

ECOLOGICAL PROBLEMS ON THE URBAN DEVELOPMENT IN THE TAIHU LAKE REGION OF SOUTHERN JIANGSU

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ABSTRACT: The Taihu Lake region in southern Jiangsu is one of the regions with flourishing economy and the highest level of urbanization due to favourable natural conditions and socio-economic foundation. However, there emerge a series of urban ecological problems on continuous stretch of cities and towns, a vague division of urban functions, ground subsidence, serious pollution of atmosphere and waters arising from dense population, irrational distribution of industry, backwardness of municipal engineering facilities, and inexperienced scientific management of water resources. In order to improve the urban eco-environment in this lake region, we should work out an overall regional eco-environmental programme, perfect the urban economic set-up from the requirements of urban material circulations and energy exchanges, and finally put into practice the urban functional regionalism, so that the Taihu Lake region in southern Jiangsu has not only a higher economic benefit, but also a beautiful and comfortable eco-environment.

KEY WORDS: eco-environment, material circulation, environmental division, coordination balance

In southern Jiangsu, the Taihu Lake region covers three municipalities: Suzhou, Wuxi and Changzhou and ten counties: Jiangyin, Shazhou, Changshu, Taicang, Kunshan, Wuxi, Wujiang, Wuxian, Wujin and Yixing, with a total land area of 15,000 square kilometers and a population of roughly 11,000,000.

Located close to such metropolises as Shanghai, Nanjing and Hangzhou, the region is flourishing in industrial and agricultural production, thanks to the favorable natural and economic conditions and the convenient land-water communications. However, along with the steady expanding of urban sizes and the growth of small cities and towns, the areas un-

der cultivation have been rapidly on the decrease. For this reason, the contradictions between population and land in this region are becoming increasingly intensified, whereas due to the densely urban population, the irrational industrial distribution and the congested traffic conditions, environmental quality is sharply on the decline and the urban eco-environment is deteriorating with every passing day. Hence, it is of vital significance in the harmonious development of regional economy to summarize the ecological issues and predict the ecological changes possibly emerging in the process of future urban development.

I. BASIC NATURAL AND ECONOMIC FEATURES IN THE TAIHU LAKE REGION

As cities or towns are the focal point in the specifically regional economic development as well as the organic whole of dynamic development formed under a high concentration of a variety of substantial elements, they are, however, restricted by such factors as natural conditions and social economy. Therefore, to analyse natural and economic conditions is the prerequisite for the study of urban ecology.

1. A Region Typical of Rivers and Lakes in the South of the Lower Reaches of the Changjiang River, Characterized by Mild and Moist Climate, Abundant Rainfall and Dense River Networks

In this lake region, the annual average temperature is about 15–16°C; the monsoon circulation constitutes an essential factor to bring the climate of this region under control. In winter, the wind direction prevails to the north and to the south in summer, with the dominant wind direction for an average year being to the southwest. The annual average precipitation is about 1,000–1,400mm; summer (from June to August) is a season when the precipitation is the most abundant throughout the year, amounting to 35–40% of the whole year, with rainstorm being concentrated to cause waterlogging in some localized areas, especially in the city proper.

Being a big dish-like depression lying at the south bank of the Changjiang River Delta, this region is dense in the river network, widespread in lakes and marshes, well-known as a region of rivers and lakes downstream in the south of the Changjiang River. Here the water area distributed as lake groups covers up to 5,000 square kilometers, occupying 33% of the total land area and constituting the key to keep the balance of water storage within the region. It was only estimated from those larger lakes that the water-storing capacity is roughly 6.3 billion cubic meters^[1], stable in water level, providing plentiful water sources for navigation, and water supply for industry, agriculture and the urban inhabitants. In the whole region, the navigable water run total more than 5,300 km, accounting for one-fourth of those in the whole province. But owing to the smooth terrain, the rivers flow in an indefinite direction. For example the river, 42 km long, from Wuxi to Suzhou, its fall of water level is only 28 cm, and its hydraulic grade is nearly 1 / 150,000.

Hence a phenomenon of backward flow is apt to happen under the influence of the violent storm, the changing wind direction in localized areas as well as the water drainage and diversion of the floodgates along the Changjiang River banks, all these adding complicatedness to the urban environmental water conservancy.

2. A Region with Booming Economy and High Level of Industrial and Agricultural Production and Famous for a Land of Fish and Rice and a Major Economically Flourishing Region as Well

Here, being characterized by the fertile soil and high agricultural intensive level, this region is not only an essential marketable grain base but also an important growing area of live pigs, freshwater fishes and evergreen fruits in Jiangsu Province. What has been renowned both at home and abroad is the traditional craftsmanship, such as the silk of Suzhou, the textiles, silk filature and flour industry in Wuxi, and the cotton textile industry, printing and dyeing industry and rolling stock of Changzhou, all of which began to take shape before liberation and in addition to which there emerged after liberation such industries as machinery, electronics industry and building materials. Industries run by the county and township are, too, blooming, playing a prominent role throughout the nation. Since the year 1979, the urban-rural per capita gross output value in industry and agriculture has exceeded US \$ 1,000, while the per capita cereals reached over 1,000 catties, known as one of the most rich and populous regions in the nation.

3. A Densely Populated and Highly Urbanized Region Crowded with Cities or Towns

Here is one of the densely populated areas in Jiangsu Province, with an average population density of 800 persons per square kilometer, a figure that is 180 persons more than that of the entire province and about 6 times more than that of the whole country. In the three cities of Suzhou, Wuxi and Changzhou, the population density exceeds 3,000 persons per square kilometer; in Jiangyin, it exceeds 1,000 persons and in Wuxi and Shazhou, it exceeds 900 persons respectively, whereas the nonagricultural population constitutes 21% of the total population. In the whole lake region, there are currently 3 municipalities under the provincial jurisdiction, 4 towns at the county level, 23 towns subordinate to a county, 327 commune market towns and 360 towns above the township level, averagely with one town in each of 43 square kilometers and with a distance of only 2-3 kilometers between township and market town to form a concentrated urban group composed of large, medium and small towns, with the three cities—Suzhou, Wuxi and Changzhou—as its centre.

II. THE EXISTING ECOLOGICAL ISSUES IN THE DEVELOPMENT OF CITIES OR TOWNS IN THE TAIHU LAKE REGION

In the lake region, the urban ecology is characterized by the two following aspects: the plentiful water resources and the more population but less land, to which all these ecological problems arising from the urban development are related. Here we take the cities

of Suzhou, Wuxi and Changzhou as examples for discussion.

1. The Excessive Load of Urban Population, the Land Shortage and the Inharmonic Relation between Man and Space

In this region, the contradictions between more population and less land have been increasingly acute. What makes things worse is that despite the higher population density in these three cities, more and more population have moved in recent years, which brought further a pressure to bear on urban population. It is estimated that in the old city proper of Suzhou, the population density reached up to 28,000 per square kilometre, 31,000 in the old city proper of Wuxi and even up to 50,000–60,000 in the most densely populated streets; and 30,000 in the old city proper of Changzhou respectively. In these cities proper, not only the architectural density is high, but the landuse structures are also far from rationality. And what is especially noteworthy is acutely short of meadows which in Changzhou, for example, account for only about 2% of the urban land utilized and which have a direct effect on the coordinated relationship between man and space.

2. Irrational Industrial Distribution, Serious Pollution and Deteriorating Environmental Quality

The improper industrial distribution in these three cities is chiefly because we didn't take into full consideration the relation between the guiding wind direction and the urban

Table 1 Quality of water intake of the waterworks in Suzhou, Wuxi and Changzhou (mg / L) (1980)

Waterworks	Phenol	Cyanide	Arsenic	COD	Ammonia-nitrogen
Beiyuan Waterworks, Suzhou	0.003	0.150	0.020	10.62	13.60
Hengshan Reserve Pump, Suzhou	0.002	0.057	0.041	8.36	6.10
Hengshan Pressure-boost Pump, Suzhou	—	—	—	6.61	3.11
Canal Waterworks, Changzhou	1.400	0.170	0.092	—	—
Zhongqiao Waterworks, Wuxi	0.003	0.003	0.003	4.98	2.00
Meiyuan Waterworks, Wuxi	0.002	0.003	0.003	5.04	0.65

water sources of the upper and lower reaches. In Suzhou, the prevailing wind is toward the southeast and the chemical industry lies in the upwind of the city; the urban water sources come primarily from the Xujiang River in the southwest, the Grand Canal in the northwest and the Yangcheng Lake in the northeast corner of the city, whereas the paper-making mill from which amounting to 40% of the waste water in the whole city are drained away is located at the upstream of the city. In 1981, the daily drainage of sewage totalled up to 475,000 tons (among which are 420,000 tons of industrial waste water and 55,000 tons of domestic sewage), equivalent to a sewage discharge of $5m^3 / sec.$, whereas the clean water

discharge channelled into the urban districts was about $40\text{m}^3 / \text{sec}$. in the flood period and about $15\text{m}^3 / \text{sec}$. in the low water period respectively, with a ratio between clean water and sewage in the low water period being merely 3:1 . At the time when spring was changing into summer and the air temperature was on the increase, the water area became seriously black and stink, where mollusks, fish and shrimps disappeared fundamentally in the river sectors close to the city, whereas the incidence of those diseases in connection directly with the urban environment was mounting. It was known from a city-wide population census on past death toll in the years 1976–1978 that among the deceased, malignant tumors ranked first, whereas the incidence of those intestine-infectious diseases was to some extent rising, all being remarkably characterized by the distribution along the river courses.

3. To Fill and Level Up Rivers and Ponds Brings About an Environmental Deterioration of Urban Waters and an Imbalance of Water Function

Along with a large scale building dykes to reclaim land from lakes, the water area in the region has been considerably reduced. Only in the county Wuxian, the reclaimed area from lakes reached up to 7333 ha, and the Shihu Lake to the south of the city Suzhou has been almost completely reclaimed into a vast land. In the city proper, the river courses have been levelled up day by day and their areas have shrunk to a minimum size in the wake of the development of production and the changes of traffic way. In the Song Dynasty the total length of the river courses in the city Suzhou was up to 82 km and 50-odd km in the Qing Dynasty, but it is now only 24.5 km left over. Since the liberation, a total of 41 rivers in the city Wuxi have been filled up , amounting to about 25.5km, whereas pools or ponds were levelled up.

What resulted from the building dykes to reclaim land from lakes or rivers had something to do with the regional ecological equilibrium, i.e. a conspicuous change in the urban waterway environment and a destruction of the urban scenery. For instance, the Shihu Lake a well-known overwater scenic spot for sightseeing in Suzhou, has been long known for its blue rippling water, combining altogether the city proper of Suzhou along with the Taihu Lake, and whether it flows backward or runs downstream is most favorable for the urban environment. However, the construction of dykes to reclaim land from the Shihu Lake and the Taihu Lake has lessened the discharge to a great extent to and from the inner city and has made the former lake weaken its function of regulating the urban environment. In the inner city of Wuxi, the filling up of the round-the-city river, 3.3 km long ranging from the Chaoyang Bridge to the Xiaojian Bridge, has not only weakened the regulating-storing functions in the water area, but silted up all the drainage exits of the originally built sewers in the city proper and damaged the former drainage system . On July 11, 1981, when a torrential rain came for as long as two hours, with precipitation of 100mm, all the streets in the urban districts were covered with water as deep as 15–50 cm, with 14,511 households and 113 factories and storehouses being inundated, as well as 30 factories stopping or semi-stopping production, and suffering a total economic loss of over

one million yuan.

In recent years, the frequency of urban waterlogging has kept on rising, which is also attributed to the imbalance of water-regulation function. Over the past 21 years ranging from the day after liberation to the year 1969, there happened only 5 times when the water level in the city proper exceeded 4m, averaging once in every 4 years, whereas during the 10 years from 1970 to 1979, there were 6 times when it exceeded 4m, averaging less than once in two years and it occurred even in two successive years when the water level surpassed 4m. It is analysed by the Flood Control Headquarters in Wuxi that as compared with the year 1957, the rising of water level caused by irrigation works and man-made factors under the similar rain pattern amounted to 58cm, that is, 3.4m, the normal water level in 1957, stands for the present flood control warning line, which testifies to the fact that the man-made factor has an effect on the imbalance of urban ecology.

4. Ground Subsidence Caused by Overloading Exploitation of Ground Water

In this region, the ground water resources are enough and to spare. The ground water is low in temperature, fine in water quality, convenient in exploitation and low in cost. It is

Table 2 The capacity of underground water exploitation and the situation of ground subsidence in Suzhou, Wuxi and Changzhou in 1980

Loca-tion	Number of deep wells	Amount of extraction (10000t. per day)	Permitted amount of extraction (10000t. per day)	Over-load times	Buried depth of still-water level (m)	Grand total value of ground subsidence (am)	Funnelled central position
Suzhou	263	18-20	7-8	2.5	50	by 40cm at the South City Gate in 1956-1979	from the South City Gate to the Panmen City Gate
Wuxi	92	10	5	1	50-60	by 79cm near the Weigong Bridge in 1955-1979	the Chemical Works and the No.3 State-Run Cotton Mill at Xihui Road
Chang-zhou	377	33	16	1	60	by 28cm at the No.1 State-Run Cotton Mill in 1978-1980	the Relay Factory and the South City Gate Waterworks

for these reasons that quite many factories, enterprises and institutions are competing with each other for its extraction, with deep wells increasing year after year. In the city Changzhou, for example, there are deep wells up to 3.7 for every square kilometer, among which 19 are located near the Changzhou Chemical Plant and the No.1 State Cotton Mill. It is due to the too densely distributed deep wells and the excessive extraction of ground water that the groundwater level was on the fall. Since the year 1970, it has come down

averagely at a rate of 4 m per annum, and reached up to 60—odd m in depth at the funnel — like centre, approximately close to the roof of the water — holding layer. Since the openings of the water—bearing layer were solidly weighed down, the ground surface became rigorously submerged accordingly. In 1978—1980, the ground neighboring the No.1 State Cotton Mill in Changzhou began to subside by 28 cm and by 70 cm in some severely affected areas of the city Wuxi in 1955—1975. Ecological consequences resulting from the ground subsidence have been reflected in varying degrees in these three cities, such as the splitting open of architecture, the discard of those deep wells as useless and the waterlogging (see Table 2).

III. AN APPROACH TO THE IMPROVEMENT OF URBAN ECO—ENVIRONMENT IN THE TAIHU LAKE REGION IN SOUTHERN JIANGSU

In line with its natural and economic features, the following three points are here proposed in order to improve the urban eco—environment in this lake region.

1. To Work out Regional Planning in Accordance with the Requirements of Regional Ecological Equilibrium

With the growth of national economy and the progress of four modernizations, the scales of population and land utilization in those cities or towns at different levels in the Taihu Lake region are bound to keep on expanding, whereas cities or towns are also bound to join into a single combination just currently like the case with the three cities of Suzhou, Wuxi and Changzhou.

Should these cities or towns proceed solely from their own economic construction without taking regional economic planning as guide, even though there are optimized master urban planning and urban functional regionalism, they may be irrational because from the regional point of view, there may happen such consequences arising from the vague division of regional functions and the contradictions between the upper and the lower reaches and between the upward and the backward wind directions.

It is for these reasons that we should consider these cities or towns, no matter in what sizes and what levels they are, within the region as a whole with which to map out the planning, whereas functions and sizes pertinent to the urban development should be harmoniously consistent with the regional eco—environment^[2]. For instance, the Dianshan Lake, the water source of Shanghai, should be placed into a unified planning of Shanghai City together with the market towns surrounding it such as Chenmu, Qiandeng and Zhouzhuang so as to develop it into a non—contaminative industry, make the water resources have a process of dilution and purification and improve regional eco—environment.

2. To Define the Division of Urban Functions Proceeding from the Requirements of Living Environment

Guided by the regional planning, cities or towns at all levels should have a division of

functions in combination with natural features. In the urban districts, those factories which are liable to contaminate atmosphere and water body and damage scenic spots for sightseeing should be readjusted accordingly. Measures should be taken to either remove those pollutant-producing factories or switch their product manufacture either in the inner city of Suzhou or in the scenic spots for tourism, with an effort to build the city proper into not only a centre of politics, economy and culture, but also a key protective area of classic gardens, ancient architecture and cultural-historical relics, whereas in the outer city, a part of area may be centrally turned into several industrial districts according to the industrial types and their coordinated relations, i.e., the district of cotton textiles and printing and dyeing industries in the south city; the electronics and the instrument and meter industries in the southwest city, mainly the precise instruments and meters in the west city; mainly the building materials in the north city and mainly the light industries in the northeast city respectively, reflecting a definite division of urban functions.

It must be emphatically pointed out that after the readjustment of industrial distribution, the land to be vacated should be used as urban meadows or living quarters for the purpose of improving urban environment. For instance, in the city Suzhou, the existing classic gardens should be taken as a centre, along with a proper transformation around it and a wider range of tree-planting in order to make them become one garden within the other. Besides, we should make good use of the three-vertical and three-horizontal river courses inside and outside the city, properly pull down or remove, repair or reconstruct houses and buildings on both river banks so as to link them together with these ancient-styled gardens, form an afforestation system, extend the meadow areas and improve the microclimatic conditions.

3. To Readjust Urban Economic Structures in Accordance with the Requirements of Material Circulation and Energy Exchange

A city is an open ecological system, the core of which is the material circulation and the energy exchange. Again, a city is an area where the population is highly concentrated, socio-economic activities are being underway most frequently, the exchanges of material and energy are most complicated and the effects on natural environment are most violent. Every day, inhabitants totalling several hundred thousand or even up to one million have to use up large quantities of grain, vegetables, non-staple food and a variety of daily necessities, whereas those industries, mines and enterprises have to consume huge amounts of materials and fuel and prepare their commodities for circulation and marketing. A city can't exist independently without the environment surrounding it. The larger it is, the more it will depend on the outside environment and the more materials it will export and import. Following the rising economic level and the changes in way of life, there is a world of difference in energy consumption^[3]. Hence, there is a need to make a systematic approach to the relationship between the energy exchange and the material circulation in the inner city and seek for a solution of things unreasonable in the urban internal structure.

In history, these three cities had basically a feature of light textile industry and traditional handicraft art and its economic structure being comparatively reasonable. Nevertheless, under the influence of giving priority to the development of heavy industry and concentrating solely on output value, a certain number of seriously environment-polluted factories such as metallurgical industry and chemical industry came into being which, a departure from their original foundation, have brought undesirable results to this region famous for its rivers and lakes. In the city Wuxi located along the banks of the Taihu Lake, due to the excessive expanding of heavy industries, the freight volume has been growing rapidly. According to the statistics, in 1961 a total of merely 680,000 tons were transported into the city, but up to 2,910,000 tons in 1980. Among the huge quantity of raw materials to be moved into the city proper, chemicals, iron and steel, machinery, coal and fuels accounted for 70% of the gross freight volume, and consequently dust, coal ashes and industrial garbage were enormously on the increase, thus having an effect not only on the urban appearance but also on the environmental quality. From now on, when taking into consideration the urban expanding orientations, we should give first priority to the harmonious pattern of the optimum material circulation and energy exchange, the restructuring of economy and the setting up of new dynamic equilibrium in compliance with the optimum principles of ecological structures and functions. For our part, we should make full use of the original foundation of these cities or towns in the Taihu Lake region, bring their local technical superiority into active play, guide them toward the light-duty industrial structure, put stress on the development of such non-pollution or less-pollution industries as light textile, silk cloth, arts and crafts, electronics, instruments and meters, precise and light-duty machinery, and on the development toward the high-grade, precision, advanced and light-duty direction with top quality and low consumption, impose restrictions on those industries like metallurgy and chemicals, which are expensive in consuming raw materials, heavier in freight volume and grave in contamination, actively boost tourism and get firm hold of the orientation of urban development.

To sum up, the major objective in the study of urban ecology is not only to create a productive condition with good economic benefits, raise systematic productivity, but also provide a graceful, comfortable and modernized environment.

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