

# Research on Building Urban Sustainability along the Coastal Area in China

Sun Jiaojiao, Fu Jiayan

**Abstract**—At present, in China, the research about the urban sustainability construction is still in the exploratory stage. The ecological problems of the coastal area are more sensitive and complicated. In the background of global warming with serious ecological damage, this paper deeply researches on the main characteristics of urban sustainability and measures how to build urban sustainability. Through combining regional environmental with economic ability along the coastal area, then authors put forward the system planning framework, construction strategy and the evaluation index system, in order to seek the way of building urban sustainability along coastal area in China.

**Keywords**—Urban sustainability, coastal areas, construction strategy, evaluation index system.

## I. INTRODUCTION

COASTAL areas are the most urbanized and populated areas city in China. The rapid development of industrialization and urbanization has caused the energy depletion and ecosystem damage. [1] The sustainability of urban activity and the impact of this activity on the environment are directly related to China's social and economic sustainability. Coastal cities face common eco-issues. One is the heavy rains and floods by Typhoon in the summer. The other is salinization phenomenon by a high content of salt in the coastal soils, which is not conducive to the growth of green plants. The third is fragile ecological environment by person destruction which including marine aquaculture and coastal degradation. Now most countries take the city-building strategy of sustainable development. When it comes to the problem between human and eco-environment, it is the main driving force for forming harmonious relationship between human and nature to construct eco-city. Scholars all over the world pay more attention to the theory and practice about sustainable development of city. It becomes a consensus that applying the concept of building urban sustainability to plan and construct a modern new city. [2] But coastal cities have different levels of construction. We should evaluate the level of eco-city construction. The evaluation results can reflect socio-economic contradictions and environmental issues in the process of urban development. It also can reflect the performance of eco-city construction and the future development trend. By analyzing these issue and effectiveness, we can provide scientific strategies for city administrators and builders.

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Fig. 1 The case of flood disaster

## II. COASTAL CONSTRUCTION CRITERIA--SUSTAINABLE DEVELOPMENT

From Howard's *Garden City* to Mc Harg's *Design with Nature*, from Geddes' *Eco-region* to William Rees' *Ecological Footprint*, it has never stopped theoretical discussion on the relationship between city and nature. After the 1980, the concept based on the system of eco-city has been widely used. However, there is no generally accepted mode and planning practice of eco-city construction. Therefore, it's a common problem faced by all the architects to seek the ecological planning and design approaches which is rooted in local and ecological. [3]

China Environmental Protection Administration has established *the establishment of the ecological County, municipality and province-building indicators*. The rules includes 28 indicators for the eco-city evaluation, such as economic development, environmental protection, and social progress and so on. [4] The rules can be integrated evaluation the level of eco-city sustainable development. But not suitable for coastal cities, because its geographical environment is different from the land city. The level of sustainable development in coastal cities are closely related to marine environment. Therefore we need a scientific, complete and reasonable evaluation index system. [5] We should take into account the coastal areas from different aspects such as the geographical situation, the ecological status, the level of social and economic development and so on. It should make the economic development meet the ecological laws and not damage the eco-system. We should comprehensively analyze the ecological suitability, environmental capacity and environmental carrying capacity of various marine and land. Then we can determine the best ecological niche of environmental quality and establish evaluation index system of coastal ecological environment. The sustainable development

of coastal cities can be evaluated scientifically and accurately.

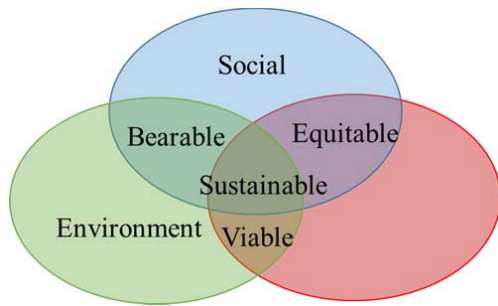


Fig. 2 The relationship between sustainable development and other factors

III. CONSTRUCTION STRATEGY OF URBAN SUSTAINABILITY ALONG THE COASTAL AREA



Fig. 3 Framework for urban sustainability along the coastal area

A. Ecological Environment Improvement

Firstly, establish a multi-level windbreak system. [6] In the fight typhoon, urban planning builds multi-level windbreak system with green space along the beach, river and road. Then its width can be controlled between 150~250m. The system can effectively reduce wind speed of the coastal landing and play a role in landscape.

Secondly, create suitable micro-climatic condition. A lot of consumption and emissions which is from the life and production can make the urban to be a heat island. [7] We can use the construction strategy of combining artificial and natural circulation system. Then we research on the air duct and the overall form of the city. [8] On the one hand, it can be considered connecting the lakes, rivers and the city park to form the city's ventilation corridor. So as to achieve the purpose of reducing the temperature in summer. On the other hand, through a combination of appropriate construction groups, we can improve the micro climate environment in each of the plots.

Thirdly, build a reasonable water network according to water rates. [9] Planning establish an ideas of “dredging first and combination of storage”. It can avoid short-time heavy rainfall and flood disaster by typhoon. It also can build water eco-system through reserving river, excavation Storage Lake, increasing artificial river and building wetland patches. Increasing water area will play a significant role on improving the surrounding environment and reducing the heat island effect.



Fig. 4 The case of reasonable water rates

Fourth, to build a multilevel system of landscape. The soil salinity in coastal areas is higher, which is not conducive to plant growth. [10] It can improved control of saline alkali soil by using the ecological landscape design method of “multi-level green open space system and differentiated improvement measures”. The landscape ecological pattern can be composed of wetland patches, river green corridor, dry patches, small green patches, important road greening and protection forest. Under the guidance of this pattern, the soil improvement measures and landscape greening methods are used in different areas.



Fig. 5 The case of reasonable water rates

B. Structure and Form of Eco-City

Social, economic and environmental unity is the core state of urban sustainable development. It is a high degree of harmony between human and environment. Sustainable urban structure and morphology are the key to reduce the energy consumption and carbon emissions in a region, which is mainly reflected in two aspects: the moderately city compact and the ecological corridor. [11] Compact city is useful to promote land mixed-use, reduce the travel distance, and also bring the city a sustainable multiplier effect. [12] The existing research has showed that the density of land development and carbon emissions has a more obvious negative correlation, which provides an empirical basis for the compact urban form. [13] In addition, some cities (such as Xiamen, Wuhan) through the wind environment simulation found that reasonable corridor is a significant role in regulating the summer air temperature and improving the urban climate environment.

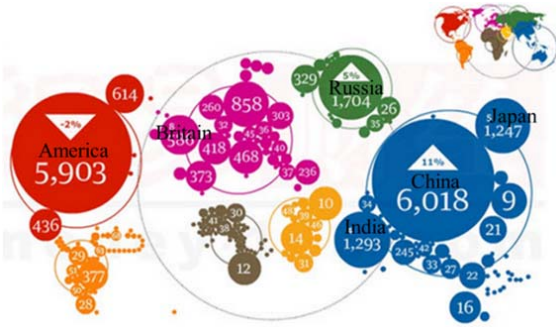


Fig. 6 World CO<sub>2</sub> emissions

To accomplish these two goals, the basic idea is started the ecological project with point, line and surface system engineering. Firstly, to established radiation basis points. It takes the ecological construction of urban center as the leading. The use of the central advantage of the economic, technology and humanity make the city center to create a base of ecological radiation. Through the radiation effects of these points to stimulate the surrounding area. Secondly, Through the use of transport links (such as waterways, roads, railways and so on) and landscape link (such as coastlines, rivers and green belt and so on) strengthen the protection of the ecological environment. Third, to establish ecological protection network by radiant point and linear bond drive. The level will be expanded to the surrounding area, so as to gradually realize the ecological transformation of coastal cities.

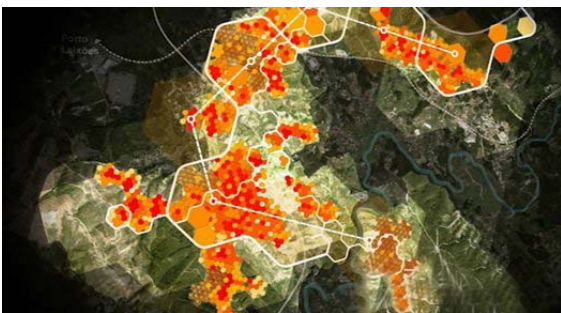


Fig. 7 Ecosystem city case: PlanIT Valley

*C. Application of Ecological Technology*

Solar energy collection and utilization network can be divided into three parts of the new energy center, solar lighting Park, and solar community. [14] New solar energy center includes collect, research, education, and other functions, and also as a base for display of related technology and applications in the industrial parks. It encourages the installation of solar water heaters, solar photovoltaic panels on the roof of the community residential. In addition, it sets up more than 50% solar lighting in the outdoor lighting of the park and centralized layout solar collector points in community parks as source of energy for community public activities.

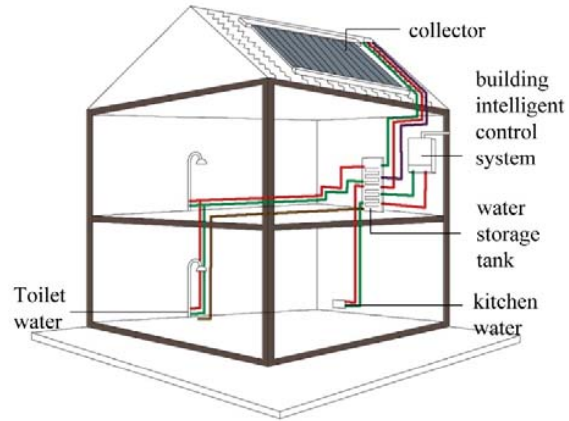


Fig. 8 Diagram of the principle of photovoltaic power generation

Rainwater harvesting and utilization network is an important measure of sustainable utilization of urban water resources. [15]It can establish a network of rainwater collecting from lake, ground and roof. Collected rainwater through the pipeline send to water treatment facilities, the water can be used in daily life, road flushing and greening irrigation and other uses.

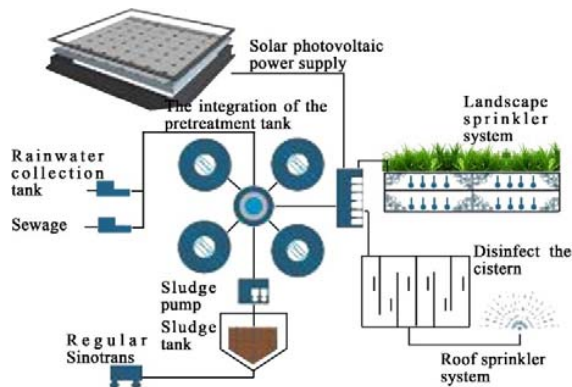


Fig. 9 Ecological measures

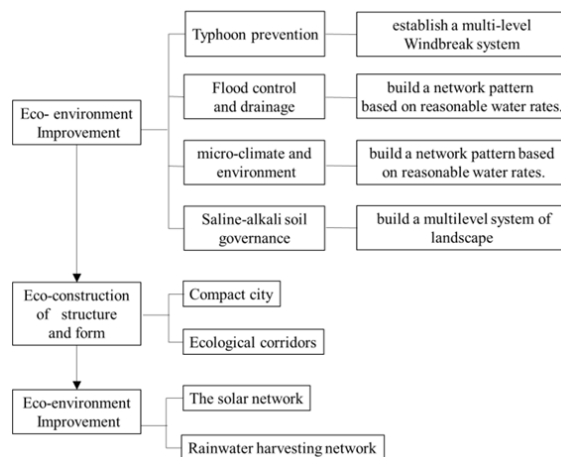


Fig. 10 Design strategy for urban sustainability along the coastal area

#### IV. EVALUATION INDEX SYSTEM FOR URBAN SUSTAINABILITY ALONG THE COASTAL AREA

As the urban ecosystem is composed of complex multiple variable, it is a huge and complex index system to describe and evaluate the urban sustainability. [16] Evaluation index system has a variety of functions such as description, evaluation, interpretation, early-warning, decision-making function and so on. How to set up the system? It starts from analyzing the economic development status and the coastal zone ecological system status of the coastal city. On the time scale, it reflects the development speed and trend of the urban functional system. On the spatial scale, it reflects the overall layout and function types. On the number, it reflects the functional strength and scale. On the level, it reflects the function and structure. Thus, it reflects the improvement of planning strategies on the marine environment.

#### V. CONCLUSION

This paper researches on the construction of the urban sustainability along the coastal area in China. It puts forward a series of strategies for the coastal cities of ecological improvement, eco-structure and eco-technology. Its purpose is not only to give a targeted solution to the common ecological problems in the region, but also to deal with the larger regional climate and energy crisis.

#### REFERENCES

- [1] Jonkman Sebastiaan N. Yasuda, Tomohiro Tsimopoulou V. Kawai, H. Kato F., "Advances in coastal disasters risk management - Lessons from the 2011 Tohoku tsunami," *Proceedings of the Coastal Engineering Conference*, 2012
- [2] Wang Lijun, Wang Honghai, Yu Ying, "Rational development of Chinese coastal city of thinking," *Proceedings of the Coastal Engineering Conference Applied Mechanics and Materials*, v 174-177, p 3552-3555, 2012.
- [3] Mneimneh Farah, Srour Issam, Kaysi Isam, Su Hai-Long, "A New eco-city: Incorporating sustainability into the concept master plan," *Construction Research Congress 2014: Construction in a Global Network - Proceedings of the 2014 Construction Research Congress*, p 643-652, 2014.
- [4] Huang Jianhuan, Yang Xiaoguang, Cheng Gang, Wang, "A comprehensive eco-efficiency model and dynamics of regional eco-efficiency in China," *Journal of Cleaner Production*, v 67, p 228-238, March 15, 2014
- [5] Qin Q, Zhu L, Li Z, Ghulam A, Nan P, "Satellite monitoring of spatio-temporal dynamics of China's coastal zone eco-environments: Preliminary analysis on the relationship between the environment, climate change and human behavior," *Environmental Geology*, v 55, n 8, p 1687-1698, October 2008.
- [6] Yamanoi K, Kawai, E, Mizoguchi, Y, Kudo, T, Matsuoka, H, "Effects of the thinnings windbreak fence on height growth of the coastal forest," *Nihon Ringakkai Sh i/ Journal of the Japanese Forestry Society*, v 83, n 2, p 143-149, 2001
- [7] Baik J.-J., ; Kim Y.-H, Chun H.-Y, "Dry and moist convection forced by an urban heat island," *Journal of Applied Meteorology*, v 40, n 8, p 1462-1475, August 2001
- [8] M. Dupont, C. Celestine, T. Feuillard, "Natural ventilation in a traditional house on a West Indies Island (Guadeloupe): Field testing on site and in a wind tunnel," *Renewable Energy*, Vol. 4(1994), p.275
- [9] M. van der Velde, S.R. Green, M. Vanclooster, B.E. Clothier, "Sustainable development in small island developing states: Agricultural intensification, economic development, and freshwater resources management on the coral atoll of Tongatapu," *Ecological Economics*, Vol. 61(2007), p.456
- [10] Wang Xin Jun, Hsu Po-Han, Zhou Rui, Su Hai-Long, "Activating eco-city in China: The system engineering for cities' green transition," *2011 5th International Association for China Planning Conference*, 2012.
- [11] Heinonen Jukka, Junnila, Seppo, Dimitrios Papastefanakis, Natassa Marini, "Implications of urban structure on carbon consumption in metropolitan areas," *Environmental Research Letters*, v 6, n 1, 2011
- [12] Ghassan Zubi, "Technology mix alternatives with high shares of wind power and photovoltaics—case study for Spain," *Energy Policy*, Vol. 39, No. 12, pp. 8070-8077, 2011.
- [13] Rigopoulos, Eirini Karakatsani, Markos Damasiotis, Dimitrios Papastefanakis, Natassa Marini, "Renewable energy sources (RES) projects and their barriers on a regional scale: The case study of wind parks in the Dodecanese islands," *Greece. Energy Policy*, Vol. 37(2009), p.4874
- [14] Erië Hopenbrouwer, Erië Louw, "Mixed-use Development: Theory and Practice in Amsterdam's Eastern Dockland," *European Planning Studies*, Vol. 13, No. 7, pp. 968-983, 2005.
- [15] Ali Alireza, Mashhadi, Kandiah, Venu, Berglund, Emily Zechman, "Multiobjective Optimization to Explore Tradeoffs in Rainwater Harvesting Strategies for Urban Water Sustainability," *World Environmental and Water Resources Congress 2014: Water Without Borders - Proceedings of the 2014 World Environmental and Water Resources Congress*, p 1812-1818, 2014.
- [16] Zhang Yan, Yang, Zhifeng, Yu, Xiangyi, Berglund, Emily Zechman, "Measurement and evaluation of interactions in complex urban ecosystem," *Ecological Modelling*, v 196, n 1-2, p 77-89, July 10, 2006.

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