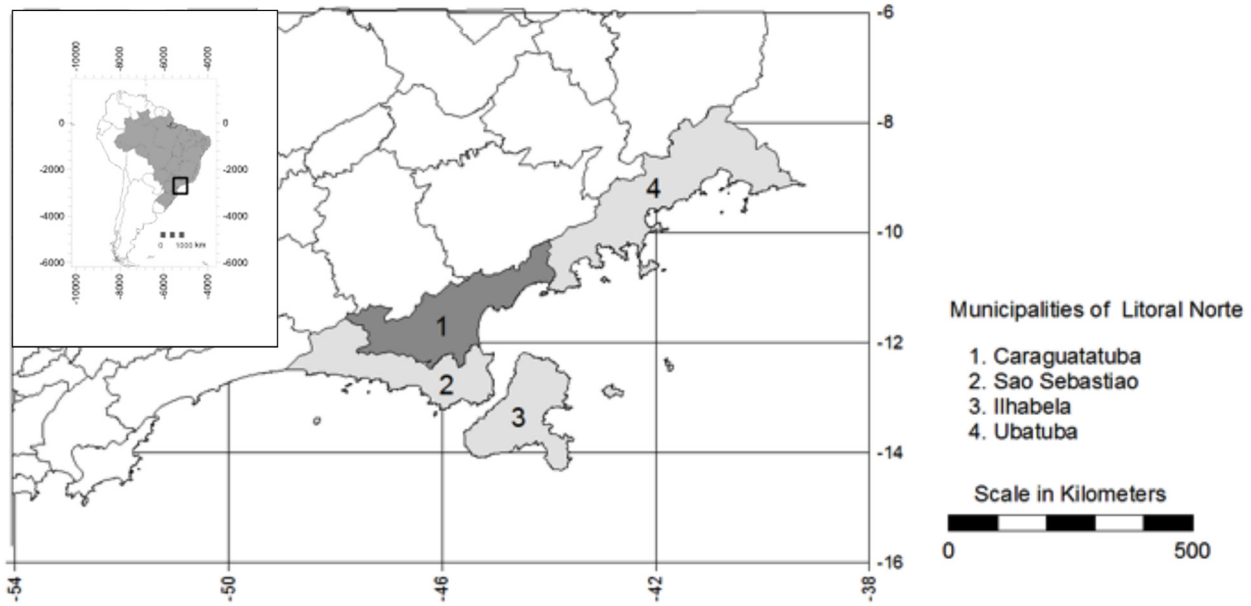

Figure 2. Caraguatatuba localization (Source: prepared by the author).

seasonality resulted from the predominance of summer tourism (Secretaria do Meio Ambiente & Coordenadoria de Planejamento Ambiental 2005). Caraguatatuba's location is shown in Figure 2. The city currently has 113.208 inhabitants with a population growth rate of 1.48% per year, well above São Paulo State average – the 0,82% (Fundação Sistema Estadual de Análise de Dados 2018).

In Caraguatatuba, the main issue related to water resources is the lack of environmental sanitation, which allows the inappropriate disposal of effluents directly into rivers and urban channels (Arcadis Tetraplan 2010). According to Fundação Sistema Estadual de Análise de Dados (2018), the sewage network in Caraguatatuba serves 57,94% of the city, well below the average of the State of São Paulo, which is 89,75%.

Currently, apart from summer tourism, the city is also characterized by urban growth potential that can occur in a short period of time due to the pressures generated by offshore oil and natural gas exploration in the region, called pre-salt (Asmus et al. 2012).

Population growth is one of the most used scenarios in predicting trends in land use and land use trends (Geneletti 2012, Petrov et al. 2009, Shearer 2005, Pettit & Pullar 2004). The accelerated urban growth is related to the increase of the demand for water use and respective conflicts of land use and occupation, according to Carter et al. (2005).

The economic activities transformation has been promoting a change in the urban development pattern of Caraguatatuba. The North coast has, historically, the highest percentage of occasional households in the total household composition, closely related to tourism based on the second residence. However, Caraguatatuba currently has decreasing percentages of this type of occupation. In this process, the places intended for fixed dwelling have been growing more intensely than those for occasional use, what indicates changes in the functions that the territory has been assuming (Marandola Júnior et al. 2013).

This change in the profile of urban growth, shifting from the occasional tourist use to the search for job opportunities, results in the occupation and valuation of different areas. If the tourist expansion spreads over several kilometres of the coast, searching for nearby spaces or with easy access to the beaches, the urbanization focused on the current process concentrates on cheaper areas, which have been those with restrictions of use. In the case of Caraguatatuba such areas of expansion are precisely in areas of environmental risk (Marandola Júnior et al. 2013).

Currently, 18 environmental risk areas have been mapped in Caraguatatuba, 16 of which are in urban areas and only 2 are in rural areas. The areas of environmental risk are illustrated in Figure 3.

Historically, in Caraguatatuba, there is an intensive process of informal occupation of vulnerable areas with environmental fragility, due to the scarcity of areas suitable for urban occupation in the region (Arcadis Tetraplan 2010). In 1967, there was a natural disaster in Caraguatatuba caused by a waterspout. The precipitation drenched the slopes, causing the slide of Serra do Mar scarps, the disappearance of 23% of the houses and displacing 20% of the population of that time (Marandola Júnior et al. 2013).

The undesirable creation of informal urban settlements has been the object of public concern, both because of its proximity to the state park and because of its impacts on the quality of water resources, which includes the deterioration of the quality of beaches in the

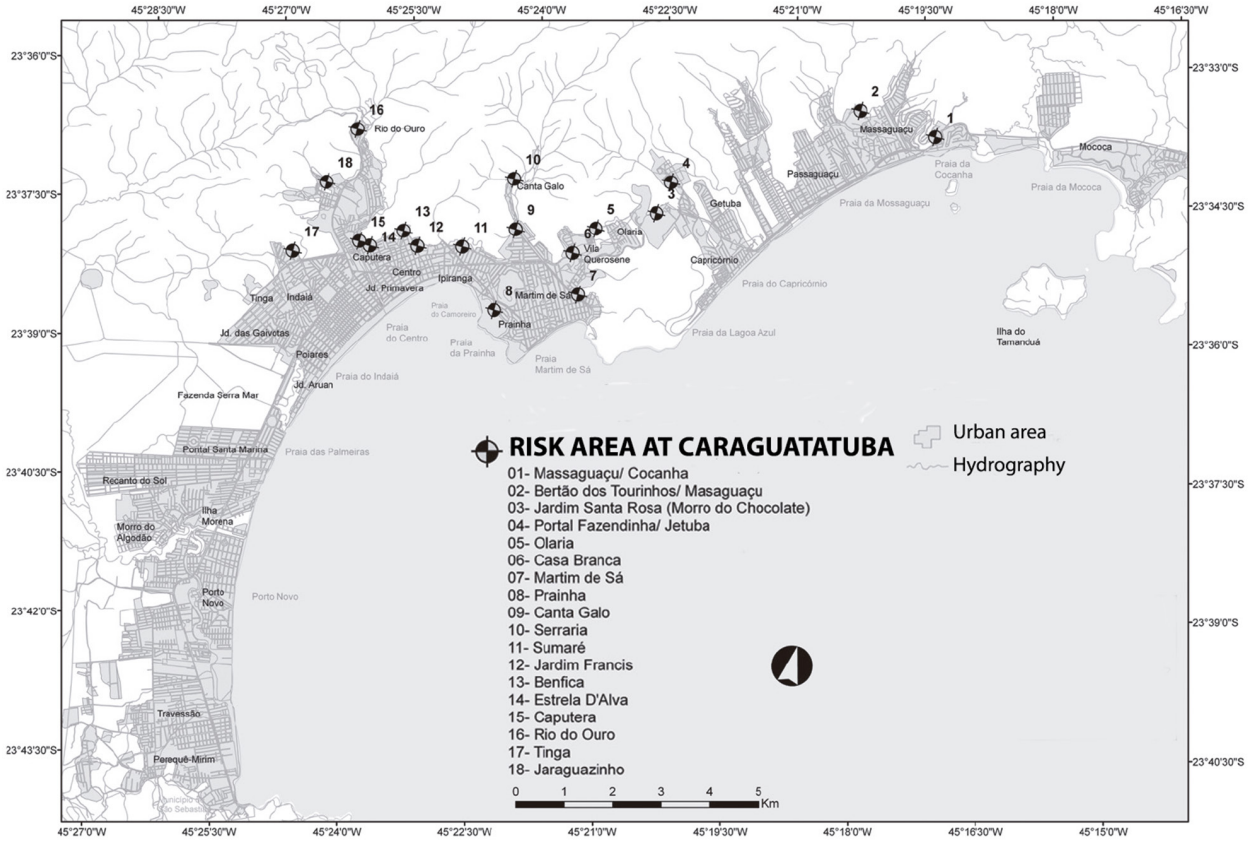

Figure 3. Environmental risk areas in Caraguatatuba (source: adapted from Marandola Júnior et al. 2013).

region, which ensures tourism and moves the local economy (Arcadis Tetraplan 2010).

Methodology

The research was carried out in six methodological steps, described in this section. The first of them contemplated the analysis of the historical context of conflicts of water resources with urban developement in the province of Alicante, Spain, and in the city of Caraguatatuba, Brazil. The second of them addressed an overview on the planning tools and legal framework of drought and flood management plans in the selects areas. The third step was the detailed analysis of selected tools specifically designed to manage the conflict of water resources. The fourth step identify the common structure in the selected Spanish planning tools and applied it as a model. The fifth step did the comparison by that model with the Caraguatatuba case. The last step identified possible improvements in the Caraguatatuba case.

The first step of this research bases in a bibliographic review in scientific journals in order to understand the historical contex of conflicts of water resources with urban developement in the selected cities. The Alicante system for managing water conflicts was selected because of its many decades of experience. In Brazil, the city of Caraguatatuba, located on the north coast of the State of São Paulo, was selected because a Water Safety Plan is being developed there. The fact that the Water Safety Plan of Caraguatatuba is in the process of elaboration makes this analysis timely, since it allows the

incorporation of suggestions for improvement in its final product.

The second step of this research addressed an overview on the planning tools and legal framework of drought and flood management plans in the selected area. In Spanish case were analyzed:

- Júcar Basin Plan 2015/2012 (Confederación Hidrográfica del Júcar 2015b) and respective Flood Risk Management Plan (Confederación Hidrográfica del Júcar 2015a);
- Special Plan for Alert and Eventual Droughts in the Júcar Basin (Confederación Hidrográfica del Júcar 2006);
- Study of the Impacts of Climate Change on Water Resources and on Water Masses (Ministerio de Agricultura, Alimentación y Medio Ambiente 2012);
- Impact on the Spanish Coast by Effect of Climate Change (Ministerio de Medio Ambiente 2004).
- In Brazilian case were analyzed:
- National Policy on Water Resources - Federal Law 9,433/97;
- National Policy on Civil Protection and Defense - Federal Law 12,608/12;
- Meeting minutes of the Caraguatatuba Water Safety Plan (Comitê de Bacias Hidrográficas do Litoral Norte 2014a, Comitê de Bacias Hidrográficas do Litoral Norte 2014b, Comitê de Bacias Hidrográficas do Litoral Norte 2014c, Comitê de Bacias Hidrográficas do Litoral Norte 2014d, Comitê de Bacias Hidrográficas do Litoral Norte 2014e).

The third step of this research focused on the structure and main contents of selected planning tools specifically designed to manage the conflict of water resources, notably the:

- Flood Risk Management Plan developed for the Júcar Hydrographic Basin (Confederación Hidrográfica del Júcar 2015a);
- Special Plan for Alert and Eventual Drought in the Júcar Hydrographic Basin (Confederación Hidrográfica del Júcar 2006);
- Meeting minutes of the Water Safety Plan of Caraguatatuba (Comitê de Bacias Hidrográficas do Litoral Norte 2014a, Comitê de Bacias Hidrográficas do Litoral Norte 2014b, Comitê de Bacias Hidrográficas do Litoral Norte 2014c, Comitê de Bacias Hidrográficas do Litoral Norte 2014d, Comitê de Bacias Hidrográficas do Litoral Norte 2014e).

In the both plans the preparation and content of steps were analyzed:

- Definition of objectives;
- Diagnosis;
- Establishment of indicators;
- Elaboration of action scenarios with respective action strategies;
- Establishment of a legal framework;
- Mechanisms for monitoring the plans.

The fourth step identify the common structure in the Spanish planning tools and applied it as a model. Next, in the fifth step there is the comparison about that model with the Caraguatatuba case. The comparison made it possible to identify significant differences in the procedures adopted in the steps of:

- Diagnosis;
- Elaboration of scenarios;
- Definition on legal framework.

Finally, in the last step, by the differences found in that comparison was possible to identify opportunities for improvements in the procedures adopted in the Brazilian practice, with emphasis on the strategies of land use and occupation actions.

RESULTS

In this section, the tools for the management of conflicts of water resources applied in Alicante and Caraguatatuba will be analyzed. In Alicante, it will be analyzed the Flood Risk Management Plan (Confederación Hidrográfica del Júcar 2015a) and Special Plan for Alert and Eventual Droughts in the Júcar Basin (Confederación Hidrográfica del Júcar 2006). In Caraguatatuba, it will be analyzed the Water Safety Plan.

The analysis of the planning tools seeks to identify common points in the steps elaboration: definition of objectives, diagnosis, indicators, scenarios with respective strategies of action, legal framework and monitoring of the plans.

Flood Risk Management Plan for the Júcar River Basin

Flood risk management plans are a document drawn up at the international level by the United Nations Educational, Scientific and Cultural Organization (UNESCO), called "*Flood Risk Management: A Strategic Approach. 2013*" in which essential rules for the management of flood risks are stipulated. These rules include: accepting that absolute protection is not possible, planning for accidents, and promoting some floods as desirable (Confederación Hidrográfica del Júcar 2015a).

The Flood Risk Management Plans – FRMP – carried out in Spain involve the Preliminary Assessment of Flood Risk and identification of Potential Areas of Significant Flood Risk - PASFR, with the performance of hazard maps and flood risk maps (Confederación Hidrográfica del Júcar 2015a).

At national level, the Royal Decree 903/2010 establishes forecasts for coordination with other sectoral plans, assigning its article 14 to the coordination of hydrological plans of the basins and article 15 for coordination with other plans (territorial and urban planning tools, civil protection plans, agrarian development plans, forestry policy, transport infrastructure and other plans affecting floodplain areas), which should be compatible and coordinated with the content of the flood risk management plan (Confederación Hidrográfica del Júcar 2015a) .

In the JRBD FRMP, for areas determined in a preliminary risk assessment, it was established as a general objective to ensure that the current flood risk is not increased and that, if possible, the risk is reduced through different programs of action (Confederación Hidrográfica del Júcar 2015a).

For the identification of river sections that have caused significant flooding in the past and for areas liable to future flooding, a geographic representation of historical information relating to previous hydrological and hydraulic studies has been defined for the geomorphological elements associated with potentially floodable areas and information identified by the administrations responsible for civil protection (Confederación Hidrográfica del Júcar 2015a).

By ordering the PASFR candidate by decreasing values of potential unit damage and calculating the accumulated values of potential damage, it was observed that 35% of the coast length accumulates 95% of the total value of the potential damages (Confederación Hidrográfica del Júcar 2015a).

Once the PASFRs were identified it was possible to perform the hazard maps. The hazard maps represent the delimitation of the public channels and the easement and inspection zones, the preferential flow zone, the delimitation of the public maritime-terrestrial domain, the margin of the sea in cases where it is different, and its zones of easement and protection (Confederación Hidrográfica del Júcar 2015a).

To prepare the hazard maps, 3 scenarios were considered as a function of the statistical probability of flood occurrence: high probability (which is associated with a return period of 10 years), average probability (associated with a 100 year return period) and low probability or scenario of extreme events (return period equal to 500 years).

The indicators adopted for the hazard case are: flooded surface, drafts and speeds, time of concentration in the basin, transport of sediments and obstacles in the channels. In each of the indicators, in each probability scenario, it was assessed on a five-category scale because the damage was very severe, severe, moderate, light or undamaged (Confederación Hidrográfica del Júcar 2015a).

Among the measures taken to minimize the damage caused by floods is the land use planning. The measures foreseen to adapt the existing urban planning to the FRMP criteria include the possibility of buildings removal or consider them as a public utility as well as propose limitations in the ground use for the flood zones in their different hazardous situations, with the establishment of constructive criteria required for the different buildings located in the flood zones, or even consider the territory as non-urban-type (Confederación Hidrográfica del Júcar 2015a).

As a legal framework, the need for coordination with other existing hydrological plans and programs is established at national level. By Royal Decree 407/1992 of April 24, the Basic Regulation of Civil Protection was approved, which establishes what should be the object of a State Civil Protection Plan. The State Civil Protection Plan has the character of a master plan, therefore it establishes general, functional and organizational and planning aspects that must be fulfilled in the coordination and support plans, and in specific procedures of the FRMP (Confederación Hidrográfica del Júcar 2015a).

Table I. Summary of the main procedures for the preparation of the Flood Risk Management Plan (source: prepared by the author).

FUNDAMENTAL STAGES	MAIN CONTENT
objectives	do not increase or reduce the current risk, accepting the event as inevitable
diagnosis	geographical representation of historical information
indicators	flooded surface, drafts and speeds, concentration time, sediment transport, obstacles in the canals
scenarios	high probability (return of 10 years), average probability (return of 100 years) and low probability (return of 500 years)
legal framework	Royal Decree 407/92 that defines the Basic Regulation of Civil Protection for State Plans.
monitoring	Automatic Hydrological Information System relative to circulating levels and flows of rivers and tributaries, level and volume dammed, flow eliminated, rainfall, flow consumed in the main uses of water.

The monitoring of the FRMP takes place through the Automatic Hydrological Information Systems - AHISs. This system provides information on the circulating levels and flows of the main rivers and tributaries, the level and volume dammed, the flow eliminated by the devices of the dams (valves, thief and floodgates), the pluviometry in numerous points and the flows consumed by the main uses of Water. To capture these variables, sensors are used, which are in contact with the medium, equipped with decoders that provide an electrical or logic signal of the state of the measured variable. Júcar AHIS provides real-time data every 5 minutes from a series of control points, with historical data available since 1989 (Confederación Hidrográfica del Júcar 2015a).

Table I summarizes the fundamental steps for the realization of FRMP with its main contents:

Table I shows that flood risk management considers the event as inevitable, uses historical information to map and characterize possible damages, uses quantitative hydrological indicators, elaborates scenarios with specific and gradual strategies, and such procedures are supported by a previous legal structure and uses a monitoring system that allows the revision and updating of the plan.

Special Plan for Alert and Eventual Droughts in the Júcar Basin

The drought phenomenon is determined when the water resources of a management system are abnormally reduced over a given period of time, compared to a representative historical series. However, if the lack of water is considered habitual in a region, it is a situation of aridity and not of dryness. On the other hand, it is not necessary to establish a restriction in the water supply to configure the so-called socioeconomic dryness, but it is enough that some economic sector is impacted by the water shortage with unfavourable economic consequences (Confederación Hidrográfica del Júcar 2006).

The growing anthropic pressure on water resources is increasing the incidence of socioeconomic drought, with increasing economic losses. To manage water scarcity, JRBD prepared the Special Plan for Alert and Eventual Droughts in the Júcar Water Basin – SPAED.

The general goal of SPAED is to minimize the environmental, economic and social impacts of drought situations. The specific objectives are: to guarantee the availability of water necessary to guarantee the health and life of the population; minimize negative effects for urban supply and economic activities, considering the priority of uses established by Law; avoid or minimize the negative impacts of drought on the ecological status of the water bodies, mainly guaranteeing the ecological flow (Confederación Hidrográfica del Júcar 2006).

As a diagnosis, for a period of drought to be characterized, a variation of basic demand is stipulated in relation to the annual demand, where the one-year deficit can not exceed 5 to 10%, in two consecutive years the sum of the deficit can not be higher to 10-16%, and in ten consecutive years the accumulated deficit does not reach 16-30% of annual demand. In this sense, the SPAED establishes the following percentages: at one year 10%, at two years 16% and at ten years 30% (Confederación Hidrográfica del Júcar 2006).

The historical drought in the JRBD is inscribed in dry cycles of precipitation and contributions. The first one is between 1977/78 - 1986/87, reaching special gravity in the hydrological years 1983/84 to 1985/86. Subsequently, in the period 1992/93 - 1995/96, among the operating systems most affected by the decrease in contributions was the Júcar system, which was 35% lower than the average. In 1997/98 - 2000/01, there was also

a drought condition, and the driest year of the cycle was 1998/99 to 1999/00.

As indicators were used control elements of representative management chronological series such as: rainfall, flow, supply and levels of dams, and aquifer levels (Confederación Hidrográfica del Júcar 2006).

From the analysis of the indicators, the SPAED establishes 4 scenarios (normality, pre-alert, alert and emergency) with respective action measures. The establishment of gradual scenarios allows guidelines for land use and occupation to be established so that urban development can cope with the occurrence of extreme events.

As a legal framework, the hydrological gravity of the situation prompted the publication of Royal Decree 1265/2005 of 21 October 2005, in order to adopt exceptional administrative measures for the management of water resources and to correct the effects of drought in the Júcar river basins, Segura and Tajo, granting special powers to the Hydrographic Demarcations Government Board for studies and application of emergency measures that can mitigate the effects of drought (Confederación Hidrográfica del Júcar 2006).

Royal Decree 1265/2005 established in its article 2 paragraph 3 that the fulfillment of the functions defined in this decree, in each of the Boards of Government, will constitute a Permanent Commission. The Commission first established itself in the JRBD at the beginning of December 2005, and established the need to set up a Technical Support Drought Workshop to study and deal with the actions planned to mitigate the effects of drought (Confederación Hidrográfica del Júcar 2006).

As a monitoring, a review of SPAED is considered under normal conditions, at most, every 6 years. This period is less than the mean between droughts, which may be 8 years (Confederación Hidrográfica del Júcar 2006).

Table II. Summary of the main procedures for the elaboration of the Special Plan for Alert and Eventual Droughts in the Júcar Basin (source: prepared by the author).

FUNDAMENTAL STAGES	MAIN CONTENT
objectives	minimize environmental, economic and social impacts, accepting the event as inevitable
diagnosis	deficit in relation to the annual demand, based on historical information
indicators	rainfall, flow, supply and levels of dams, and water levels of aquifers
scenarios	normality, pre-alert, alert and emergency
legal framework	Royal Decree 1265/05, which defines the adoption of exceptional measures and correction of droughts, with the constitution of a Permanent Commission on Droughts.
monitoring	hydrological indicators (rainfall, flow, supply and levels of dams, and aquifer levels), increase of supply (new infrastructure)

However, a review is also carried out in the following cases: Where the magnitude of the differences is such that it makes significant changes to the indicators and changes in the forecast or in the SPAED program of measures; After a drought, based on the findings of the post-dry report, unless the report itself considers a SPAED characterization sufficient; When a revision of the Emergency Plan of a significant water supply in the basin is produced or new operational infrastructures are available with incidence for the management of the droughts; When there is a significant change in the limits of indicators and management measures as a consequence of the consideration of models that take into account climate change (Confederación Hidrográfica del Júcar 2006).

Table II summarizes the fundamental steps for the realization of SPAED with its main contents:

Table II shows that the management of droughts considers the event as inevitable, uses historical information and geographic coverage to characterize possible damages, uses quantitative hydrological indicators, elaborates scenarios with specific and gradual strategies, and such procedures are supported by a prior legal structure and uses a monitoring system that allows the review and updating of the plan.

Water Safety Plan of Caraguatatuba

The WSP follows the Guidelines for Drinking-Water Quality of the World Health Organization (World Health Organization & International Water Association 2009), with a special focus on the organization of water supply systems. The WSP is an international practice applied in Europe, Australia, Latin America and the Caribbean. The WSP approach should consider managing the risks that can influence water quality and availability, in relation to the continued supply of drinking water. Significant risks that are not being controlled should be mitigated, and may include short, medium and long term implementation measures (World Health Organization & International Water Association 2009).

The WSP of Caraguatatuba is being drafted by the Water Basins Committee of the North coast of the State of São Paulo since 2014. As the final version was not published, the minutes of the meetings of the WSP were analysed. The fact that WSP is in the process of elaboration makes this analysis suitable, since it allows the incorporation of suggestions for improvement in its final product.

The WSP is a document that seeks to identify and prioritize the potential risks that can be verified in a water supply system, from the water collection stages to the distribution to the consumer's tap. To this end, it establishes control measures to reduce or eliminate negative impacts to water resources, establishing processes to verify the management efficiency of the control systems and the quality of the water produced. The general objective of the WSP is to ensure the quality of water for human consumption through the use of good practices in the supply system (Comitê de Bacias Hidrográficas do Litoral Norte 2014a).

As a diagnosis of the WSP, the identification of the current activities of use and occupation of the land that can generate hazards to the quality of the water, as well as the description of the system of supply and its possible faults are carried out, being such aspects considered as hazards. After hazard identification, the risk characterization and classification (Comitê de Bacias Hidrográficas do Litoral Norte 2014c) is performed. Risk classification is performed by analyzing the probability of occurrence (once a day, once a week, once a month, once a year or once in ten years), and severity (lethal for more than 10 % of population, lethal to less than 10%

of the population, harmful to more than 10% of the population, harmful to less than 10% of the population or with no significant negative impact) (Comitê de Bacias Hidrográficas do Litoral Norte 2014e).

In Caraguatatuba, a water supply system was selected from the Porto Novo Water Treatment Station, with a flow of 1,998m3 / h, which uses the river Claro as a spring (Comitê de Bacias Hidrográficas do Litoral Norte 2014b). A characterization of the land use and occupation was carried out in the river Claro river basin, with the delimitation of the risk assessment in a marginal range of 150 meters along the river (Comitê de Bacias Hidrográficas do Litoral Norte 2014d, Comitê de Bacias Hidrográficas do Litoral Norte 2014e).

In order to control the quality of raw water, quality indicators were adopted: turbidity, color, pH and alkalinity, during drought and rainy periods, to capture the upper and lower river Claro (Comitê de Bacias Hidrográficas do Litoral Norte 2014b).

After the diagnosis and establishment of the indicators, the operational monitoring stage is foreseen. This stage includes the definition of critical limits, monitoring procedures and definition of corrective actions (Comitê de Bacias Hidrográficas do Litoral Norte 2014a).

The next step would be the establishment of so-called Management Plans, where procedures for routine management and management in exceptional situations should be defined, with the definition of communication documents and protocols. The Management Plans in Exceptional Conditions should contemplate natural disasters, such as hydrologic phenomena of drought and flood, with the realization of Emergency Plans.

Emergency Plans should specify those responsible for coordinating proposed measures, alternative schemes for water supply and communication plans to alert and inform affected consumers (Comitê de Bacias Hidrográficas do Litoral Norte 2014a). In this way, it can be considered that the WSP does not exist the elaboration of scenarios of action, but of Routine Management Plans and Emergency Plans with respective actions for phenomena of drought and flood.

There is no specific legal framework for the WSP, however, since the preparation of Emergency Plans for Droughts and Floods is foreseen, the National Policy on Water Resources - Federal Law 9.433 of 1997 and the National Policy on Civil Protection and Defense - Federal Law 12,608 of 2012.

The National Policy on Water Resources - NPWR, in article 1, item IV, establishes that water management must always provide for the multiple use of water, and in its section III, provides that in situations of scarcity, priority use of resources water is the human consumption and the watering of animals. The NPWR, in article 2, item III, establishes among the objectives the prevention and defense against critical hydrological events of natural origin or due to inappropriate use of natural resources (Brasil 1997).

The National Policy on Protection and Civil Defense - NPPCD, in its Article 2, establishes as a duty of the Union, States, Federal District and Municipalities to adopt measures necessary to reduce disaster risk. In its article 3, single paragraph, NPPCD is expected to be integrated with territorial planning, urban development, environment, climate change, water resources management, among other sectoral policies. In its article 5, item IV, establishes as one of the objectives of the NPPCD the incorporation of disaster risk reduction among the elements of territorial management, being the municipal competence, according to Article 8, the incorporation of the actions of protection and civil defense in planning municipal territory (Brasil 2012).

NPPCD, in article 22, establishes the national registry of cities with areas susceptible to high impact landslides, sudden floods or related geological or hydrological processes. In the same article, item 2, it will be up to the registered cities to draw up a Contingency Plan for Civil Protection and Defense and the creation of control and inspection mechanisms in order to avoid building in critical areas (Brasil 2012).

However, according to *Agência Câmaras de Noticias* (Câmara dos Deputados 2017), this registry was not regulated. In this way, as such cadastre is not regulated, nor is it guaranteed the inclusion of Caraguatatuba in such cadastre, the guidelines stipulated by the WSP and respective Emergency Plans are recommendations that may or may not be incorporated into the territorial planning of Caraguatatuba.

Regarding monitoring, the last stage of preparation of the WSP would contemplate the verification of its implementation and validation of the Plan by monitoring the evolution of the indicators adopted (Comitê de Bacias Hidrográficas do Litoral Norte 2014a). Table III summarizes the fundamental steps for the accomplishment of the WSP with its main contents:

Table III shows that WSP is limited to water quality issues, uses only current information on land use and occupation to characterize possible damages, uses qualitative hydrological indicators, does not elaborate action scenarios (choosing Plans of Routine Management and Emergency Plans for drought and flood), as there is no regulation of its previous legal structure is configured as a set of recommendations and provides a monitoring system to verify its implementation and validation.

DISCUSSION

In this section we will compare the results of the analysis carried out in Alicante and Caraguatatuba, concerning the structure of the tools for water conflicts and land use and occupation, with their respective main contents.

Based on the analysis and results of the practice adopted in Alicante, it is possible to propose a model for the elaboration of tools for the management of water conflicts with the use

Table III. Summary of the main procedures for the preparation of the Caraguatatuba Water Safety Plan (source: prepared by the author).

FUNDAMENTAL STAGES	MAIN CONTENT
objectives	Ensure the quality of water for human consumption through the use of good practices in the water supply system
diagnosis	Identification of land use and occupation activities that may generate hazards to water quality, as well as a description of the water supply system and its possible failures
indicators	turbidity, color, pH and alkalinity
scenarios	There is no elaboration of scenarios, but of Routine Management Plans and Emergency Plans for drought and flood
legal framework	National Water Resources Policy - Federal Law 9.433, 1997, and National Policy on Protection and Civil Defense – Federal Law 12.608, 2012
monitoring	Monitoring the evolution of indicators

and occupation of the land. By comparing the fundamental steps with respective main contents of the FRMP illustrated in Table I with the fundamental steps and respective main contents of the SPAED illustrated in Table II it is possible to infer that both tools have a common planning structure which is also reflected in their contents.

In this way, it can be affirmed that there is a common structure in the tools of planning of the conflicts related to the water resources and use and occupation in the ground adopted in Alicante, shown in Table IV.

Table IV allows to identify a common structure in the elaboration of the tools adopted in Alicante, related to their fundamental stages and their contents, being: definition of objectives considering the water event as inevitable, the realization of the diagnosis based on historical information and spatial comprehensiveness, the establishment of indicators with quantitative hydrological data, the establishment of different scenarios to intensify the conflict with the respective action measures, the existence of a previous legal framework to make feasible the implementation of the proposed actions and a monitoring system based on the monitoring of the indicators that allow verify the efficiency of the plans and enable their updating. When comparing the results of Table IV with the results of Table III, it is possible to identify significant differences in the systems of water conflicts management with land use and occupation adopted in Alicante and Caraguatatuba.

In both cases analyzed, the main content of the goal setting, indicator setting, and monitoring systems are intrinsically linked to the scope of each planning tool. The scope of the tools applied in Alicante is to manage the availability of water resources, therefore, it has a quantitative targeting. The scope of the WSP applied in Caraguatatuba is to guarantee the quality of the water, therefore, it has a qualitative direction. The definition of the scope (quantitative or qualitative) of water resource planning tools directly influences the selection of indicators and their monitoring systems.

The stages of diagnosis, scenario preparation and legal framework setting are not only related to the scope of planning tools, but also have elaboration procedures that are fundamental to improve the efficiency of expected results in the planning tools. Table V illustrates the comparison of the procedures adopted in the diagnostic stages, the elaboration of scenarios

Table IV. Results of the comparison between the procedures of the Flood Risk Management Plan and the Special Plan for Alerting and Eventual Droughts in the Júcar Basin (source: prepared by the author).

FUNDAMENTAL STAGES	MAIN CONTENT
objectives	plan to accept the event as inevitable
diagnosis	historical information and spatial scope
indicators	quantitative hydrological data
scenarios	elaboration of different gradual scenarios with respective strategies of action
legal framework	structure that allows the application of the planning tools
monitoring	monitoring of the indicators allows verification of the efficiency of the plan.

Table V. Comparison between the procedures for the elaboration of stages of the water conflicts management system with the land use and occupation adopted in Alicante with the Caraguatatuba Water Safety Plan (source: elaborated by the author).

	ALICANTE	CARAGUATATUBA
STAGES	**MAIN CONTENT**	
diagnosis	historical information and spatial comprehensiveness	Identification of current land use and occupation activities that may cause hazards to water quality
scenarios	elaboration of different gradual scenarios with respective action strategies	elaboration of routine and emergency scenarios
legal framework	Legal structure that allows the application of the planning tool.	National Water Resources Policy - Federal Law 9.433, 1997 and National Policy on Protection and Civil Defense - Lei Federal Law 12.608, 2012

and the establishment of legal frameworks in the tools analyzed.

Table V allows to identify that the water conflicts management system with the land use and occupation adopted in Alicante and the WSP of Caraguatatuba have similar fundamental stages. However the main content of these steps present significant differences.

For the diagnostic phase, the system adopted in Alicante adopts the spatial coverage and historical information related to the occurrence of drought and flood events, that is, it uses current and historical data of occurrence of events. The WSP uses the spatial mapping and only current data of the activities that can impact the quality of the water.

According to Therivel (2004), past trends can aid in the planning of future actions. The incorporation of historical data in the elaboration of the Caraguatatuba WSP diagnosis can contribute to the improvement of evaluation and mitigation of impacts, since the technical evaluation can suppress aspects that, at first, do not seem significant, or do not incorporate the environmental perception of the affected population about the damages caused. Such differences can modify the valuation of impacts, and consequently, the selection of those that should be prioritized and mitigated.

For the stage of elaboration of scenarios, the system adopted in Alicante incorporates the elaboration of gradual scenarios with respective strategies of action. The WSP of Caraguatatuba does not elaborate different scenarios, but Management Plans for normality and extreme events. The use of gradual scenarios allows action strategies to be incorporated into land use planning systems, since in extreme events the priority is for urgent measures. As the Caraguatatuba WSP does not incorporate gradual scenarios, such as the case of pre-alert and alert for drought events, or short, medium and long term flood return time, important measures of land use and occupation are no longer incorporated in the system, leaving the population more vulnerable to the negative impacts of such events.

Regarding the establishment of legal framework, the system adopted in Alicante has

a prior legal apparatus that ensures that the guidelines proposed by the FRMP and SPAED are applied. In the case of the WSP of Caraguatatuba, the lack of regulation of existing legislation makes its guidelines not compulsory, that is, they may or may not be incorporated into the land use and land use planning system.

To be effective, a tool to support strategic decisions must be associated with the development of policy regulation and formal decision-making procedures. The absence of these characteristics can turn it into another bureaucratic exercise (Gallardo & Bond 2011).

From the analysis performed, it is possible to identify specific actions of the Spanish experience that could be incorporated in the management system adopted in Caraguatatuba. Table VI presents possible contributions of the water conflicts management system with land use and occupation adopted in Alicante to the WSP of Caraguatatuba.

Table VI identifies 8 actions established in the water conflicts management system with land use and occupation adopted in Alicante that could be incorporated in the WSP guidelines of Caraguatatuba. The first three items of Table 6 (specific construction criteria for flood zones, targeting activities compatible with flood zones and regulated legal apparatus) are guidelines present in the FRMP. The 5 other items in Table VI (creation of catchment points for temporary supply, limitation of non-essential uses: swimming pool and car washers, water exchange exchange bank, water purification units and water desalination units) are guidelines present in the SPAED.

These actions are proposed based on the establishment of a previous legal framework, which guarantees the application of the planning tool. On the other hand, the establishment of gradual scenarios, such as different times of return for floods, and pre-alert, alert and emergency scenarios in the case of droughts, allows land use and land use guidelines to be established so that the development can cope with the occurrence of extreme events.

CONCLUSIONS

The province of Alicante, located mainly in JRBD in Spain, faces water conflicts related to the use and occupation of the land for decades. The intensification of this conflict is mainly due

Table VI. Contributions of the water conflicts management system with the use and occupation of the land adopted in Alicante for the Caraguatatuba Water Safety Plan (source: prepared by the author).

	MEASUREMENT	EVENT
1	constructive criteria for flood zones	FLOOD
2	directing activities compatible with flood zones	
3	regulated legal framework	
4	creation of catchment points for temporary supply	DROUGHT
5	limitation of non-essential uses: swimming pool and car washes	
6	bank for the exchange of water resources	
7	water purification units	
8	water desalination units	

to tourism development in the area. In order to manage water conflicts with the demand for land use and occupation, the Government adopted specific planning tools such as the Flood Risk Management Plan and the Special Plan for Alert and Eventual Droughts in the Júcar River Basin.

In this way, it was possible to establish a common structure of procedures for planning tools for the management of water conflicts with land use and occupation in the province of Alicante. Considering that the perspectives of climate change indicate the intensification of these conflicts, this model, based on the Spanish historical experience, can be of great use to other localities in the management of similar conflicts.

The model elaborated from the Spanish practice was applied in the case of the city of Caraguatatuba, north coast of the State of São Paulo, Brazil. Caraguatatuba is a city of great tourist flow, presents a high rate of population growth, and is currently preparing the Water Safety Plan. When comparing the system adopted in Alicante with Caraguatatuba case, it was possible to identify opportunities for improving the Brazilian case.

These improvements are related to: the need to establish a legal framework to ensure the implementation of the plan, record the occurrence of extreme water events and incorporate it into the planning system, and elaborate gradual scenarios with the establishment of guidelines for use and occupation of the land.

It is necessary to accept that the occurrence of extreme water events is gradual and inevitable, because the existence of the natural hydrological cycle, coupled with the growth of demands for water resources, is enhanced by the perspective of climate change. In this way, the land use and land use planning integrated with the management of extreme water events allows cities and regions to reconcile economic activities and infrastructure with the natural conditions of the environment, avoiding or minimizing the negative impacts of the occurrence of disasters.

In this way, it can be concluded that the article contributes to directing the management of conflicts between water resources and land use and occupation, with the formulation of a planning model to incorporate climate change into land use and occupation actions. This model is able to promote consequent improvements in the application of the tool used in Caraguatatuba.

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