Journal of Environmental Sciences Vol. 11, No. 2, pp. 167—173, 1999 ISSN 1001—0742

Landscape planning in an East Asian coastal region: the Hangzhou Bay area, China

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Abstract—The first area in China to which the McHargian approach to landscape planning was applied was the Hangzhou Bay area on the central coast. Using published maps and documents and analyzing remote sensing data, an ecological inventory (GIS) was first developed. Based on these data, several criteria for land and water use suitability evaluation were produced. These were then overlayed to evaluate the entire region for several categories of land and water uses, and a suitability synthesis map was produced. This map became the basis for developing several possible concepts and plans for the sustainable development of the region. It is a timely and much needed approach in a rapidly developing country like China if development is to fulfill both present needs and allow future generations to fulfill theirs too.

Keywords: ecological planning, suitability, sustainable development.

1 Introduction

McHarg's suitability evaluation approach to a land use planning known as "ecological planning" has practiced in some countries of East and South Asia for over 25 years. It has been applied in academia, in research, in business and in government mainly though the effort of McHarg's Asian graduates who have returned to their countries after completing their studies at the University of Pennsylvania in the USA. The study presented in this paper was done by a non-Asian McHarg disciple, the author. He conducted the first ever ecological planning study of a region in China mainland where there are, to the author's workledge, still no McHarg disciples.

Under China's "open door policy" of 1978, some 14 so called "open coastal city regions" and five "special economic zones" have been designated for intensive investment and economic development(Oborne, 1986). The study included here includes one of those "open coastal cities", Ningbo, which is located on the south coast of Hangzhou Bay. Ningbo City was an important trading port in ancient times remaining so today being connected to Korea, southeast Asian and Japan by modern shipping routes. Its new port at Beilun handles over half of the imports and exports of the entire province of Zhejiang in which the city is located. The McHargian approach is use here to develop a plan for the future of the entire Hangzhou Bay area including Ningbo.

2 The study area

The study area is located at 30°—31°N, 121°—122°E on the central coast of the Chinese mainland. Its bay is funnel-shapped and is a typical trumpet estuary, unique in China(Zhang, 1985). The bay has an area of about 10000 km^2 and opens out onto the east China Sea. It receives water from Qiantang River which drains a catchment of some 55000 km^2. The mouth of this river is the sight of the famous scenic "Qiantang tidal bore" which at time reaches a height of over three meters(Zhang, 1985). The Zhoushan Islands located just outside of the bay are a kind of natural defense for the bay's mouth and are the sight of the strongest tidal flows in China(Zhang, 1985).

To the north of the bay is the Hangjia Plain which is part of the Changjiang(Yangtze) River delta cut by numerous natural and man-made waterways, including the famous Grand Canal which terminated in Hangzhou City. To the south of the bay are the narrower Hangshao and Yaobei Plains with NE-SW thending moderate relief hilly and high terracelands and highly undulating

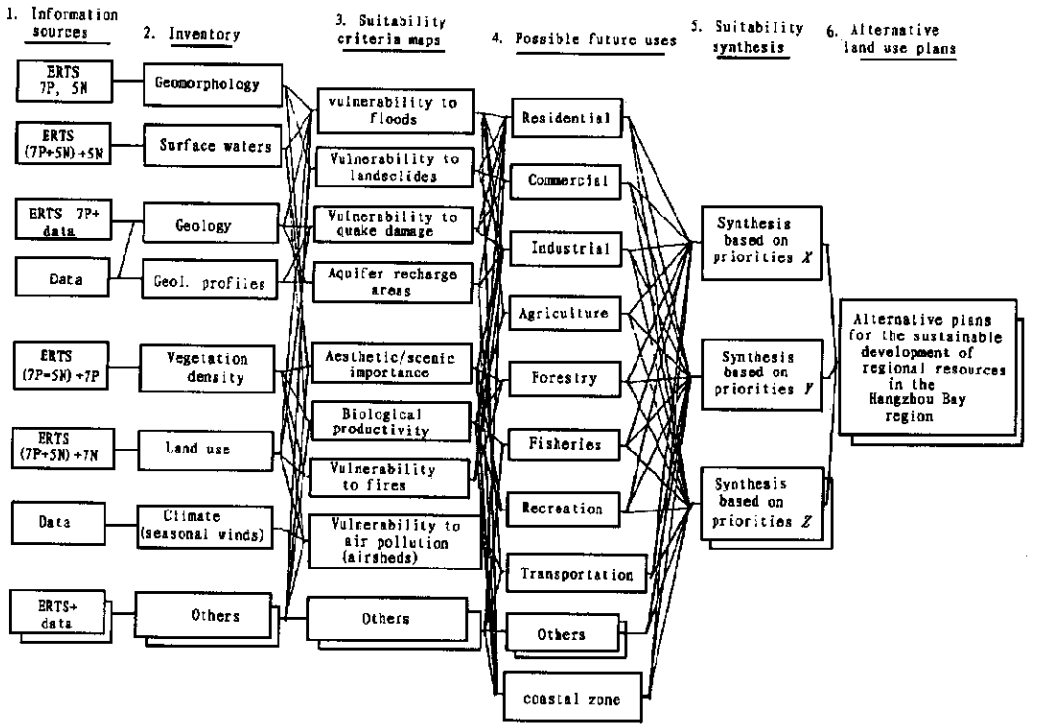

Fig.1 Environmental planning for the Hangzhou Bay area, research flow chart

mountainous terrain to the south forming some of China's most beautiful and dramatic landscape. Over 20000000 people live in the study area's eight administrative districts, with over a million living in the city of Ningbo(Lo, 1992).

3 The methodology

3.1 Step 1

McHargian ecological planning always begins with the development of a data bank of geographic information about the biophysical and socio-cultural nature of the region, called an "ecological inventory". To the greatest extent possible, the region should be defined as an ecologically meaningful unit, such as a river basin or other region that has physiographic unity. The sources of information for the data bank may include reliable published and /or unpublished documents and maps as well as studies especially contracted for the study. Data in mapped or mappable form is most desirable. When the required data is either non-existent or inaccessible, as was often the case in this study, remote sensing techniques may be used (IGU, GSC, NSFC, 1987; Lo, 1986). MSS(multi-spectral scanner) landsat photographs (taken in May, 1978) were used in this study.

The information included in the ecological inventory, as in most such data bases, consisted of: geology, geomorphology, surface hydrology, pedology, vegetation distribution, climate, and land use. All of these maps except soil and climate were developed by interpreting the landsat photographs and field checking the preliminary results during a week-long site survey in the autumn of 1987. The other maps were developed using national scale published information. All maps were drawn at a common scale, in this case 1:1000000, to math the scale of the landsat images.

3.2 Step 2

Once the data base developed, they were interpreted and reconstitute as criteria maps representing natural and social processes. These criteria are used to identify the locations considered to be relatively most to least suitable for all of the planned land and water uses. In this study, criteria reflecting safety/hazards, healthy/sickness and welfare/amenity objectives were developed. These are considered to be desirable common goals for almost all urban and regional plans and are consistent with the concept of sustainable development, i. e. development that meets the needs of the present without compromissing the ability of future generations to meet their own needs (WCED, 1987).

The safety/hazard-related criteria included in this study are: relative vulnerability to damage from floods and high tide (including sea level rise), and relative vulnerability to damage from earthquakes and Tsunami tidal waves. At the time of the study, information was insufficient to identify areas of relative vulnerability to landslides and forestfires, etc. which are likely to occur in the southern hilly part of the study area.

Healthy functioning of the ecosystem is represented by a map of relative biological productivity. This criteria is of particular importance in locating land and water uses so as to contribute to the sustainable development of the region's "living resources" even during the processes of urbanization and industrialization. Here again, information was inadequate to develop criteria that directly affect human health, such as relative vulnerability to air pollution (airsheds) and so on.

Finally, a map of relative scenic value represents but one of the many possible welfare/amenity criteria, which might also include areas of relative cultural value, historical importance, and areas of scientific importance, to mention a few. In every case, these criteria incorporate non-price benefits which are also important in sustainable development but are easily lost due in part to the difficulty in the quantification of their "economic" value.

3.3 Step 3

In order to determine which land and water uses are to be included in the regional plan, several scenarios for the long-term (more than 20 years ahead) future of the region were developed. Within the national context and considering the overwhelming importance of agriculture and marine resources among all of the uses (Vink, 1983) to feed China's huge population (Brown, 1995), the preservations of the nation's soil, afforestation, and a continuation of traditional organic recycling, as well as expansion of aquaculture appear to be essential priorities in any future scenario for that country. Such actions would also be fundamental to a "sustainable" approach to development (Smil, 1984). It would also be necessary to strictly control the avoidable concersion of highly productive agricultural land and fishing grounds to non-agricultural/non-fishing non-reversible uses, a major problem in most of the rapidly developing regions of that country among others. China does not have much "unused" land to bring under cultivation, nor much land for further multi-cropping (Brown, 1981). This makes a primary industry protection strategy all the more important in any future planning scenario. Since Hangzhou Bay area is part of one of China's most biologically productive regions (Abe, 1986), such as a strategy would seem most suitable for the study area.

The next element in the scenario should reflect the needs of people for urban uses, especially housing. China's population presently accounts for nearly 20% of that of the entire world, a figure expected to decline to about 15% by the middle of the 21st century but still over 1.5 billion by the year 2017, equal to the world's entire population in 1900, and peaking at 1.66 billion in 2045 (Brown, 1995). Today, some 20.6% of China's people are reported to live in cities (MDN,

1986). By the end of century, somewhere between 35% and 78% may be urban dwellers, most expected to be adsorbed in China's smaller and medium-sized cities (Gao, 1986). Many of the cities in the region fall into this category. Thus, the importance of sustainable absorbing this new urban influx is a matter of priority second only to feeding the people. Therefore, urban uses are given second priority in the region's long-term planning scenario.

Finally, tourism is a major industry and an important source of foreign exchange in China like other developing nations. This trend is expected to increase as China become more open and better known to the world(MDN, 1987). For this reason, it is considered important to methodically inventory and protect natural, cultural, historical and scenic as well as other recreational assets so as to attract tourists, foreign and domestic, in the future. Tertiary industry (recreation/tourism) is the assigned their priority in the region's future planning scenario. When China becomes a "developed" nation, the priority of this sector in planning can be expected to rise, so it is not too early to start preparing for that now.

3.4 Step 4

Before the suitability evaluation is done, it is considered advisable to delineate the region's "coastal zone". The "coastal zone" is the interface between air, land and water in which human activities may significantly influence or be influenced by the natural and social processes operating there(Bratz, 1972). This will be a basic input into any plan and should help aid decision-makers in determining what types and degrees of regulations and guidelines would be needed on every use in the region so as to protect water quality and land use safety in that zone. In this study, all of the criteria developed are sufficiently water related so that they can be used to help delineate at the region's "coastal zone", both landward and seaward.

3.5 Step 5

The locational suitability of the basic land/water use types defined in the scenario (Step 3) is evaluated next. All of the suitability criteria developed in Step 2 are used to undertake the suitability evaluations. Each criteria has a different relative importance in each suitability evaluation. The more criteria that can be developed, the more comprehensive and complex the evaluation becomes. Land/water used suitability is essentially that location or locations identified as "best" for that use, i.e. the least negative impact location with most benefits(McHarg, 1992).

First, a map of relative suitability for primary industries was developed. This was done by giving the greatest importance/weight to the biological productivity criteria, followed by vulnerability to hazards. Scenic values were considered to be relative unimportant.

Next, the relative suitability for urban uses map was developed. Here, all hazard vulnerability maps were given the greatest emphasis in the interest of protecting the safety of the urban residents. Hazards were followed by biological productivity most often lost to urbanization. These food-producing areas must be protected if urban development is to be "sustainable". Such an approach is similar to that of "sustainable urban design" (Van, 1986) which requires a holistic view leading to more compatible mixed-use communities, efficient buildings, diverse transportation systems, ecologically sound agriculture, water and waste conservation, and different solutions for different places. Many models for sustainable, resource-conserving technology in Chinese urban ecosystems have been reported(Meier, 1974), and these should help make this kind of urban development more readily acceptable in China.

The next suitability map to be developed was for that of relative suitability for recreation. Here, scenic values were given the highest priority followed by hazard vulnerability. In the future, as the tourist industry expands, the need to given greater emphasis to natural hazard vulnerability

will increase, especially for structure-dependent uses, such as hotels and so on.

3.6 Step 6

Before final lands use planning proposal are developed, the individual land use suitability maps developed in Step 5 above need to be synthesized. This can be done by first determining the priorities for source allocation from the future scenario introduced in Step 3. In this study, the priorities used were: (1) agriculture/forestry/fisheries; (2) resource-conserving urbanism (including secondary industries); and (3) recreational uses of the non-structural type. A "pre-emption method" (McHarg, 1992) was used to develop the land use suitability synthesis map. On these maps, all areas of land and water are allocated to the uses for which they are most suitable and to those uses which are most compatible with the most suitable uses. For instance, if agriculture is most suitable, certain recreational uses may be compatible and possibly co-exist on/near the same place. However, in principle, urban and agricultural uses tend to be relatively incompatible but their compatibility may be increased if the urbanism is "resource-conserving" as suggested before. The resulting complex map shows all of the possible combinations of every suitable land use in every location. This map becomes the basis upon which any number of planning proposals can be made, but it is itself NOT a plan.

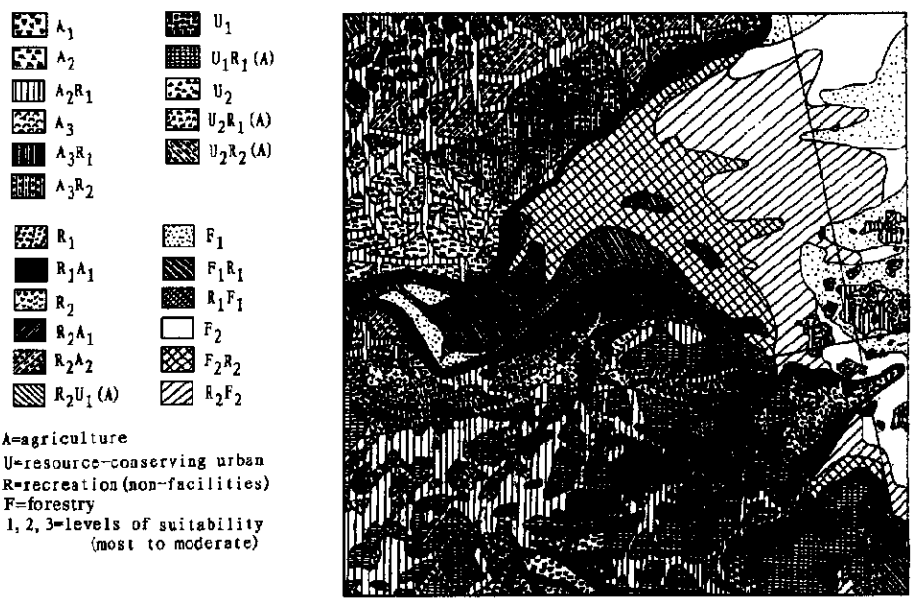

Fig.2 Land use suitability synthesis map by the pre-emption method

3.7 Step 7

The suitability synthesis developed in Step 6 serves as the basis for an number of sustainable ecological planning concepts. In the concept developed in this study, the highly productive and hazardous nature of the Yangtze River Delta to the north is the reason why its main most suitable uses are agriculture and aquaculture and coastal recreation with compatible forms of resource-conserving urbanism. On the south, there appears to be considerable potential for urban development concentrated around the four urban centers of Shaoxing, Shangyu, Beilun and Ningbo. The hilly inland areas are considered to have considerable potential for a mixed pattern of low density urban development with compatible recreation upland and for agriculture with

compatible recreation in more lowland areas. Almost all of the southern coast is seen to have potential for mixed coastal recreation with commercial fishing and agricultural used. These tidal coastal and adjacent areas face onto aquatic recreation and mixed fishing areas in the shallow portions of the bay. These shallows give way to fishing and navigational uses in deeper bay areas. The expansion of existing road and rail transit lines to connect that parts of the region, and port development at Beilun and Chapu-Qinshan to connect the region to the rest of China and the world by sea, are also suggested in this concept.

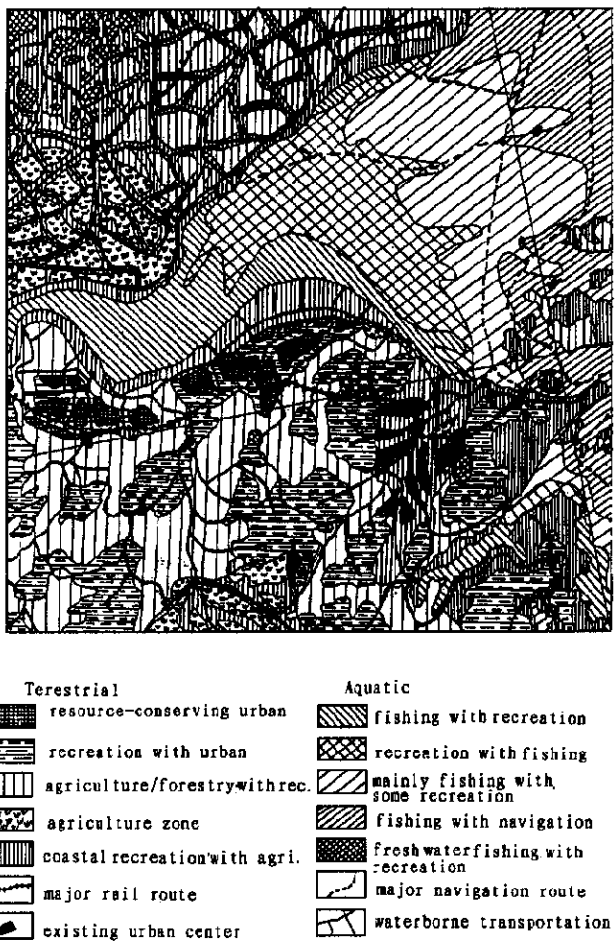

Fig. 3 An environmental plan for the Hangzhou Bay area (proposal)

Based on the ecological planning concept just described, an ecological planning proposal for sustainable regional development of the Hangzhou Bay and its surrounding region was developed. Despite the regional scale of the proposed plan, the plan shows clearly that the most suitable form of Ningbo City appears to be a series of urban clusters connect together by greenbelt along the rivers that run through the city itself. These greenbelts of natural open space are the places most vulnerable to natural hazards as well as being, coincidentally, those places most valuable for primary industrial productivity. Recreational uses being compatible with agriculture are natural uses for those greenbelt too. The urban landscape of Ningbo City with this kind of sustainable

waterfront development could be dramatically improved in terms of both scenic value and safety as well as improving the health and welfare of the city's population.

4 Concluding thoughts

It was not the purpose of the author, a resident of another country (Japan) and a citizen of yet another(USA) to tell the Chinese what plan its the best for their country or any part thereof. Rather, the author strongly believes that whatever plans are made or adopted, they should aim at achieving "sustainable development". This necessarily implies both a large scale and long-term view as the starting point for urban development.

The Hangzhou Bay area is one of the most biologically productive regions in China. The loss or deterioration of this extremely important feature could have is serve impact on the nation, particularly on China's largest city, Shanghai, located just to the northeast. This influence would of course be most directly felt by the 20 million resident of the region itself. For these reasons, among others, pollution from all sources should be strictly controlled, and ecological landscape planning should be strongly encouraged and, where possible, used.

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