Urban-Coastal Development. Study Method for Quantifying in a Global Scale

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Coastal areas support population concentration. An important reason is because marine environment facilitates certain activities such as fishing, industry, tourism and transportation. This high global population concentration causes serious damage to very dynamic and fragile coastal marine ecosystems, often leading to major problems and social conflicts (Barragán, 2014)**.** Urbanisation is a process involving a given model of geographic space occupation. It usually increases pressure on ecosystems and respective services. Also, cities organise territory and become core areas in a much larger space. In the case of cities and coastal agglomerations (CCAs), the influence area is on land, though also intertidal and marine.

The world began to experience unprecedented urbanisation rates when average urban growth attained an annual 2.6% from 1950 almost up to the present (ONU-Habitat, 2009). During this period, the world's urban population nearly quintupled, from 700 million to 3.3 billion people. This led the degree of urbanisation to rise from 29% in 1950 to over 50% in 2008. The trend is on going, with more than 7.2 billion people now inhabiting our planet (UN-DESA, 2013), and is expected to continue. Forecasts indicate that in 2050 70% of the world's population will live in urban areas (ONU-Habitat, 2009). A large part of the urbanisation phenomenon observed worldwide is closely associated to the pace of urban population growth in the less developed countries (UN-DESA, 2013).

This research is aimed at quantifying the importance of coastal cities in the world. The study includes the methodology of a detailed analysis of all cities with over 100,000 inhabitants, from 1945 to 2012. The development of study method for quantifying cities and coastal agglomerations is of major interest, for two main reasons:

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- About 40% of the world's population (Burke et al., 2001; IOC/UNESCO, IMO, FAO, UNDP, 2011) lives in coastal areas, a large demographic concentration on a small part of the Earth's surface (between 4% per UNEP (2006), and 15% per Cohen and Small (1998)). This means that a huge amount of goods and services (associated to supply, regulation and culture) must be obtained from coastal marine ecosystems

- The scale and speed of the urbanisation process on the coast generates changes never seen before. The case of the Chinese coast in the last 70 years and especially the last two decades is very illustrative (Ting et al., 2014). Adjustment to these changes should be reflected in the management model for coastal areas and their ecosystem services.

The method developed in this paper provides important results on the global scale. From this method it is possible to quantify the urban development in coastal cities around the world. It also allows quantify the relationship between population development and certain characteristics of interest for the integrated coastal zone management (ICZM): vulnerable marine environments, such as deltas or estuaries; as well as large infrastructure, such as road and port, among others.

Two main information sources were used. The first corresponds to United Nations databases (Demographic Yearbook) supplying details about the world's cities and agglomerations with 100,000 or more inhabitants, which accounted for approximately 78% of the world's urban population in 2012. The United Nations definition of cities and urban agglomerations has been used (UN-DESA, 2013). Google Earth was the second source used. Photographs and images from its remote sensors supply a great deal of detail for observation.

Both source types are normally used very much (McGranahan and Marcotullio, 2004). But what is important about this work is that quantitative aspects from CCAs around the world were cross-referenced with their qualitative attributes. The latter were obtained by observing in Google Earth diverse characteristics of all CCAs.

The working method encompasses the following tasks:

a) To organise information from original databases. The database contains 4,285 cities and agglomerations around the world with more than 100,000 inhabitants between 1945 and 2012 (UN-DESA, 1955, 1964, 1974, 1984, 1995, 2008, 2013);

b) To differentiate between coastal and inland cities and agglomerations. For this reason a 100 km wide band was used in Google Earth. When the city or agglomeration is on an island, per UNEP criteria (Dahl, 1995), we considered it coastal even if it was more than 100 km from the coast;

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c) To enable our results to be compared to others, the world's CCAs were classified according to number of inhabitants in five separate groups, taking into account the United Nations intervals. The result is the following:

- Small cities: from 100,000 to 500,000
- Medium cities: from 500,000 to 1 million
- Large cities: from 1 million to 5 million
- Very large cities: from 5 million to 10 million
- Megacities: above 10 million

d) To geo-reference all CCAs in the world. ArcGIS shapefiles were done for the world's cities, to geo-reference them and indicate their relationship to the coastal zone;

e) To describe CCAs based on interpretation of Google Earth images with respect to their geographic location, habitat type, associated ecosystem, relationship to other cities with more or less than 100,000 inhabitants and links with port infrastructures, etc. Criteria used for delimitation is based on three different environments: natural, socioeconomic and administrative;

Coastal areas occupy a very small number of the planet surface percentage. However, the value of their ecosystem services exceeds a third of the global one (Barbier et al., 2011; de Groot et al., 2012). Valuing ecosystems from their services involves consider not only the material goods that they produce, but also the importance of other services they provide, such as protection against erosion, for example (UNEP, 2011). The importance of marine and coastal ecosystem services remains in time. Even for several coastal ecosystems increases (Constanza et al, 2014). For this reason, it is interesting to study the evolution of cities and coastal agglomerations against inland ones. In this way, Pressures on coastal and marine ecosystems are obtained.

First, noteworthy is the interest and great value attached to the result obtained after crossing the sources of information used. Indeed, it is not common, at least on a global scale, linking population statistics databases with information obtained by remote sensing data. The detailed quantification of the urban population phenomenon was observed complemented by qualitative information on Google earth. It is the most appropriate form of approach the analysis of the implications of urban expansion to the territorial model and associated coastal marine ecosystems. Consequently, the method developed in this research is the main result.

Overall, it can be said that coastal urbanisation has been a very rapid process. For that reason there are problems adjusting to sustainability. ICZM should reinforce interest in planning increasingly mixed uses of the coast. Special attention must at least be paid to those that depend on or are associated to water (freshwater and saltwater).

Generally speaking, the described processes lead to a future where ICZM is closer than ever to urban management, and vice versa – because the city is moving beyond its traditional territorial scope. There will be situations that are not well defined, where the city colonises the natural coastal marine space with some of its features (highways, ports, industries). The number of responsible public administrations then increases. Urban institutions are endowed with others in charge of managing the coast and the sea. Ultimately, strictly urban issues are still present (housing, transportation, industry, etc.), though other very different ones have been added (protected spaces, natural processes, coastal fishing, etc.).

Certain management tools will therefore be indispensable: strategic planning, land planning guidelines, plans to build land transportation networks, water supply and treatment infrastructures, solid waste management, plans for large production complexes (industrial, ports), etc. The above combine in space and time with plans to manage ecosystems and biodiversity, to manage coastal fisheries. The CCAs will be administered as a coastal socio-ecosystem occupying more space and qualitatively different.

The demographic aspects of the CCAs, the speed of the urbanisation phenomenon over time, the overall impact of coastal space occupation, the limited capacity to adjust to those changes in a poverty context, etc., will force profound changes regarding ICZM vis-à-vis the planning of coastal problems, their public projection and inclusion on the political agenda, the growing relationship to urban issues, less exclusive attention to natural coastal ecosystems, technical arguments, knowledge required for coastal marine management and education, etc.

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