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Ecological and environmental characteristics and management planning of Mawei Economic Development District

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Abstract—The natural and social background of the district was described, and the major ecological and environmental problems were analysed. The measures and planning for the ecological and environmental protection were recommended. Systematic analysis method and environmental mathematical models were suggested to be used for the ecological and environmental general planning in this paper.

Keywords: environmental carrying capacity; environmental planning; pollution control.

REGIONAL BACKGROUND

Natural conditions

The Mawei Economic Development District is located at Minjiang River Estuary (119°37'E longitude, 25°59'N latitude), and the upstream 23 km for away from Fuzhou City, the capital of Fujian Province, a coastal province of Southeast China (Fig. 1).

The climate is subtropical one with annual mean temperature of 19.6°C and an average rainfall of 1319mm/a. Due to the influence of monsoon, the prevailing wind is northeast.

The local vegetation is classified as the type of subtropical evergreen broadleaf forest that can be further subdivided as follows: (1) The evergreen broadleaf forest with *castanopsis cuspidata, schima superba* and *cycloblannopsis glauca* as dominant species is distributed in gully and front of temples; (2) Evergreen conifer forest with masson pine as dominant kinds most widely distributed on the hills in Mawei District under 500m above sea level; (3) The vegetation with

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acacia richii as dominant kinds is found nearby villages and scenic spots under 350m above sea level; (4) Vegetation with cogograss as main kinds is distributed on barren hills; (5) Chinese pine *pirus tabalaeformis* community occurs at 300—800 m above sea level; (6) *Casurina equisetifolia* community found along the sand beach of bank of Minjiang River or sides of streets; and (7) Fruit trees are planted on hill and by villages. The soil of the Mawei region belongs to red earth and has a pH value of low acidity. It develops out of granite.

In the Mawei District and adjacent area, there are 105 species of terrestrial vertebrate, 16 species of beasts, 68 species of birds, 13 species of reptiles and 8 species of amphibious animal. Among them, clouded leopard, viverra zibetha, filis bengalensis, black kite, kestrel and silver pheasant belong to endangered species protected by the central government.

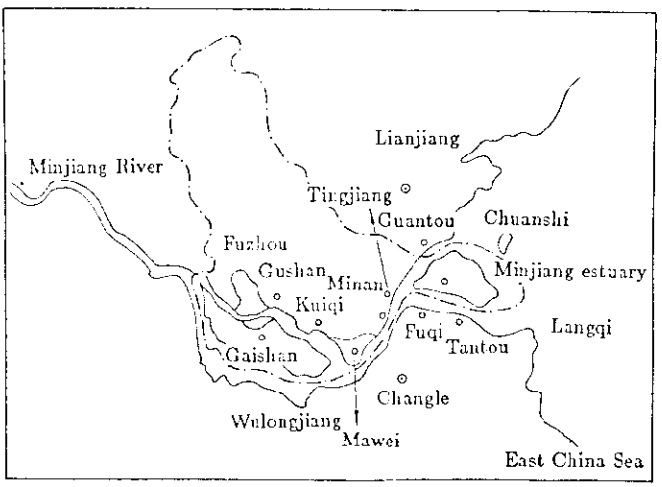

Fig. 1 Geographical location of Mawei region

The investigation of algae shows that there are 13 genera of diatom phylum, 4 genera of green alga phylum, 4 genera of blue green alga phylum, 2 genera of cryptomonad phylum, 1 genus of each of euglena and dimophyceae phylum.

Social situation

Mawei has become one of the foreign trade ports in southeast coastal area of China since ancient times and remains the only coastal port linking Fuzhou with other coastal cities in China. Mawei is connected to Fuzhou by railway, highway and waterway.

The economic development district has an existing area of 4.4 km^2 and a planning area of 11.6 km^2 with a population of 26000. It has a basically complete municipal infrastructure and public buildings. Service trade, culture and education, public health, physical culture and amusement are developing.

In general, following conditions are favorable for economic development: The richness in subtropical natural resources and the complete industrial system in Fuzhou area can give a support to economic development in Mawei region; among the residents in Mawei and Fuzhou districts, there are many relatives to overseas Chinese. This is favorable for attracting foreign investment; there is a certain industrial basis in Mawei region.

Environmental pollution

Water quality in the Mawei reach of Minjiang River is yet quite good. All pollutants, except COD, BOD_5, NH_3-N, oil and Cu, are in compliance with the national surface water standard in second grade. Thus the pollution of Minjiang River belongs to organic type. There is a great assimilation and dilution capacities for pollutants in Minjiang River due to its large river runoff.

Investigation of air pollution shows that the concentration of SO_2 and NO_x in air is 0.01—0.03mg/m^3 and 0.01—0.022 mg/m^3, respectively, and both are in compliance with the national air quality standard in first grade. The concentration of suspended particulates is 0.16—2.27 mg/L beyond the first standard.

The average contents of Ni, Cd, Pb, Zn and S in soil are within their background values.

MAJOR ECOLOGICAL AND ENVIRONMENTAL PROBLEMS

Relative fragility of the ecological and environmental systems

1. Limitation of land use

The region has only construction land of 4.4 km^2, which is a manmade flat, and a little cultivated area. The solum is thinner on the field of a hill. Artificially imposed disturbance and disruptions of vegetation cause top layer soil erosion. Thus, it is very difficult to renew the lost surface soil. Investigation shows that Minjiang River has an average sand content of 0.13 kg/m^3 in whole river and 0.2 kg/m^3 in Luoxingta section. The lack of land will be main restrictive element in economic development.

2. Natural conditions unfavourable to transport of pollutants

The Mawei District is situated at the left bank of Minjiang River, downstream to the Minan gorge and with its back to the hill and face to the river. The wide water surface and throat obstruction with Minan gorge lead to gentle water flow, so that the natural conditions are unfavorable to transport of pollutants. The results from calculation of flushing time show that the distance from Luoxingta to Minan is 1.48 times that from Minan to Fuqi while the flushing time of the former is 2.1 times the latter.

In terms of small scale, the greater wind velocity along the river is favourable for horizontal diffusion of air pollutants; but in terms of middle distance, the hills around the Mawei region make air pollutants transportation only to be restricted roundabout Mawei District that is unfavourable for transporting pollutants to a longer distance.

3. Lower ecological niche as compared with Fuzhou

The distance from Fuzhou to Mawei is 16 km only. The location of Mawei, on the one hand, furnishes favourable conditions for economic development, on the other hand, is lower ecological niche as compared with Fuzhou City because Mawei has relatively poorer conditions of culture, education, physical culture, health and life than Fuzhou. These will be unfavorable to attract talents and become one of major factors affecting development rate of economy. The reason for those who prefer to live in city is that there are a higher ecological niche, economic benefit and comfortable living conditions in city.

4. Instability of stratum texture

The stratum texture of Mawei district belongs to the coastal fault block difference rise area in the middle Fujian Province with the existence of fracture zone. Thus, in order to avoid major losses, it is important to find out geographic tectonic environment of the region, pattern of tectonic fracture and existing action stratum in the construction area.

5. Ecological economy to be restricted

The unreasonable structure of industry not only wastes funds for production, increases production cost, adds transport load, but also makes economic benefit to be lower, adds environmental pollution and suffers social losses.

Among three conditions (i.e., richness in natural resources, convenient transport facilities and intensive technique and intelligence) for the development of the economic district, natural resources in Mawei District are relatively inadequate and must be input from other parts of the country. It is required that production structure of the district should fit its natural resources conditions.

Potential pollution problems

The environmental quality of Mawei District, in general, is still good at present. All pollutant indices can be in compliance with the second grade of national standard of air and surface water, except few indices in few places. The plant and soil are not polluted significantly. Potential environmental pollution problems, however, are unnegligible during the development of economy in the district. They are as follows:

1. The air quality of residential area may be degraded in the future

The location of planned residential area is in the north fields on a hill. There has been a poor boundary diffusibility and a less speed of ground wind as well as greater influence of temperature inversion. All these make air pollutants in residential area difficult to be diffused and make pollutants, especially SO_2, to be accumulated near ground. In the region has a coal of sulfur content of 1%, a great importance should be attached to the harm of SO_2 to residents.

Luoxingta and old Mawei town are situated to the leeward of industrial district of economic developing area. The air quality will be at risk of degradation in the future along with increase

of economic construction scale and fuel coal.

2. Oil pollution in Minjiang River is prominent

At present, oil, COD and BOD_5 have been beyond the national surface water standard in the second grade, especially, annual rate of oil levels has been beyond the standard being at 47%. The major reasons for beyond the standard of oil are leakage of oil due to incomplete combustion in engine of boats and oil discharged from Fuzhou City. The boat flux per day is 5 boats over 1000 ton and 500-600 boats below 1000 ton in Mawei reach.

The boat flux should be increased greatly as the new port will be completed and operated in the future. Thus, oil pollution will become one of the major potential environmental problems in the reach.

3. Toxic organic pollutants in Minjiang River

As a generally acknowledged carcinogen in the world, 3, 4-benzopyrene has been found out to be 0.0076μg/L in the Minjiang River. The level of 3,4-benzopyrene has not yet been beyond the standard for drinking water, but trends to be further increased with the increase of combustion of coal and diesel.

An attention should be paid to that the artificial organic pollutants, such as benzothiazole, dimethyl phthalate, dibutyl phthalate, alkane and so on, have been found in the upper reaches of Minjiang River. These pollutants are from combustion of coal, plastics and leakage of oil. The organic pollutants from nonpoint sources will become potential water pollution problems in Minjiang River with the development of industries, especially, the township enterprises, and affect the development and utilization of drinking water resources in the Mawei District.

ECOLOGICAL AND ENVIRONMENTAL PLANNING AND STRATEGY

Ecological and environmental indicators system

Natural environmental indicators: geographical landscape features, topography climate, patterns of land-use, type of vegetation.

Natural resources indicators: land, water, light and heat, aquatic product, plant and animal resources.

Economic indicators: industrial structure of intensive intelligence and technology with high benefit and low pollution, abroad-orientational economy.

Environmental pollution indicators: parameter of environmental pollution, items of environmental quality, environmental capacity and strategic measures.

Environmental capacity of carrying pollutants

In accordance with requirements for environmental planning, the atmosphere and water environmental capacity of carrying pollutants are considered in this study.

1. The atmosphere environmental capacity of carrying air pollutants

In order to compute the atmosphere environmental capacity of carrying SO_2 and NO_x, a three dimensional atmosphere diffusion model was made which is suitable for hills. SF_6 was used as a tracer in the diffusion experiment.

The results from calculation of experimental data indicate that under existing condition of pollution sources, there is still a 70—80% surplus capacity for carrying SO_2 and NO_x available in Mawei region, except the place near to the Fishery Company. If the pollution sources out of Mawei region are taken into account, then the surplus carrying capacity in this region would be less than 70—80%.

2. Water environmental capacity of carrying pollutants

The water environmental capacity of carrying pollutants is a supportability of water environment to pollutants. It is not only dependent on water environmental natural attributes such as water quality, temperature, geographical features and topography of a place, but also properties of pollutants.

In order to compute water environmental carrying capacity for BOD_5 and NH_3-N, the two dimensional water quality mathematical model was made. The Rhodamine-B was used as a tracer for dispersion experiment. The results show the volume of pollutants (capacity) that Mawei reach of Minjiang River can yet admit is 7.0 ton/d for BOD_5 and 0.86 ton/d for NH_3-N, respectively, in the future, based on the existing pollution sources at 715 m^3/s of volume flow.

Ecological and environmental planning

On the basis of the principles of ecological and environmental planning and the actual situation of the region, the methods of combination of systematical dynamics with ecological register was used. Mawei and its adjacent area can be divided into six functional sections: industrial section; public construction section; residential (res.) and business (bus.) section; recreation (rec.) and tourist (tour.) spot; natural protected area, and water quality-fishery protected section (Fig. 2). They are described as follows:

1. Industrial section

This section includes the areas used by the old local industries, wharf, warehouse and industrial area for new development district, and ranges in order along Minjiang River and has good transport capacity.

In order to meet requirements of ecological and environmental quality of each functional section, the high benefit and less pollution industries such as optical processing, precision machine manufacture, electrical equipment manufacture, food processing and packing are suitable in this section.

2. Public construction section

This section is used for public construction in the region.

3. Residential and business section

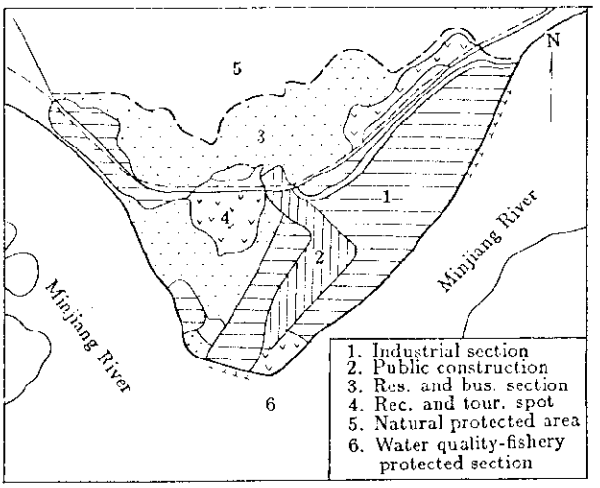

Fig. 2 Ecological and environmental planning diagram

The residential and business sections consist of such small sections as Majiang, Wanglong and Zhonghu hill and residential sections along river bank. Features of this section are populous and hilly so that the air pollutants in this section are difficult to be diffused. Thus, fuel structure and way of heat supply must be changed to improve atmosphere environmental quality, which must be in compliance with the second grade of the national standard.

The service netpoints are arranged in the form of radiation to the small sections of Majiang, Wanglong and Zhonghu hill respectively. Small scenic spots are scattered in harmonization with natural landscapes to provide residents with places for physical exercises and rest.

4. Recreation and tourist spots

The recreation and tourist spots are composed of Tianma Park, Maxian Hill Park, and the ancient buildings and trees must be protected to make tourist industry become one of important economic pillars of Mawei District.

5. Natural protected area

This section includes hills above 200m of isoline in Mawei region, Qinzhi hill and green forest zone near Zhonghu road. The significance of natural protected area set up here lines in regulating whole ecosystem and environment of the region, improving microclimate, controlling soil erosion, purifying air of the city, providing residents with fine outskirts scene and protecting wild animal and plant resources.

In the zone of 500—700 m of isoline, the way of closing hillsides to facilitate afforestation should be taken. In the zone it is unsuitable to cultivate, the reasonal deploughing should be practiced, the reclamation and cultivation on steep hillsides must be strictly forbidden.

6. Water quality—fishery protected section

Drinking water resource protected area is a reach from Kuiqi to Fishery Company. It is forbidden that industries discharged heavy pollutants are built and rubish is dumped into river in the area. This reach is not only the sole way through which eel and river crab migrate, but also has species and numbers of fish are more than other reach of Minjiang River. At present, fishery resource in Minjiang River is decreasing day by day, it is necessary to build fishery resource protected area in this reach. The water quality must be in compliance with the second grade standard here. For this reason, it must be to control discharge of heavy metals, to forbid using fishing tools which are destructive to fishery resource, and to strengthen fishery management.

Ecological and environmental strategy

The strategic goal of Mawei Economic-Technical Development District will be developed to become an abroad-orientational industrial region with distinctive local features, intensive technology and science research, light-duty and less pollution. It must also become the center for importing and distributing advanced technology, exporting and earning foreign exchange for Fuzhou City. The abroad-orientational industrial pattern and favourable natural environment make this region a compound and multifunctional ecological system which includes enterprises with three kinds of investment, port trade, residential commerce, tourist recreation, natural protection and so on.

Take into account of Mawei region in a monotonous ecological environment, natural ecological system in a simple structure, fragile function and limitation of environmental capacity of carrying pollutants, the economic development of the region should not mainly depend on expanding production scale, increasing input of raw material and output of products, but rather developing products with high technology and raising industrial output value and ability to export and earn foreign exchange. In order to raise funds and attract foreign investment, the industries with high benefit, short-cycle, exporting and earning foreign exchange must be developed in the near future, but consider interests of protecting ecological environment, the industrial structure must be revised by means of technical reform and transform of products to advance towards the goal of high technology, high output value and less pollution after a period of economic development. Establishment of environmental protection monitoring stations at Mawei region is one of the important management measures. In order to compare the change of environmental quality of Mawei in the feature, it is necessary to establish the Mawei environmental data base.

For improvement of air environmental quality, alternation of energy source structure, emission through high chimney, and central heating are necessary. Raise of afforestation level is also an important measure for improving air environmental quality.

For improvement of water environmental quality, establishment of water resources protection region, building of municipal and industrial wastewater treatment plant is primary methods for preventing water pollution in Mawei and Fuzhou.